



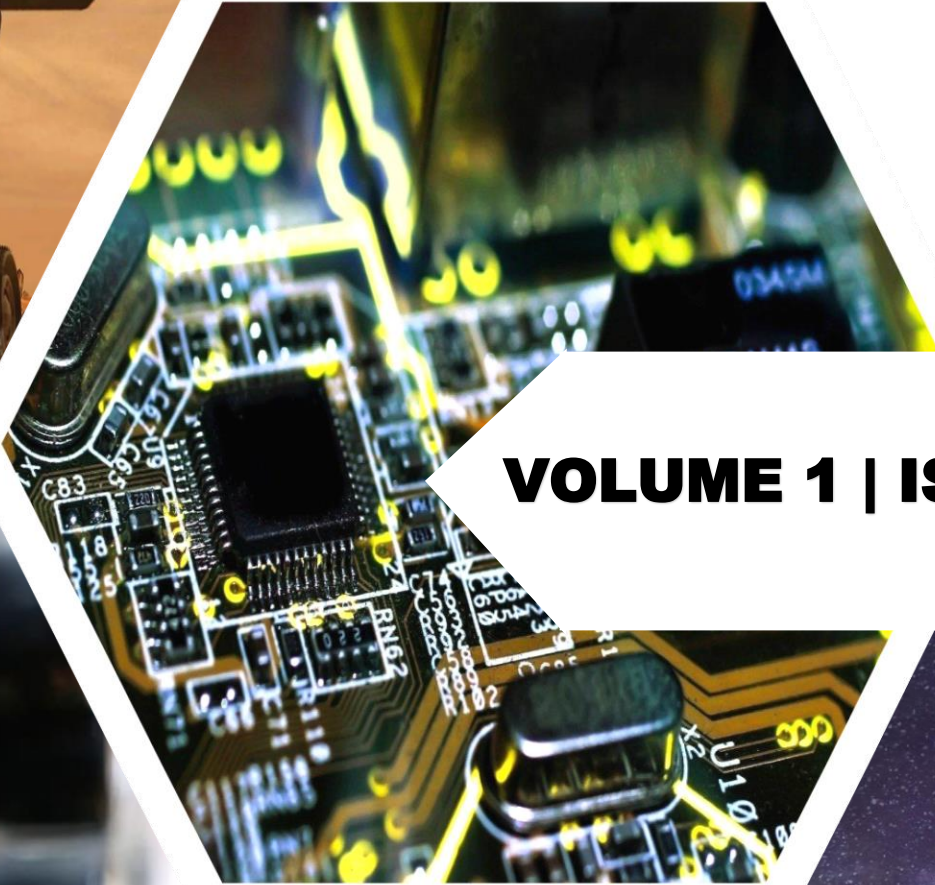
# Geethanjali



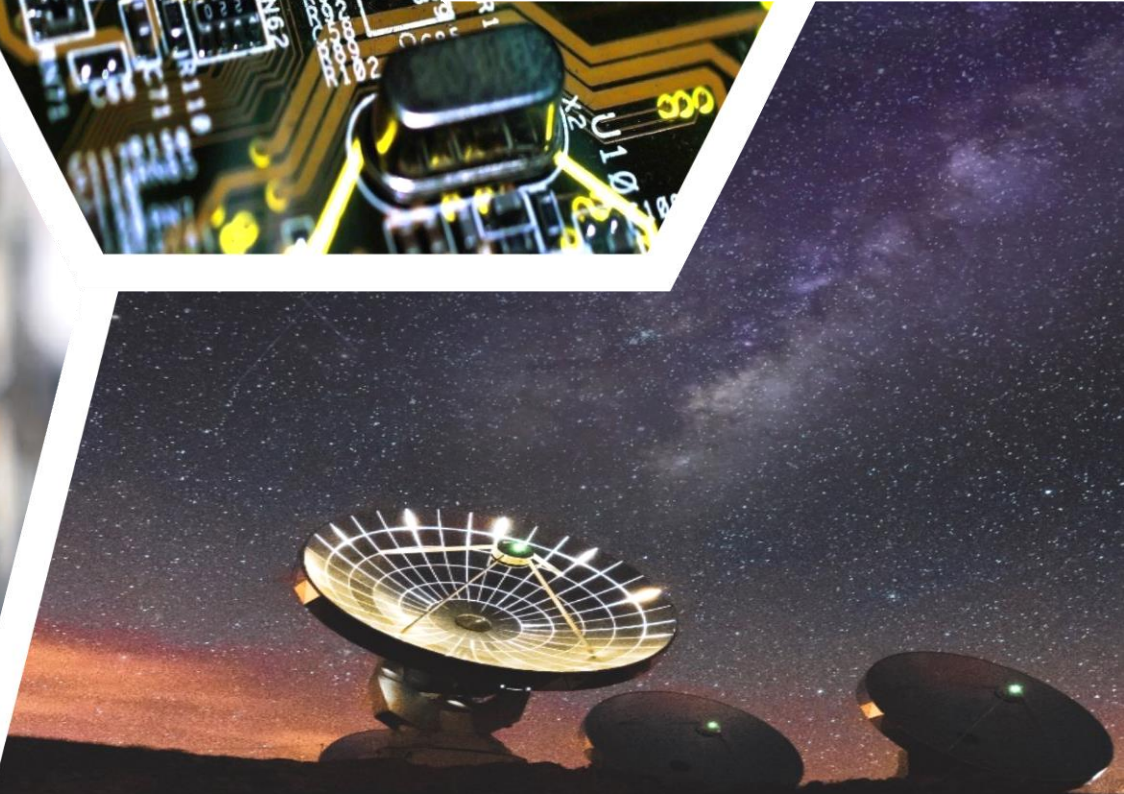
College of Engineering and Technology

## TECHNOCHRONICLE

An ECE magazine



**VOLUME 1 | ISSUE 01**



**techno\_chronicle**



**technochronicle.magz@gmail.com**

## **FOREWORD**

*-From the desk of the Chairman*



I heartily congratulate the department of ELECTRONICS & COMMUNICATION ENGINEERING for releasing 'Techno-Chronicle', a Technical Magazine of ECE Department.

I strongly believe that these magazines should serve a purpose.

If a student or teacher is looking forward for the release of the next issue, then the litmus test is through. For that, the magazine should contain publications, which are of generic interest too, in addition to the technical content of course. It could be latest Development / Innovation in the field of Electronics & Communication which when presented in a simple and lucid manner will interest the students. The practical applications and implication of latest research outcomes must be communicated in an interesting way, which will attract their attention. The write-ups should not be too technical with jargon that is not understood and appreciated by the students.

Achievements of the students of the college will give them a moral boosting and give them a confidence that they too are capable of doing them. Additionally some entertaining articles will also amuse the readers.

I wish this magazine the best of luck in this Endeavour.

**CHAIRMAN**

**Shri. G.R. Ravinder Reddy**

## PRINCIPAL'S MESSAGE

I am greatly delighted to write this message for our ECE department's Techno Chronicle magazine, which is the first technical magazine from the department. It is indeed heartening to note that students and faculty of the department have taken tremendous interest in writing various articles for the magazine and I am sure the readers would find them interesting. I appreciate the tenacity of the department, which has obviously resulted in the successful release of the magazine.

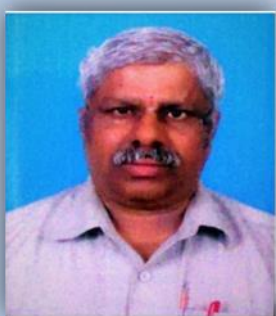


I am confident that this untiring effort of the department would motivate other departments too, to publish their respective technical magazines. I further, wish the department of ECE would sustain this momentum and continue with many other technical activities.

**PRINCIPAL**

**Dr. Udaya Kumar Susarla**

## MESSAGE FROM THE HoD



I am happy to announce the release of the first issue of ECE technical magazine, **Techno Chronicle**. The motto of this magazine is to encourage students, staff and faculty members to collect the latest information about research and developments in the areas of engineering, technology, administration, economy, quality assessment and quality assurance, pedagogical requirements etc., in the present scenario of rapidly changing world. This would improve the awareness among the stakeholders about the latest trends in the socio-economic scenario and pave a path for fulfilling the dreams of budding engineers.

I congratulate the editorial board and other team members for making this issue successful and valuable.

**Dr. S. Suryanarayana, ME, Ph.D.**  
**HoD- ECE Dept**



## **MESSAGE FROM THE DEAN**

It is often said “Give me a copy of your college magazine, I will tell you about the quality of your college”. I strongly believe in this statement. For a magazine carries the contributions; reflecting ethos and as aspirations of the students, faculty and other team members of an institution.

I am quite pleased to release the maiden issue of our department technical magazine **Techno Chronicle** that harnesses the creative energies of the academic community, and distils the essence of their inspired imagination in the most brilliant way possible.



Nurturing creativity and inspiring innovation are two of the key rudiments of a successful education, and a technical magazine is the perfect amalgamation of these two factors. No doubt this creative endeavor will bring out an array of artistic and scientific expressions with distinct individual signatures. They amply demonstrate the communication skills, poetic prowess, imagination and creativity, humour and humanism, technical competence, and patriotism of the contributors. I do appreciate and applaud the editorial team for their successful completion of this tedious yet daunting task of putting together the myriad thoughts and dreams of our students and faculty into a meaningful and delightful visual fest.

May all our students soar high in uncharted skies and bring glory to the world and their profession with the wings of education!

**Prof. B. Hari Kumar**

**Dean – SE & CE**

## **FOR THE STUDENTS**

*Hello Geethanjalites!*

Thank you for taking time out of your schedules to read this magazine. It means a lot to us.

Writing is one of the most powerful tools known to humankind and we wish that this magazine would help students learn, practice and develop the art of discussion through the means of writing.

It gives us immense pleasure to announce the publishing of this magazine. We hope it will offer an effective learning experience and deem itself a dear resource to all the students and teachers who read it.

Firstly, we thank the Chairman, Principal and HOD for giving this magazine and us a chance. We also thank our advisory board, especially Prof. S. Bhujanga Rao Sir for his guidance and valuable inputs that helped us improve our content.

Lastly, we would like to thank our committee members wholeheartedly for their steadfast dedication and belief that led to the successful publishing of this magazine. This would have been impossible without you.

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## EDITORIAL



The in-house technical magazine, **TECHNO CHRONICLE**, of our ECE department has become a reality in November 2020, despite disturbances caused by COVID-19. Surely, it is a moment of joy. I congratulate all the students who worked extra hours, in spite of their busy academic schedule and those who contributed articles that enriched the magazine.

We all have an onerous responsibility to promote and enrich our ECE Magazine. There are about 25 articles received for publication in this first edition of **TECHNO CHRONICLE**. Pleasantly, half of them are from students and the rest from faculty. After editing, 19 articles are printed. A large variety of topics related to ECE technologies- Electronics and Communications, and job applications are covered. Thus, these articles are expected to elicit good response from readers.

Electronics and Communications Engineering technologies have been growing into almost every facet of human life - education, health, automation, entertainment, security, defense, forecasting, and so on.

I trust the magazine, with these informative articles, will provide useful and interesting information to the readers and also promote advanced learning and motivation to publish articles in successive editions of Techno chronicle and reputed journals.

In conclusion, I quote a saying of Dr. A.P.J Abdul Kalam, "If four things are followed- having a great aim, acquiring knowledge, hard work and perseverance, then anything can be achieved."

I wish this magazine will serve its purpose fruitfully and reach the status of "much awaited periodical" in near future.

**S. Bhujanga Rao**  
**Professor-ECE Dept**

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# COMPLEX ENVELOPE-A STUDY OF ITS APPLICATIONS IN COMMUNICATION SIGNAL ANALYSIS

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**Abstract:** *Communication signals are generally modulated and modulated signals are mostly real and band-pass. Signals are analyzed to determine their characteristics such as bandwidth, noise content, power and so on. Analysis of real signals is more difficult than complex signals. The search for easier methods of signal analysis led to the introduction of the concept called 'analytic signal' in 1946 by D Gabor. 'Pre-envelope' in 1957 by R.Arens, 'complex envelope' in 1982 by S O Rice and several others. The complex envelope of band pass signal finds applications in communication engineering as well as signal processing. A brief discussion on it's origin and detailed discussion on its applications are presented in this paper.*

Keywords: Band-pass signal, Fourier spectrum, Hilbert Transform, analytic signal, pre-envelope, complex envelope, canonical representation, narrowband noise, bandpass sampling.

## I. INTRODUCTION

'Phasor' is a concept introduced to make electrical circuit analysis simple under sinusoidal steady state conditions. A real valued sinusoidal  $x(t) = A \cos 2\pi f_o t$  is considered to be the real part of a complex exponential  $x_+(t) = A e^{j2\pi f_o t}$ . Analysis of linear circuits is much simpler to perform using  $x_+(t)$  rather than  $x(t)$ . The complex function  $x_+(t)$  is a rotating phasor, whose amplitude A, frequency  $f_o$ , and phase are fixed. So the information contained in the phasor is negligible.  $x_+(t)$  is like a pure carrier that contains no information unless modulated. Modulation causes one of the above characteristics that is amplitude A or frequency  $f_o$ , or phase to change with time in accordance with the information bearing message. This information bearing phasor is termed as 'analytic signal' by D Gabor in 1946 and renamed as pre- envelope in 1957 by Arens. The concept of 'complex-envelope' was introduced later in 1982 by S O Rice to apply for the analysis of band pass signals as well as noise. Section II discusses several pre- requisites such as Hilbert transform, pre envelope and band pass signals, which are necessary to understand the concept 'complex-envelope'. In section III, we introduce the concept 'complex envelope' and discuss its applications in signal analysis and processing.

## II. PRE-REQUISITES FOR UNDERSTANDING COMPLEX ENVELOPE

Though applicable for all kinds of signals, the complex envelope is more useful in the analysis of bandpass signals. The pre- envelope of a band-pass signal is a concept necessary to define and understand the concept 'complex envelope'. These terms are defined and explained in section II.

**(A) BAND PASS SIGNAL**

A signal  $x(t)$  is called band-pass signal if its Fourier spectrum  $X(f)$  is negligible for all frequencies except for a band of frequencies, as shown in fig(1).

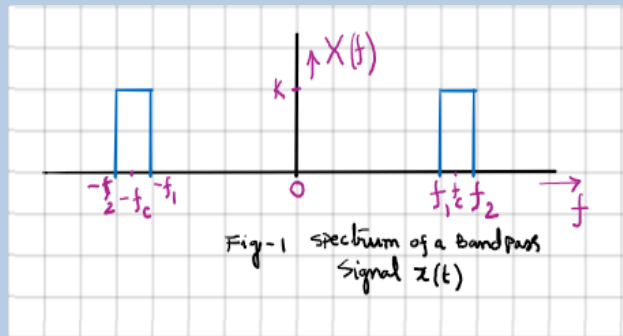


Fig (1). Spectrum of a Band-Pass Signal

The width of the positive band,  $f_2 - f_1$ , is called the bandwidth of  $x(t)$  and the centre frequency  $f_c$  is called the carrier frequency. If  $f_2 - f_1 \ll f_c$ , then  $x(t)$  is called narrow band signal. As an example, a low pass signal  $m(t)$  with band width  $W$  gets transformed into a band pass signal with band width  $2W$ , when we multiply  $m(t)$  by a pure sinusoidal signal  $c(t)$ , called carrier of the form  $\cos 2\pi f_c t$ . This process is called product modulation which results in a band pass signal,

$$s(t) = m(t)c(t) \tag{Eq(1)}$$

Another example of band-pass signal is the amplitude modulated signal with full carrier as given by equation (2).

$$s(t) = [1 + k_a m(t)]c(t) \tag{Eq(2)}$$

In fact, any modulated signal is a band-pass signal.

**(B) HILBERT TRANSFORM**

The Hilbert transform of a signal  $x(t)$  is denoted by the symbol  $\hat{x}(t)$  and it's defined by the time-domain convolution,

$$\hat{x}(t) = x(t) * \frac{1}{\pi t} \tag{Eq(3)}$$

Hilbert transform is clearly understandable in the frequency domain. By taking the Fourier transform of equation(3),  $F[\hat{x}(t)] = F\left[x(t) * \frac{1}{\pi t}\right]$

$$\hat{X}(f) = X(f)F\left[\frac{1}{\pi t}\right] \tag{Eq(4)}$$

But,  $F\left[\frac{1}{\pi t}\right] = -j \operatorname{sgn}(f) \tag{Eq(5)}$

$$\operatorname{sgn}(f) = \begin{cases} 1, & \text{for } f > 0 \\ 0, & \text{for } f = 0 \\ -1, & \text{for } f < 0 \end{cases} \tag{Eq(6)}$$



Therefore,

$$\hat{X}(f) = \begin{cases} -jX(f), & f > 0 \\ 0, & f = 0 \\ jX(f), & f < 0 \end{cases} \quad Eq(7)$$

Equation (7) clearly indicates that the magnitude spectra of the signal and its Hilbert transform are equal as

$$|X(f)| = |\hat{X}(f)| \quad Eq(8)$$

But the phase spectra are different because the phase of  $\hat{X}(f)$  is  $-90^\circ$  with respect to  $X(f)$ , for  $f > 0$  and  $+90^\circ$  with respect to  $X(f)$ , for  $f < 0$ . Thus Hilbert transform is a phase shifting transform. As an example, the signal  $x(t) = \cos 2\pi f_o t$  has the Hilbert transform  $\hat{x}(t) = \cos(2\pi f_o t - 90^\circ) = \sin 2\pi f_o t$  and the Hilbert transform of  $\sin 2\pi f_o t$  is  $\sin(2\pi f_o t - 90^\circ) = -\cos 2\pi f_o t$ . There are several other properties of Hilbert transform which are extremely useful in communication engineering. For example if  $s(t) = m(t)c(t)$  and the spectra of  $m(t)$  and  $c(t)$  are non-overlapping, then the Hilbert transform of  $s(t)$  is given by

$$\hat{s}(t) = m(t)\hat{c}(t) \quad Eq(9)$$

### (C) PRE-ENVELOPE or PRE-COMPLEX ENVELOPE

The pre-envelope of a signal  $x(t)$  is denoted by the symbol  $x_+(t)$  and is defined by equation (10)

$$x_+(t) = x(t) + j\hat{x}(t) \quad Eq(10)$$

Thus Pre-envelope is a complex expression with the signal itself as the real part  $x(t)$  and its Hilbert transform  $\hat{x}(t)$  as its imaginary part. The Significance of pre-envelope is better understood in the frequency domain. By taking Fourier transform of equation (10),

$$X_+(f) = X(f) + j\hat{X}(f) \quad Eq(11)$$

Using equation (7), we obtain the result

$$X_+(f) = \begin{cases} 2X(f), & f > 0 \\ X(f), & f = 0 \\ 0, & f < 0 \end{cases} \quad Eq(12)$$

Equation (12) shows that the spectrum of the pre-envelope of a signal contains only positive frequencies and the negative part of the spectrum vanishes. It should be noted that the total information of  $x(t)$  is there in  $x_+(t)$ . It may also be noted that we could have eliminated the positive part of the spectrum and kept only the negative spectrum by defining  $x_-(t) = x(t) - j\hat{x}(t)$ . However, as there are no negative frequencies in reality,  $x_+(t)$  is preferred to  $x_-(t)$ . The fact that Fourier transform possesses Hermitian symmetry, namely  $X(-f) = X^*(f)$  for a real signal  $x(t)$ , the information is

identical in positive and negative parts of the Fourier spectrum. The concept of pre-envelope of a real signal  $x(t)$ , helps in several mathematical manipulations necessary in the analysis of signals, analogue as well as digital. As an example, consider the real signal  $x(t) = A \cos 2\pi f_0 t$ . Its pre-envelope,  $x_+(t) = A \cos 2\pi f_0 t + j A \sin 2\pi f_0 t$ .

$$x_+(t) = A e^{j2\pi f_0 t} \quad \text{Eq (13)}$$

As a second example, let us consider a low pass signal  $m(t)$  whose spectrum is as in Figure (2a). The pre-envelope  $m_+(t)$  has the spectrum shown in Figure (2b).

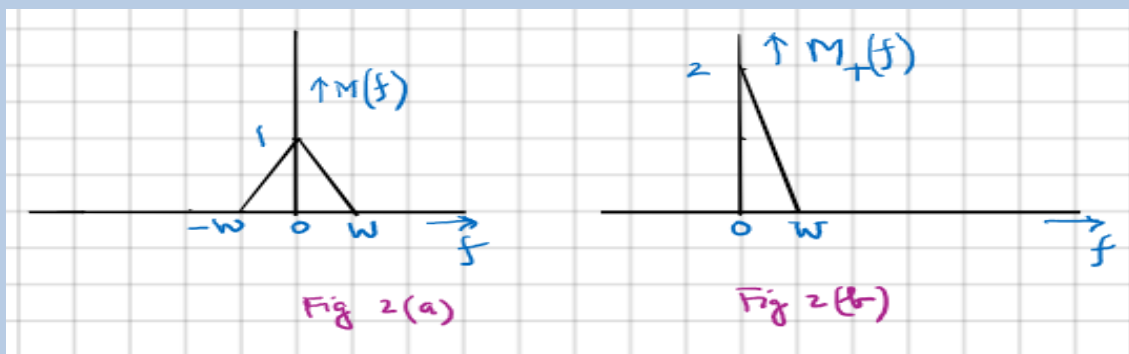


Figure 2: Spectra of a low-pass signal and its pre-envelope

As another example let us consider a real-valued band pass signal  $s(t)$  whose spectrum is as shown in Figure (3a). The spectrum of its pre-envelope  $s_+(t)$  is shown in Figure (3b).

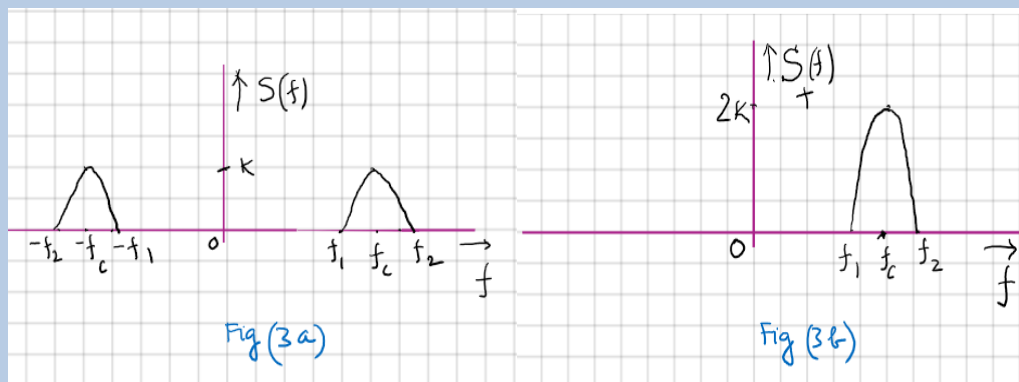


Figure 3: Spectra of a band-pass signal and its pre-envelope

As pre-envelope is a complex signal enveloping the actual real valued signal, the name pre-complex envelope is also used for pre-envelope some times. Now let us investigate a technique to shift the spectrum  $s_+(f)$ , so that the resulting spectrum would be a base-band spectrum. This technique is discussed in the next Section-III.

### III. COMPLEX ENVELOPE

Let  $x(t)$  be a real valued band pass signal whose Fourier spectrum  $X(f)$  is as shown in the Figure (4a).

The spectrum of its pre-envelope is shown in the Figure (4b).

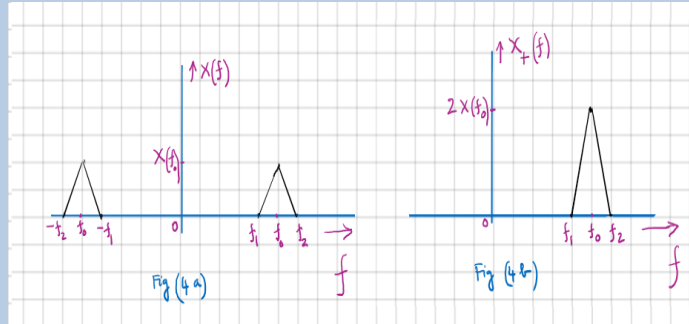


Figure 4: Fourier spectra of a band pass signal and its pre-envelope

In order to shift the positive spectrum  $X_+(f)$  of the pre-envelope  $x_+(t)$ , it is necessary to apply the frequency shifting property of Fourier transform. As  $F[x_+(t)] = X_+(f)$ ,  $F[x_+(t)e^{-j2\pi f_0 t}] = X_+(f + f_0)$ . Thus by multiplying  $x_+(t)$  by the exponential  $e^{-j2\pi f_0 t}$ , the spectrum  $X_+(f)$  gets shifted to the left side towards the y-axis ( $f=0$  axis) by  $f_0$  Hz, as shown in Figure (5).

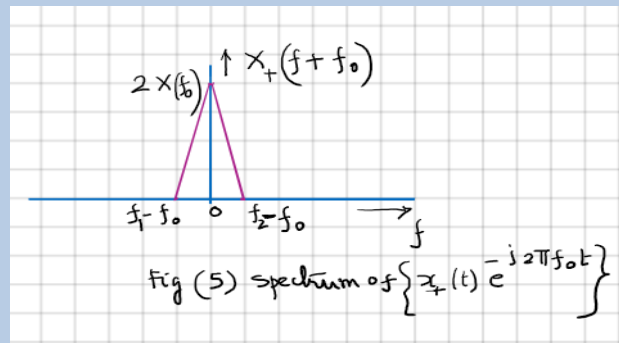


Figure 5: Frequency Shifted spectrum of Pre-envelope

**Def:** The Complex envelop of a real valued band pass signal  $x(t)$  is defined by the expression

$$\tilde{x}(t) = x_+(t)e^{-j2\pi f_0 t} \quad Eq(14)$$

Here  $f_0$  is called the center or carrier frequency and as we know  $x_+(t) = x(t) + j\hat{x}(t)$  is the pre-envelope of  $x(t)$ . If  $x(t)$  is a low pass or base band signal, then pre-envelope is same as its complex envelope as  $f_0$  will be zero for low-pass signals.

## IMPORTANT APPLICATIONS OF COMPLEX ENVELOPE

### Canonical Form of Representation of Band Pass Signals

The complex envelope of a band pass signal  $x(t)$  is a complex expression, because its pre-envelope  $x_+(t)$  is complex and by multiplication with a complex exponential function  $e^{-j2\pi f_0 t}$ , the complex nature will not change. So let us assume

$$\tilde{x}(t) \equiv x_c(t) + jx_s(t) \quad Eq(15)$$

Here  $x_c(t)$  is the real part and  $x_s(t)$  is the imaginary part of the complex envelope  $\tilde{x}(t)$

As  $\tilde{x}(t)$  is a low pass signal, though complex, the two components  $x_c(t)$  and  $x_s(t)$  are also low pass signals.  $x_c(t)$  is called the in-phase component and  $x_s(t)$  is called the quadrature component of  $\tilde{x}(t)$ .

$$\begin{aligned} \text{But } \tilde{x}(t) &= x_+(t)e^{-j2\pi f_0 t} = [x(t) + j\hat{x}(t)][\cos 2\pi f_0 t - j \sin 2\pi f_0 t] \\ &= \{x(t)\cos 2\pi f_0 t + \hat{x}(t)\sin 2\pi f_0 t\} + j\{x(t)\sin 2\pi f_0 t - \hat{x}(t)\cos 2\pi f_0 t\} \quad \text{Eq(16)} \end{aligned}$$

Comparing equation (16) with equation (15) ,

$$X_c(t) = x(t) \cos 2\pi f_0 t + \hat{x}(t) \sin 2\pi f_0 t \quad \text{Eq17(a)}$$

$$\text{and } X_s(t) = \hat{x}(t) \cos 2\pi f_0 t - x(t) \sin 2\pi f_0 t \quad \text{Eq17(b)}$$

$$\text{It may be verified from 17(a) and 17(b) that } x(t) = x_c(t)\cos 2\pi f_0 t - x_s(t)\sin 2\pi f_0 t \quad \text{Eq(18)}$$

This result is very significant because using this expression, any band pass signal or noise can be expressed in terms of two low pass components, in-phase and quadrature. Though not necessary the other result from equation 17(a) and 17(b) is  $\hat{x}(t) = x_s(t)\cos 2\pi f_0 t + x_c(t)\sin 2\pi f_0 t$ . As

complex envelope is complex in general, it is possible to represent  $\tilde{x}(t)$  in polar form as well.

$$\tilde{x}(t) = a(t) e^{j\phi(t)} \quad \text{Eq(19)}$$

$$\begin{aligned} x(t) &= \text{Real part of } [x_+(t)] = \text{Real part of } [\tilde{x}(t)e^{j2\pi f_0 t}] \\ &= \text{real}[a(t)e^{j[2\pi f_0 t + \phi(t)]}]x(t) = a(t)\cos[2\pi f_0 t + \phi(t)] \quad \text{Eq(20)} \end{aligned}$$

Here  $a(t)$  is known as the real envelop and  $\phi(t)$  is the phase of the band pass signal  $x(t)$ . The two entities  $a(t)$  and  $\phi(t)$  are also low pass signals like the in phase and quadrature components  $x_c(t)$  and  $x_s(t)$  respectively.

### Applications of complex envelope in the analysis of the communication signals

Equations (18) and (19) represent complex envelopes of band pass signal  $x(t)$ . The question now is how to extract  $x(t)$  from the complex envelope  $\tilde{x}(t) = x_c(t) + jx_s(t)$ ?

Equation (18) suggests an answer to this question

$$x(t) = x_c(t)\cos 2\pi f_c t - x_s(t)\sin 2\pi f_c t \quad \text{Eq(18)}$$

Multiplying both sides by  $\cos 2\pi f_c t$  and then passing the product through a low pass filter whose band width is just adequate to pass the low pass signals  $x_c(t)$  and  $x_s(t)$  we get the low pass components  $x_c(t)$  and  $x_s(t)$  as shown in figure (6).



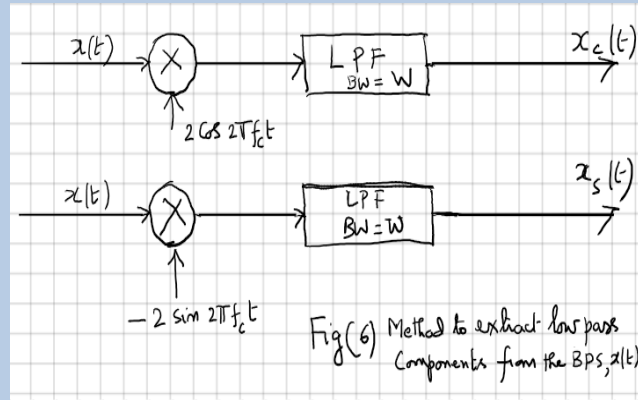


Figure 6: A practical method to produce In-phase and Quadrature components of a band-pass signal

If  $x(t)$  is a modulated signal, then the two components  $x_c(t)$  and  $x_s(t)$  *combinedly* provide the demodulated low-pass message signal. Figure (6) indicates that  $x(t)$  can be used to generate the components  $x_c(t)$  and  $x_s(t)$ . Equation (18) shows how  $x(t)$  can be reconstructed from the components  $x_c(t)$  and  $x_s(t)$  as shown in figure (7).

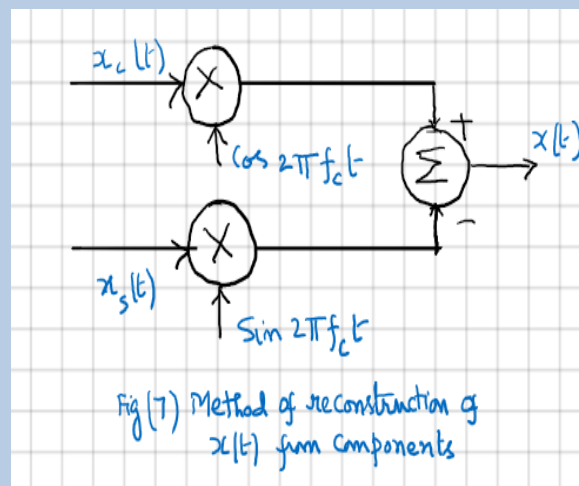


Figure 7: a practical method to obtain  $x(t)$

### Some practical applications of complex envelope in communication theory

1. **AM** signal is of the form  $s(t) = A_c [1 + k_a m(t)] \cos 2\pi f_c t$ . This is a band pass signal with band width  $2W$ , where  $W$  is the band width of  $m(t)$ , the message signal. By using the technique of figure (6) we can see that  $s_c(t)$  is the in-phase component  $= a_c(t)[1 + k_a m(t)]$  and  $s_s(t) = \text{quadrature component} = 0$ .

2. **DSB -SC** waves are given by  $s(t) = A_c m(t) \cos 2\pi f_c t$ .  $S(t)$  is also a band pass signal with suppressed carrier.  $s_c(t) = A_c m(t)$  and  $s_s(t) = 0$

3. **SSB-SC** Waves are given by  $S(t) = A_c m(t)/2 \cos 2\pi f_c t \pm A_c m(t)/2 \sin 2\pi f_c t$ . The negative sign represents that lower side band is suppressed and upper side band transmitted.  $s_c(t) = A_c m(t)/2$  and  $s_s(t) = \pm A_c m(t)/2$

4. **FM Signal** analysis is made simple by using complex envelope. A pure sinusoid  $c(t) = A_c \cos [2\pi f_c t + \phi(t)]$  is frequency modulated by a single tone modulation  $m(t) = A_m \cos 2\pi f_m t$  to generate an FM Signal.

$$S(t) = A_c \cos [2\pi f_c t + \beta \sin 2\pi f_m t]$$

Where the modulation index  $\beta \equiv \frac{k_f A_m}{f_m}$ . We cannot analyse the FM wave by simply using the

$\cos(A + B)$  Formula. Instead, we express  $s(t)$  as the real part of complex quantity

$$\begin{aligned} A_c e^{j(2\pi f_c t + \beta \sin 2\pi f_m t)} S(t) &= R_e \{A_c e^{j[2\pi f_c t + \beta \sin 2\pi f_m t]}\} = R_e \{A_c e^{j\beta \sin 2\pi f_m t} \cdot e^{j2\pi f_c t}\} \\ &= R_e \{\tilde{s}(t) e^{j2\pi f_c t}\} = R_e \{s_T(t)\} \end{aligned}$$

We now analyse the complex envelope  $\tilde{s}(t) = A_c e^{j\beta \sin 2\pi f_m t}$ , which is a periodic signal. Using the Fourier series we can show  $\tilde{s}(t) = \sum_{n=-\infty}^{\infty} A_n J_n(\beta) e^{j2\pi n f_m t}$ , where  $J_n(\beta)$  are the Bessel functions.

$$\begin{aligned} s(t) &= R_e \{\tilde{s}(t) e^{j2\pi f_c t}\} = R_e \left\{ \sum_{n=-\infty}^{\infty} A_n J_n(\beta) e^{j2\pi n f_m t} \right\} \\ &= A_c \sum_{n=-\infty}^{\infty} J_n(\beta) \cos \{2\pi (f_c + n f_m) t\} \end{aligned}$$

### 5. Application of complex envelope in LTI system analysis

Assuming an LTI system to be band-pass, its impulse response will be of the form

$$h(t) = x_c(t) \cos 2\pi f_c t - h_s(t) \sin 2\pi f_c t$$

This may also be expressed in polar form as,  $h(t) = R_e[\tilde{h}(t) e^{j2\pi f_c t}]$  if  $x(t)$ .

This is a band pass input signal of the form,  $x(t) = R_e[\tilde{x} e^{j2\pi f_c t}]$ .

The output of the system  $y(t)$  will then be given by.  $y(t) = R_e\{\tilde{y}(t) e^{j2\pi f_c t}\}$ .

As we know  $y(t) = h(t) * x(t)$  for any LTI system, it can be proved that  $\tilde{y}(t) = \tilde{h}(t) * \tilde{x}(t)$ .

### 6. Application of canonical form of band pass signals in band pass signals sampling

A signal  $x(t)$ , whose spectrum (Fourier transform) is limited only to  $f_c - w < |f| < f_c + w$ , is called a narrow band pass signal. Its band width  $W$  is much smaller compared to the carrier frequency  $f_c$ . As an example, consider the narrow band-pass AM signal with **1000 KHz** carrier and **10 KHz** band width. If we apply the Nyquist criterion for sampling this signal, the sampling frequency must be greater than or equal to **2020 KHz**.

It is proved that the required sampling frequency for band pass signal is much less than the so called the Nyquist frequency. Consider a band-pass signal  $x(t)$  expressed in canonical form as,  $x(t) = x_c(t)\cos 2\pi f_c t - x_s(t)\sin 2\pi f_c t$ . If  $2W$  is the band width of  $x(t)$ , then the band width of its low pass component signals is  $W$  each. So, the sampling frequency for each component signal is just greater than *or equal*  $2W$ . It can be proved that the in-phase component  $x_c(t)$  is completely represented by its samples taken at a rate of  $2W$  samples per second. Similarity, the quadrature component  $x_s(t)$  is also completely represented by its samples taken at a rate of  $2W$  samples per second. But these two sets of samples are to be taken at slightly different instants of time. By properly interleaving samples of  $x_c(t)$  and  $x_s(t)$ , and based on the relationship between the bandwidth of the signal  $x(t)$  and the highest frequency of  $x(t)$ , that is " $f_c + W$ ", the sampling frequency is found to be in the range  $4W \leq f_s \leq 8W$ .

### 7. Application of 'canonical form' in analysing noise performance of single side band communication receivers

In general, the modulated band pass signals are corrupted by white noise  $w(t)$  before reaching the demodulator. If  $s(t)$  is the signal, then the received signal would be *of the form*  $s(t) + w(t)$ .

This combined signal passes through a band pass filter effectively. Output of the band pass filter will be  $x(t) = s(t) + n(t)$  where  $n(t)$  is a narrow band noise hence the narrow band noise may be represented in canonical form as

$$n(t) = n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t.$$

It can be proved by using this expression that the **power spectral density** of each of these components is twice that of the power spectral density of the white noise  $w(t)$ .

$$\text{Power spectral density of } n_c(t) = S_{nc}(f)$$

$$\text{Power spectral density of } n_s(t) = S_{ns}(f)$$

$$\text{Power spectral density of } w(t) = S_w(f)$$

$$S_{nc}(f) = S_{ns}(f) = 2S_w(f)$$

This result is very useful in the derivation of signal to noise ratio (SNR) of single side band communication receivers.

## **EMPLOYABILITY SKILLS AND JOB OPPORTUNITIES: FACTS AND FIGURES**

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**Abstract:** *The job market in India is going to be more dynamic than ever. The Indian workforce is estimated to increase from the current 473 million to 600 million by 2022. The major forces impacting these shifts are globalization, expanding Indian domestic market and adoption of new technologies like AI, IoT and Robotics by Indian industries. The rapid advancements and growth in the areas of telecommunication, wireless communication, chip designing, embedded systems, IoT, image processing, robotics, bio-medical instrumentation, microwave and RF communications and many such other areas provide ample job opportunities for the graduating students of ECE to choose their career in the desired core area. Students with good coding skills in 'C', 'JAVA' and other programming languages find myriad number of job opportunities in IT sector as well. This paper provides an insight into the employable talent available in India and the job market in general for the graduating students and for ECE graduates in particular.*

### **I Job opportunities in India – in a broader perspective:**

With the entrepreneurship and gig economy picking up pace, there is entirely new system of eco system of jobs become available in future. With government's investments in highways, renewable energy, urban transport, shipping, affordable housing, smart cities, airports and industrial corridors etc., infrastructure has become one of the largest contributors towards jobs. The demand for skill has also changed. While today's software jobs need people trained to work on newer technologies, the demand for skills in sector like automotive and retail is also evolving in response to the impact of digital transformation.

### **New Age IT Skills:**

The focus of employability skills in the software industry has been on programming and understanding of algorithms for the last couple of decades. The work in IT is way more diverse now, spanning from web development (frontend and backend), and mobile app development to DevOps (development operations). More recently, a lot of work in companies has been linked to Artificial Intelligence: data engineering and data science (machine learning). More and more, companies now demand these skills and foundational understanding of these areas from incoming engineers to effectively deliver the wide variety of work in companies. Programming is slowly becoming an essential skill for all graduates of engineering in the present scenario.

### **Global Skill Comparison: India, the US and China**

Companies are becoming global today in more than one way. First, companies are not competing just in their local ecosystem but with companies across the world. Second, companies today have technology workforce not in a single nation, but across multiple nations. For instance, IT and ITeS companies in India have increased their workforce in the US. The US companies for a long time have had workforce in India. Chinese companies have increasingly opened offices in the Silicon Valley and made a strong bid to attract American talent. Companies thus would finally build their workforce where the right kind of talent is available and is cost-competitive. With the understanding that Indian talent will increasingly compete in the global talent market, a comparison of programming skills across India, the US and China is made and the details are provided in the Table 1 given below. All the companies considered are large IT services/product companies and hire entry-level engineers in the range of thousands to tens of thousands every year. This comparison is



based on the scores of candidates in AUTOMATA, a machine-learning based simulated test of programming skills [2]. Coming to ECE sector, use of electronic gadgets has spread to every field across the globe. Use of mobile phones, DTH receivers, Networking Routers, GPS for different applications, RFID tags, computers, ATMs, automatic washing machines, microwave ovens, and so many other applications indicate how electronic gadgets have deeply embedded into every sphere of our life. Growing convergence between hardware and software is something that makes electronics engineers having an edge over other engineering graduates. But students have to understand that at present the number of jobs available in IT sector are multifold compared to the core jobs in ECE. Summary of the detailed analysis made in the reports of India Skills Report/2019 prepared by Confederation of Indian Industry (CII) partnering with Wheebox [1], National Employability Report [2] and Hays Global Skills Index [3] are projected in subsequent sections.

**Table 1: Programming Skills Comparison across Countries**

<b>Programming Ability Levels</b>	<b>China</b>	<b>India</b>	<b>USA</b>
A4: write functionally and logically correct code	2.1%	4.7%	18.8%
A3: write functionally correct code with few anomalies	6.5%	5.2%	15.3%
A2: not able to write functionally correct code	81.0%	52.5%	61.8%
A1: not able to write compliable code	10.4%	37.7%	4.1%

## **II Employability and Hiring-Findings from Survey Reports:**

As per the India Skills Report/2019 prepared by Confederation of Indian Industry (CII) partnering with Wheebox and others, the availability of employability talent is increasing in our country at a constant rate each year; from 33.95% in the year 2014 to 47.38% in the year 2019. It is found that the B.E/ B.Tech graduates continue to dominate the rest as far as available employability talent is concerned. The table 2 given below provides more insight into this.

**Table 2. Percentage of Employability Talent – Domain wise**

	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
B.E/ B.Tech	51.74	54.00	52.58	50.69	51.52	57.09
MBA	41.02	43.99	44.56	42.28	39.40	36.44
B.Arts	19.10	29.82	27.11	35.66	37.39	29.30
B.Com	26.99	26.45	20.58	37.98	33.93	30.06
B.Sc	41.66	38.41	35.24	31.76	33.62	47.37
MCA	43.62	45.00	39.81	31.36	43.85	43.19
ITI	46.92	44.00	40.90	42.22	29.46	NA
Polytechnic	11.53	10.14	15.89	25.77	32.67	18.05
B.Pharma	54.65	56.00	40.62	42.30	47.78	36.29

As far as the employability skills are concerned, there is a steady increase in the percentage of employability talent in both men and women as the year's progress.

Gender	2014	2015	2016	2017	2018	2019
Men	30.30	34.26	36.01	40.12	46.87	47.39
Women	42.10	37.88	39.95	40.88	38.15	45.60

The other findings from the India Skills Report/ 2019 are summarized below:

Hiring intent by companies also is increasing steadily for the last three years as indicated in the table given below. This year there was an increase of 5% from 10% last year to 15% in 2019.

	2014	2015	2016	2017	2018	2019
<b>Percentage of Hiring</b>	2	23	14	7	10	15

### Percentage of Hiring – Domain wise

Overall hiring of graduated students of B.E/ B. Tech. is hovering around 23% during the last 2 years. It went up to almost 30% in 2015. Table 3 below provides the details.

**Table 3. Percentage of Hiring – Domain wise**

Domain	2014	2015	2016	2017	2018	2019
ITI	6	7	14	13	7	12
Polytechnic	8	4	7	11	4	7
PG or Equivalent MCA/M.Sc/MA/ M.Com/CA/ M.Tech	6	8	8	6	10	11
Management or Equivalent MBA/ PGDM	22	22	16	16	19	13
Graduates – Non Engineering BCA/ BBA/ B.Com/ B.Sc etc.	24	23	23	23	24	22
Engineering B.E/ B.Tech	28	29	25	25	22	23

Number of women working continues to be very low. Details of percentage of Men and Women working is provided below.

### III. Job opportunities for ECE graduates:

Employment opportunities for the graduated students of ECE can be mainly classified into three categories as mentioned below. The sub-categories under each of the three main categories, Potential recruiters and the major skills required for the placements are detailed below.

- a. Hardware jobs in core area
  - Design and Testing: of new products, components, TVs, mobiles etc.
  - Research: New product development, sophisticated control systems
  - Production: Manufacturing of Electronic Components, maintenance of electronics hardware etc.
- b. Software jobs in core area
  - Embedded Coding
  - Software Testing
  - Solution Architect: Design of logic and overall layout
- c. Software jobs in IT sector
  - Software Maintenance and Testing

- Software Development: Design engineer

#### IV. Potential Recruiters:

The table mentioned below provides the list of organizations/ industries that are major recruiters.

Public Sector	Private Sector	IT Sector
1. ISRO (Indian Space Research Organisation)	1. Intel Corporation.	1. Microsoft
2. ECIL (Electronics Corporation of India Limited)	2. Samsung Electronics.	2. TCS
3. BARC (Bhabha Atomic Research Center)	3. Texas Instruments.	3. Infosys
4. DRDO (Defense Research and Development Organisation).	4. Phillips Semiconductors.	4. HCL Technologies
5. DERL (Defense Electronics and Research Laboratory).	5. Hewlett Packard (HP).	5. Wipro Limited
6. BHEL (Bhart Heavy Electricals Limited).	6. International Business Machines Corporation (IBM).	6. Tech Mahindra Limited
7. HAL (Hindustan Aeronautics Limited).	7. Cisco Systems.	7. Amazon
8. Railway Departments	8. HCL Technologies.	8. Mphasis
9. BDL (Bharat Dynamics Limited).	9. Reliance Communications.	9. Mindtree Ltd.
	10. Samsung.	10. Oracle Financial Services Software Ltd.
	11. Bajaj Electronics	11. Cognizant
	12. Midas Communications.	12. Zensar Technologies
	13. Honeywell.	13. Capgemini
	14. Phillips.	14. DXC Technologies
	15. Bosch.	15. Virtusa
		16. Intel
		17. Hexaware Technologies
		18. Deloitte India

V.

#### Major Skills Required:

The job market is deeply competitive and the candidates appearing for the jobs are required to showcase their skills in a proper way right from their attire to being proactive at every stage of the recruitment process. Nearly 64% percent employers express their dissatisfaction with the current engineering graduates' skills in India. As per the preferences given by employers, candidates with better communication skills and those who are ready to learn and adapt to the changing business environment are preferred. Some of the important skills required are indicated below:

#### English Communication Skills

English communication is rated as the most important employability skill, and Engineering Graduates who meet the demand for English skills are the choice of most employers. Engineering students that perform well in spoken English have better chances of employment.

#### 1. Written Communication Skills

Most of the CVs received by employers have grammatical and spelling errors. Any CV which has a spelling error will be straight away rejected. Employers look for candidates who have good writing skills.

#### 2. Logical Reasoning, Analytical and Verbal Skills

The skills are required to get through the written tests. They can be acquired by practice on a regular basis.

### **3. Team Player**

Most companies view your capability on the basis of your team work abilities, and the very first intuition that you give off. They need someone who can work up to their expectations. Employers look for engineering graduates who can get on well with their colleagues in a team and generate a positive working environment.

### **4. Good Programming Solving Skills**

Programming skills are very essential especially if you desire to seek employment in an IT sector. Knowledge in 'C' and 'JAVA' languages has become very essential to get into software jobs.

### **5. Self-Motivation**

Employers always look for people who are self-motivated. They must demonstrate that they are committed and want to contribute to the success of the employer's business.

### **6. Organizational, Interpersonal and Leadership Skills**

There are many professionals who have rampant success in their life, because they have organizational and the time management skills to be successful in their life. Interpersonal skills and leadership skills are required for a successful career in your professional life.

## **VI. Conclusions and Recommendations:**

Students have to understand and realize that all the measures taken by the institution and the teachers become effective and produce the efficacious results only if the students have a strong desire to be successful in their lives and cooperate in every effort made by the institution/teachers in the pursuit of their academic success. They should take suggestions from the teachers, parents and senior students to find ways and means of realizing their academic goals. The following recommendations are made to strengthen the academic ambience that improves the placements.

- Conduct employability assessment tests in the first year of engineering study to bring awareness among the students regarding their strengths and weaknesses. Provide training programs from first year onwards to facilitate students to work upon their deficiencies.
- Focused mentoring shall be carried out by faculty members to bring holistic development in the mentee students. Parents should be made to involve in this process for its effective implementation.
- Pedagogy needs to be changed from teacher-centric to student-centric and more importance should be given for the outcome-based teaching rather than adopting the rote learning method. Teaching should be more on the lines of application based to inculcate interest among students.
- Bring innovations in teaching such as collaborative learning to create more interest among the students.
- Students should be encouraged to undergo training in emerging areas through value added courses.
- Encourage internship programs and push project-based learning.
- Questions which require higher level of cognitive thinking should be given as assignments.
- Encourage students in bringing out their innovation and creativity. Make them participate in HACKATHONS, Paper presentations and any other such technical events or academic activities.
- Curriculum should be changed as per the needs of the industry requirements.
- Special kind of training should be provided to improve the programming skills.
- Students should be made to participate in technical competitions to



- Apart from providing placement training, mock interviews shall be conducted to make the students get the real feel and experience of it.
- Create faculty development and continuous assessment programs.
- Build faculty capacity in cutting-edge skills

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## **LI-FI (LIGHT FIDELITY)**

Macharla Kalyani, 18R11A04H3, ECE, GCET.

***Abstract:** Li-Fi stands for Light Fidelity. This technology was introduced in 2011. Li-Fi is a wireless optical networking technology that uses light emitting diodes (LEDs) for transmission of data. The term Li-Fi refers to visible light communication (VLC) technology that uses light as medium to deliver high-speed communication in a manner similar to Wi-Fi and complies with the IEEE standard IEEE 802.15.7. The IEEE 802.15.7 is a high-speed, bidirectional and fully networked wireless communication technology based standard similar to Wi-Fi's IEEE 802.11. Wi-Fi is used for general wireless coverage within building, whereas Li-Fi is ideal for high density wireless data coverage in confined area and especially useful for applications in areas where radio interference issues are of concern, so the two technologies are complimentary. Li-Fi provides better bandwidth, efficiency, connectivity and security than Wi-Fi and has already achieved speeds larger than 1 Gbps under the laboratory conditions. By leveraging the low-cost nature of LEDs and lighting units, there are many opportunities to exploit this medium.*

### **I. INTRODUCTION**

Transfer of data from one place to another is one of the most important everyday activities. The current wireless networks that connect us to the internet are very slow when multiple devices are connected. As the number of devices that access the internet increases, it makes it more and more difficult to enjoy high data rates and connect to a fixed bandwidth secure network. These days, everyone uses their laptops or mobile phones to communicate with each other through Wireless-Fidelity (Wi-Fi) systems.

In addition, Wi-Fi technology is widely used in all public areas like cafes, hotels and airports. There is an exponential increase in this system, yet we have limited Radio Frequency (RF) resources, which is a severe problem. The idea of Li-Fi was introduced by a German physicist Harald Hass during a TED (Technology, Entertainment, Design) Global talk on Visible Light Communication (VLC) in July 2011. He referred to it as "Data through illumination". He used a table lamp with an LED bulb to transmit a video of a blooming flower that was then projected onto a screen. In simple terms, Li-Fi can be thought of as a light-based Wi-Fi i.e., instead of radio waves it uses light to transmit data. In place of Wi-Fi modems, Li-Fi would use transceivers fitted with LED lamps that could light a room as well as transmit and receive information. By adding new and unutilized bandwidth of visible light to the currently available radio waves for data transfer, Li-Fi can play a major role in relieving the heavy loads, which the current wireless system is facing. This offers an additional frequency band of the order of 400 THz compared to that available in RF communication, which is about 300 GHz. Also, as the Li-Fi uses the visible spectrum, it will help alleviate concerns about the medical effects of electromagnetic waves generated by Wi-Fi systems.

By Communication through visible light, Li-Fi technology has the possibility to change how we access the Internet, stream videos, receive emails and much more. Security would not be an issue, as data

cannot be accessed in the absence of light. As a result, it can be used in high security military areas where RF communication is prone to eavesdropping.



## II. ARCHITECTURE OF LI-FI SYSTEM

As a Visible Light Communication (VLC) technique, Li-Fi uses visible light of electromagnetic spectrum between 400 THz and 800 THz as optical carrier for data transmission and illumination. The main components of a basic Li-Fi system may contain the following:

1. A high brightness white LED which acts as transmission source.
2. A silicon photodiode with good response to visible light as the receiving element.

Communication rate more than 100 Mbps can be achieved by using high speed LEDs with the help of various multiplexing techniques. Moreover, this VLC data rate can be further increased to as high as 10 GBPS via parallel data transmission using an array of LED lights with each LED transmitting a different data stream

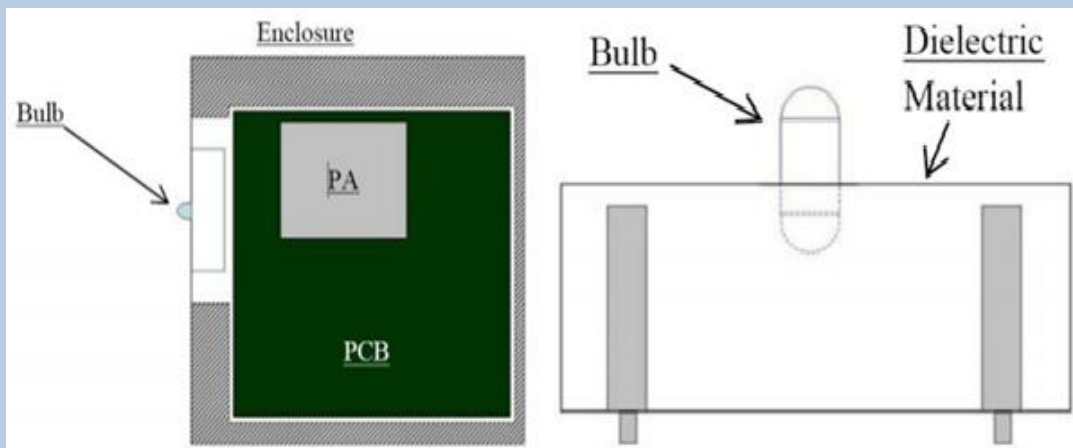
Switching the LEDs on and off can make them generate digital strings with different combination of 1s and 0s. To generate a new data stream, data can be encoded in the light by varying the flickering rate of the LED. In this way, the LEDs work as a sender by modulating the light with the data signal. The LED output appears constant to the human because they are made to flicker at a phenomenal speed (millions of times per second) and it is impossible for human eye to detect this frequency.

The Li-Fi transmitter system comprises of four primary sub-assemblies:

1. Bulb
2. RF Power Amplifier Circuit (PA)
3. Printed Circuit Board (PCB)
4. Enclosure

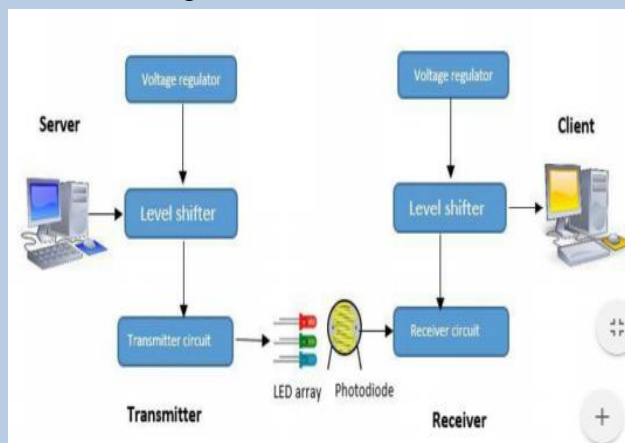
**Li-Fi Bulb sub-assembly:** The bulb sub-assembly is the main part of the Li-Fi emitter. It consists of a sealed bulb embedded in a dielectric material that serves two purposes:

1. It acts as a waveguide for the RF energy transmitted by the PA (Power Amplifier)
2. It acts as an electric field concentrator that focuses the energy into the bulb. The collected energy from the electric field rapidly heats the material in the bulb to a plasma state that emits light of high intensity of Visible light spectrum. There are various inherent advantages of this approach which includes high brightness, excellent color quality and high luminous efficacy of the emitter – in the range of 150 lumens per watt or greater.



Important factors that to be considered while designing Li-Fi are as follows:

- 1) Presence of Light
- 2) Line of Sight (Los)
- 3) For better performance use fluorescent light & LED



### III. WORKING OF LI-FI

The working of Li-Fi is very simple. There is a light emitter on one end i.e. an LED transmitter, and a photo detector (light sensor) on the other. The data input to the LED transmitter is encoded in to the light (technically referred to as Visible Light Communication) by varying the flickering rate at which the LEDs flicker 'on' and 'off' to generate different strings of 1s and 0s. The ON-OFF activity of the LED transmitter, which seems to be invisible enables data transmission in light form in accordance with the incoming binary codes: switching ON a LED is a logical '1', switching it OFF is a logical '0'.

**The LED intensity is modulated so rapidly that human eye cannot notice, so the light of the LED appears constant to humans.**

By varying the rate at which the LEDs flicker on and off, information can be encoded in the light to different combinations of 1s and 0s.

In a typical setup, the transmitter (LED) is connected to the data network (Internet through the modem) and the receiver (photo detector/light sensor) on the receiving end receives the data as light signal and decodes the information, which is then displayed on the device connected to the receiver. The receiver (photo detector) registers a binary '1' when the transmitter (LED) is ON and a binary '0' when the

transmitter (LED) is OFF. Thus, flashing the LED numerous times or using an array of LEDs (perhaps of a few different colours) will eventually provide data rates in the range of hundreds of Mbps.

Hence, all that is required is an array of LEDs and a controller that controls/ encodes data into those LEDs. All one has to do is to vary the rate at which the LEDs flicker depending upon the data input to LEDs. Further data rate enhancements can be made in this method, by using array of the LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency, with each frequency encoding a different data channel.

#### IV.APPLICATIONS OF LI-FI

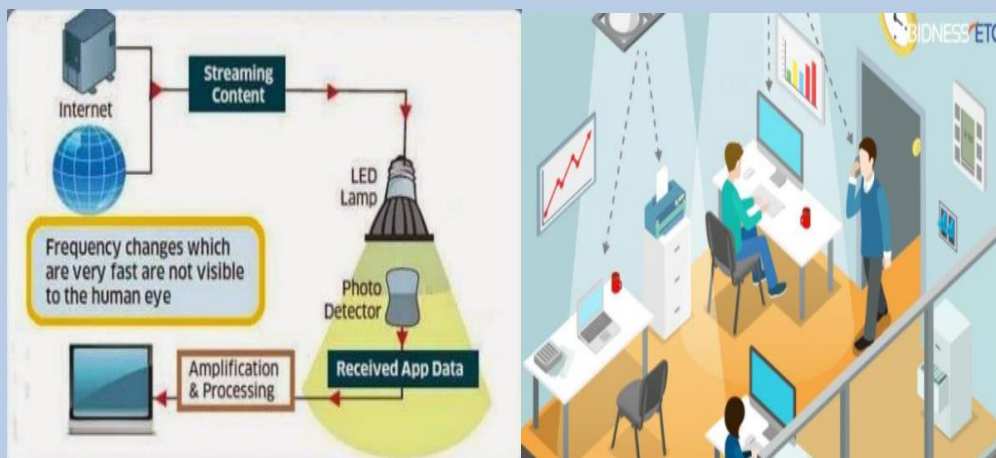
Future applications of Li-Fi could be as follows:

- a) Education systems
- b) Medical Applications
- c) Cheaper Internet in Aircrafts
- d) Underwater applications
- e) Disaster management
- f) Applications in sensitive areas
- g) Traffic management
- h) Mobile Connectivity
- i) Replacement for other technologies.

#### V.LIMITATIONS OF LI-FI

Some of the major limitations of Li-Fi are:

- Internet cannot be accessed without a light source. This could limit the locations and situations in which Li-Fi could be used
- It requires a near or perfect line-of-sight to transmit data
- Opaque obstacles on pathways can affect data transmission
- Natural light, sunlight, and normal electric light can affect the data transmission speed
- Light waves do not penetrate through walls and so Li-Fi has a much shorter range than Wi-Fi
- High initial installation cost, if used to set up a full-fledged data network
- Yet to be developed for mass scale adoption



## **VI. FUTURE SCOPE**

As light is everywhere and free to use, there is a great scope for the use and evolution of Li-Fi technology. If this technology becomes mature, each Li-Fi bulb can be used to transmit wireless data. As the Li-Fi technology becomes popular, it will lead to a cleaner, greener, safer communications and have a bright future and environment. The concept of Li-Fi is deriving many people as it is free (require no license) and faster means of data transfer. If it evolves faster, people will use this technology more and more.

Currently, LBS (location Based Service) or Broadcast solution is commercially available. The next step could be a Li-Fi WLAN for B2B market with high benefit on specific business cases and could grow towards mass market. In the long term, the Li-Fi could become an alternative solution to radio for wireless high data rate room connectivity and new adapted service, such as augmented or virtual reality.

## **VII. CONCLUSION**

The very concept of Li-Fi promises to solve issues such as, shortage of radio-frequency bandwidth and eliminates the disadvantages of Radio communication technologies. Li-Fi is an upcoming and growing technology. Thus; there is certainty of development of future applications of the Li-Fi, which can be extended to different platforms, and various walks of human life. Although there is still a long way to go to make this technology a commercial success, it promises a great potential in the field of wireless internet. A significant number of researchers 15 and companies are currently working on this concept, which promises to solve the problem of lack of radio spectrum, space and low internet connection speed.

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## EFFECTS OF COVID-19 ON THE ENVIRONMENT

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**Abstract:** *This research aims to show the positive and negative indirect effects of COVID-19 on the environment, particularly in the most affected countries such as China, USA, Italy, and Spain. Research shows that there is a significant association between contingency measures and improvement in air quality, clean beaches and environmental noise reduction. On the other hand, there are also negative secondary aspects such as the reduction in recycling and the increase in waste, further endangering the contamination of physical spaces (water and land), in addition to air. Global economic activity is expected to return in the coming months in most countries (even if slowly), so decreasing GHG concentrations during a short period is not a sustainable way to clean up our environment.*

**Keywords:** SARS-CoV2, COVID-19, Pandemic, Environmental impact, GHGs, Social distancing policies.

### I. INTRODUCTION

The new Corona virus (SARS-CoV2) has generated an unprecedented impact in most countries of the world. The virus has affected almost every country on the planet (213 in total), spread to more than 2 million people, and caused around 130,000 deaths ([WHO, 2020a](#)).

For this reason, the indirect impact of the virus on the environment has been analyzed. The first studies estimated a positive indirect impact on the environment. On the one hand, climate experts predict that greenhouse gas (GHG) emissions could drop to proportions never before seen since World War II ([Global Carbon Project, 2020](#)). This outcome is mainly due to the social distancing policies adopted by the governments following the appearance of the pandemic. This study aims to show the positive and negative indirect effects of the SARS-CoV2 corona virus on the environment. After analyzing each indirect effect, objective conclusions on the subject are presented.

### II. POSITIVE AND NEGATIVE INDIRECT EFFECTS ON COVID-19 ON THE ENVIRONMENT

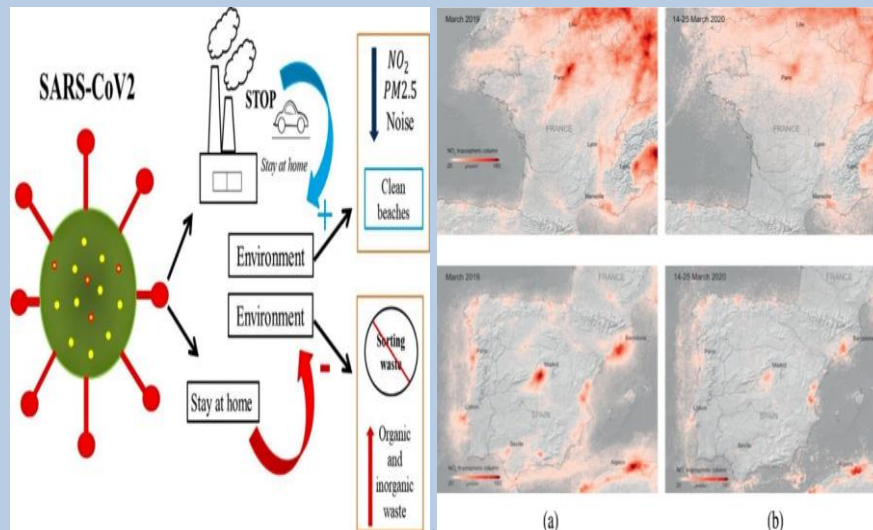
#### A. DECREASED CONCENTRATIONS OF NO<sub>2</sub> AND PM 2.5

Air quality is essential for people's health; however, 91% of the world population lives in places where poor air quality exceeds the permissible limits ([WHO, 2016](#)). The consequences of air quality degradation are manifested in a significant percentage of global mortality each year ([Zhang et al., 2017](#)). In this regard, the 2016 World Health Organization (WHO) report indicates that air pollution contributes to almost 8% of total deaths in the world; the most affected countries being those found in Africa, Asia and part of Europe ([WHO, 2016](#))

China implemented strict traffic restrictions and self-quarantine measures to control the expansion of SARS-CoV2. These actions generated changes in air pollution. Due to quarantine, NO<sub>2</sub> was reduced

by  $22.8 \mu\text{g}/\text{m}^3$  and  $12.9 \mu\text{g}/\text{m}^3$  in Wuhan and China, respectively. PM 2.5 fell by  $1.4 \mu\text{g}/\text{m}^3$  in Wuhan but decreased by  $18.9 \mu\text{g}/\text{m}^3$  in 367 cities.

On the other hand, the readings from the Copernicus Sentinel-5P satellite show a significant decrease in  $\text{NO}_2$  concentrations over Rome, Madrid, and Paris, the first cities in Europe to implement strict quarantine measures. The below figure shows average  $\text{NO}_2$  concentrations from 14 to 25 March 2020 (panel b), compared to the monthly average of concentrations from 2019 (panel-a)



Additionally, the Copernicus Atmosphere Monitoring Service (CAMS) of the European Union observed a drop of PM 2.5 last February in relation to the previous three years. According to [CAMS \(2020\)](#), a drop of approximately 20–30% of PM 2.5 is observed in large parts of China, when comparing the difference between the monthly average for February 2020 and the mean of the monthly averages for February 2017, 2018, and 2019.

### B. CLEAN BEACHES

Beaches are one of the most important natural capital assets found in coastal areas. The lack of tourists, as a result of the social distancing measures due to the new coronavirus pandemic, has caused a notable change in the appearance of many beaches in the world. For example, beaches like those of Acapulco (Mexico), Barcelona (Spain), or Salinas (Ecuador) now look cleaner and with clear waters.

### C. REDUCTION OF ENVIRONMENTAL NOISE LEVEL

Environmental noise is defined as an unwanted sound that could be generated by anthropogenic activities (for instance, industrial or commercial activities), the transit of engine vehicles, and melodies at high volume.

The imposition of quarantine measures by most governments has caused people to stay at home. With this, the use of private and public transportation has decreased significantly. In addition, commercial

activities have stopped almost entirely. All these changes have caused the noise level to drop considerably in most cities in the world.

#### *D. INCREASED WASTE*

A wide range of environmental issues, such as soil erosion, deforestation, air and water pollution indirectly accompany the generation of organic and inorganic waste. The quarantine policies, established in most countries, have led consumers to increase their demand for online shopping for home delivery. Consequently, organic waste generated by households has increased. Also, food purchased online is shipped packed, so inorganic waste has also increased.

Medical waste is also on the rise. Hospitals in Wuhan produced an average of 240 metric tons of medical waste per day during the outbreak, compared to their previous average of fewer than 50 tons. In other countries such as the USA, there has been an increase in garbage from personal protective equipment such as masks and gloves ([Calma, 2020](#)).

#### *E. REDUCTION IN WASTE RECYCLING*

Waste recycling has always been a major environmental problem of interest to all countries ([Liu et al., 2020](#)). Recycling is a common and effective way to prevent pollution, save energy, and conserve natural resources ([Varotto and Spagnoli, 2017](#); [Ma et al., 2019](#)). As a result of the pandemic, countries such as the USA have stopped recycling programs in some of their cities, as authorities have been concerned about the risk of COVID-19 spreading in recycling centers. In particularly affected European countries, waste management has been restricted. For example, Italy has prohibited infected residents from sorting their waste.

Also, the industry has seized the opportunity to repeal disposable bag bans, even though single-use plastic can still harbor viruses and bacteria.

#### *F. OTHER INDIRECT EFFECTS ON THE ENVIRONMENT*

China has asked wastewater treatment plants to strengthen their disinfection routines (mainly through increased use of chlorine) to prevent the new corona virus from spreading through the wastewater. However, there is no evidence on the survival of the SARS-CoV2 virus in drinking water or wastewater ([WHO, 2020b](#)). On the contrary, the excess of chlorine in the water could generate harmful effects on people's health ([Koivusalo and Vartiainen, 1997](#)).

### **III. CONCLUSION**

Finally, it is concluded that COVID-19 will produce both positive and negative indirect effects on the environment, but the latter will be greater. Decreasing GHG concentrations during a short period is not a sustainable way to clean up our environment. Furthermore, the virus crisis brings other

environmental problems that may last longer and maybe more challenging to manage if countries neglect the impact of the epidemic on the environment.

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## TOUCHLESS TOUCH SCREEN

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**Abstract:** Touch screen displays are found everywhere in the world. This display provides a greater flexibility to the user but after a few years, it becomes less sensitive, which causes a failure of touch response on the display. Solutions like screen protectors have been proven inefficient in long run. To avoid this problem a simple user interface for touch less control of electrically operated equipment is being developed. This paper presents a study of touch less display, its history and working. This study also focuses on overcoming the drawbacks of touch screen display by providing touch less display.

### I. INTRODUCTION

Touch less touch screen technology uses finger motions without physical contact. It simply requires a flick of the hand in one area or towards a certain direction. This eliminates the issue of unresponsive touch screens caused due to cracks. This system requires a sensor, which is neither hand mounted nor present on the screen but is instead placed either on the table or near the screen. The hardware setup is so compact that it fits into a device like a mobile phone or laptop screen. It recognizes the position of an object from five feet. Thus, a system or device can be operated without touching it - Touch less. It is also called as "Don't touch me" technology. This technology requires the user to simply draw a pattern using non-contact gestures. The pattern drawn is crosschecked with those already present in the database. Upon finding a match, the task is performed. Touch less display does not require any special sensors to be worn on fingers or hands. Merely pointing at the screen (from as far as 5 feet), is enough to operate an entire system.

Microsoft rebranded this technology as Pixel Sense and introduced its unrelated Surface tablet to consumers. The name "Pixel Sense" refers to the way this technology works: a touch-sensitive protection glass is placed on top of an infrared backlight. As it hits the glass, the light is reflected back to integrated sensors, which convert that light into an electrical signal. That signal is referred to as a "value," and those values create a picture of what is on the display. The picture is then analysed using image-processing techniques, which is then sent to the connected computer.



Figure1: (i) Original message pad (ii) Gesture Pad, and (iii) Alias Wave front's gesture-based Portfolio Wall



## II. WORKING

The device is based on optical pattern recognition using a solid-state optical matrix sensor with a lens to detect hand motions. This sensor is then connected to a digital image processor, which interprets the patterns of motion and outputs the results as signals to control fixtures, appliances, machinery, or any device controllable through electrical signals. The touch less display can detect the 3D motions without putting your fingers on the screen. Sensors are placed around the screen. First, the moving image comes like finger or hand in front of the sensor. The sensor detects the image after which light enters into the sensor and hits the pixel matrix. The pixel then converts incoming light into electric charges with the help of a photodiode, followed by a sensor, which generates electric signals. These electrical signals are processed to provide an output to the user.

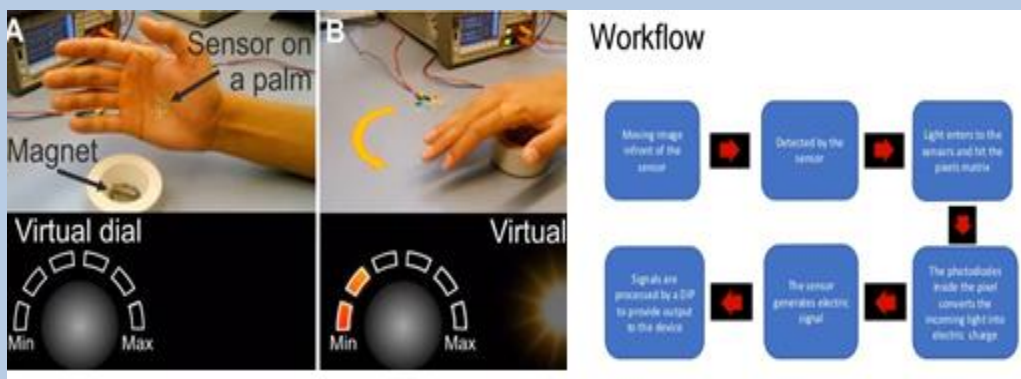


Figure 2: Smart Skin sensed-gestures and workflow.

## III. APPLICATIONS

Touch less monitor is designed for those times when using a mouse or touch may be difficult. Such as, doctors wearing surgical gloves. For instance, White Electronic Designs recently demonstrated a monitor made by TouchKo. Since its discovery, **Touch less Automation** technology garnered attention from a wide range of industries and markets. The first ones to notice were the Swiss Watchmakers, followed by others such as Semiconductor and Aerospace industries. Today, Touch less Automation is building a value proposition with an ability to target different industries with a common set of values. The **Touch less Automation Paradigma** is the first one of its kind; a machine that could easily fit in laboratories and production facilities of any industry.

## IV. DISADVANTAGES

1. People with limited arm/wrist may find it difficult to use this technology
2. Data entry may be slow.

## V. ADVANTAGES

1. Fast entry of texts into documents
2. A well-known method of data entry
3. Most people find it easy to use
4. Easy to perform verification test





**Figure3:** Touchless Monitor and applications.

## VI. CONCLUSION

This paper provides an overview of touch less touch screen technology. With the use of this technology, the user gets flexibility to use the system appropriately. The proposed touch less touch screen technology is suitable for android mobile phone, laptop, ATM machine etc. By using this technology maintenance work of touch screen display can reduce.

## **DIGITAL WATERMARKING: A POTENTIAL SOLUTION FOR MULTIMEDIA AUTHENTICATION**

Dr C V Narasimhulu, Professor, ECE. GCET

With the rapid development in digital techniques, internet usage has created a new set of challenging problems such as copyright protection, authentication and content integrity verification of the digital multimedia data (image, audio and video). Over the last few years, watermarking is extensively used as a potential solution to address these problems by embedding additional information (sequence/logo or any copyright information) called watermark into the digital multimedia content. This information later can be extracted from or detected in multimedia content to make an assertion about the data authenticity and copyright protection etc. Digital watermarks remain intact under transmission /transformation allowing us to protect ownership rights in digital form and are robust to several unintentional as well as deliberate attacks. Absence of watermark in a watermarked image would lead to the conclusion that the data content has been modified. A watermarking algorithm consists of watermark structure, an embedding algorithm and extraction or detection algorithm. Basically, there are three types of watermarks that can be embedded in an image/video such as Pseudo Random Gaussian Sequence (PRGS) watermark, binary logo watermark and gray scale or color image watermark.

Based on visual perception, image / video watermarking can be classified as visible or invisible. A visible watermarking typically contains a visual message or a company logo indicating the ownership of the image / video. An invisible watermarked image is visually very similar but not necessarily identical to the original unmarked image / video. The invisible watermark's presence can be determined only through a watermark extraction or detection algorithm.

The most important properties of any digital watermarking technique are robustness and imperceptibility. Each of these properties must be taken into consideration while applying certain digital watermarking technique. Based on embedded domain, there are two broad categories of watermarking techniques: spatial domain watermarking and transform domain watermarking. The first developments in digital image watermarking are in spatial domain. The main advantage of spatial domain watermarking is simplicity. The spatial domain schemes have low computational complexity and consequently need less computational time. Another advantage is the high capacity offered for the watermark during the embedding procedure. The disadvantage of spatial domain is that the watermark is vulnerable to attacks (low robustness). In transformed domain such as DWT, DCT etc, the image/video frame is transformed into discrete coefficients which are then modified to embed the watermark. Inverse transform is applied on the modified coefficients to get back the original image/video frame.

Embedding in transformed domain proves to be more robust against attacks such as JPEG compression, low pass filtering rotation and cropping etc. The robustness is maintained at the cost of imperceptibility in the transform domain. There are several applications of Digital Watermarking such as Broadcast Monitoring, Owner Identification, Transaction Tracking, Copy Control and DeviceControl.

# **THERMIONIC EMISSION MICROSCOPE: A TOOL TO STUDY EMISSION UNIFORMITY**

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## **I Introduction:**

An ideal cathode produces uniform electron emission across its surface, which means the work function has a single value. The work function can be defined, in simple terms, as a potential barrier at the surface, resulting in higher emission for a lower barrier height and *vice versa*. Thermionic cathodes produce emission when heat is supplied through a filament. The electron emission from a practical thermionic cathode is not uniform across its surface. The spatial emission distribution can be studied using Thermionic Emission Microscope (THEM). It comprises of sub-systems: (a) electrostatic lens to form electron beam, (b) deflection system to deflect electron beam in the form of raster scan to pickup emission image element-by-element (like in TV) and (c) Faraday cage to collect elemental currents. The cathode is a part of the lens as shown in the Fig.1. It is to be noted that an electrostatic lens or a magnetostatic lens is similar to the optical lens, which obeys diffraction, refraction and reflection laws. In order to obtain a clear image of emission from the cathode, the emission image is magnified first (typically to 10 to 50 times) by applying high voltage (typically  $-10$  kV to the cathode). The cathode is operated under saturated conditions; and, the image is formed when the electron beam lands on the phosphor screen. The basic difference between a **THEM** and a **SEM** is that in the former the object is the emitting area of cathode whose image is magnified through lens system; while, in the latter, the object is a specimen whose secondary emission image is observed.

## **II Operation:**

The emission picture of thermionic cathode surface can be seen on the oscilloscope (instead of directly on a phosphor screen) using Z-modulation. The elemental current data in both X and Y directions can be stored by controlling the deflection signals step-by-step through a computer. The ramp signals ( $-10$  to  $+10$  V) are generated either by electronic circuit or by a PC through a data acquisition system (DAS) card and are further amplified using a DC amplifier. The signal (output of Faraday cage) is amplified using a transconductance amplifier (or a picoammeter).

The operation of THEM is carried out under two modes, *viz* (1) Visual mode and (2) Data acquisition mode. The visual mode is necessary to focus the image by adjusting the spacings and the electrode voltages of lens. In this mode, the output of picoammeter is fed to Z-modulation port of oscilloscope. After optimization, we switch over to data acquisition mode in which the signal is fed to PC for storing the data to quantify the emission distribution.

## **III Design approach:**

The simulation is carried out in two stages using: (a) TRAK (2-D model), and (b) OmniTrak (3-D model) - both of which are suited for the study of charged particle optics. 2-D model is used for simulation of lens system and for obtaining electron trajectories; while, 3-D model is used to fix the deflection plates to find out the extent of image deflection. A plot of electron trajectories (after coming out of the lens) is shown in Fig. 2. The electrical circuit of THEM is shown in Fig.3

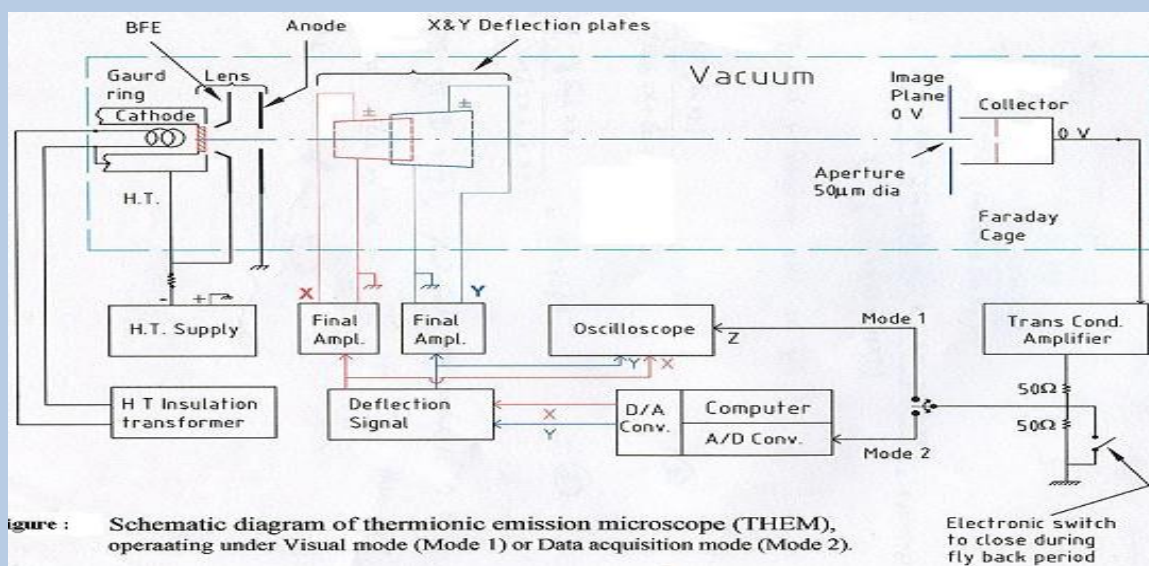
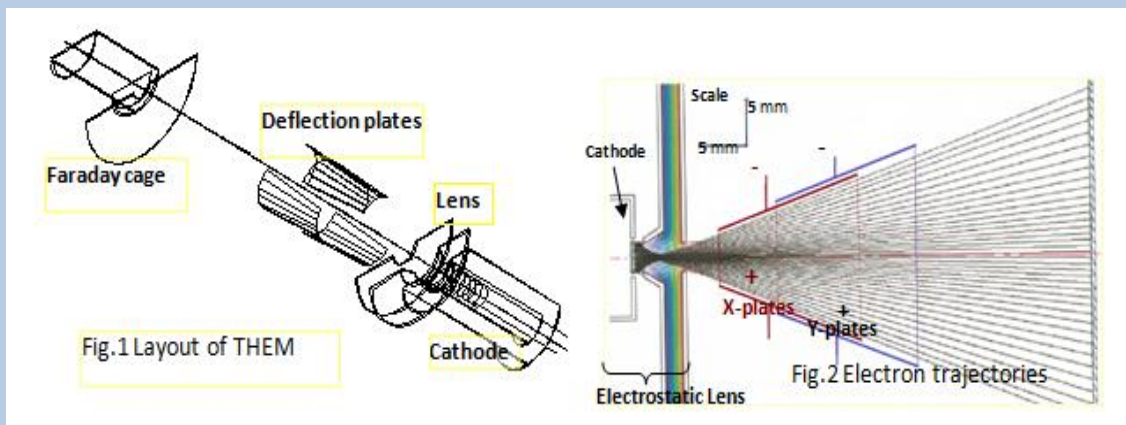


Fig.3 Electrical circuit of thermionic emission microscope (THEM)

One of the emission pictures as seen on oscilloscope (when operated under visual mode) together with corresponding emission picture and work function histogram (when operated under data acquisition mode) are shown Fig. 4.

The cathode emission image is formed on the image plane due to the electrostatic lens (in which cathode is part of the lens). The Z-modulated image is seen directly on the oscilloscope (Fig. 4(a)). A part of this image area, as indicated in white rectangular lines, is chosen for storing the data element-by-element. Using these elemental data, the emission map and the corresponding work function histogram are plotted as shown in Fig. 4(b) and Fig. 4(c), respectively. A correlation can be seen between the oscillogram and the emission map. In order to obtain the histogram, the emission values are converted into corresponding work function values using Richardson-Dushman equation:  $J = A_0 e^{-e\phi/kT}$

where  $J$  is current density,  $A_0$  is constant,  $e\phi$  is work function in electron volts,  $k$  is Boltzmann's constant and  $T$  is temperature of cathode surface in Kelvin.

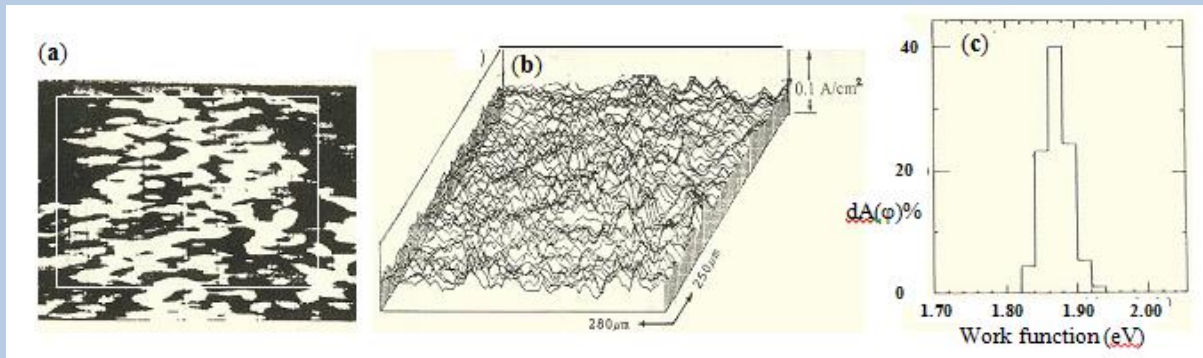


Fig.4 Results of THEM: (a) emission picture on scope using Z-modulation, (b) emission map plotted from elemental data, and (c) corresponding work function histogram.

It is to be noted that for a single crystal metal, the work function histogram is supposed to be a single vertical line. The present results correspond to a Tungsten-Rhenium (W-Re) Mixed Matrix cathode. The matrix is made out of W-Re alloy powder using nanotechnology.

#### IV Conclusion:

THEM is a useful tool to study the emission uniformity of thermionic cathode. In the present cathode, the emission distribution is fairly uniform and, accordingly, the  $\phi$ -distribution is narrow due to adaptation of nanotechnology. This uniformity in emission is essential to deliver a high quality electron beam by the electron gun in a microwave tube to achieve low noise in the RF output-power.



## WIRELESS COMMUNICATION: PHOTOPHONE TO 5G

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**Abstract:** *Communication is a very important aspect of our daily lives, without it, the knowledge we have will never be shared to anyone. Every generation will have to start back from square one. Our ancestors communicated via cave paintings, now we travelled up to a point where we can share information using light as well. This opened up avenues which were never even considered previously, we read data of constituent materials of faraway stars from other galaxies, millions of light-years away, and hopefully, find a civilization like ours. Father of radio communication Marconi was the catalyst in the wireless revolution which took us from the heavily wired exchange telephones to right now where we are, surrounded by Bluetooth, Wi-Fi, RFID, and much more. Wireless communication is completely inculcated into everyone's daily lives starting from low-end pager, which can only receive messages, to a high-end Smartphone which pretty much are capable of anything. Wireless communication plays various roles, from regular interaction via mobile phone to detection using RADAR and SONAR and even further to find our location using GPS.*

### I. INTRODUCTION

*“When wireless is fully applied the earth will be converted into a huge brain, capable of response in every one of its parts”-NIKOLA TESLA*

Communication Systems can either be Wired or Wireless and the medium used for communication can be Guided or Unguided.

In Wired Communication, the medium is a physical path like Co-axial Cables, Twisted Pair Cables and Optical Fibre Links etc. This guides the signal to propagate from one point to point. Such type of medium is called Guided Medium. On the other hand, Wireless Communication doesn't need any mechanical medium but propagates the signal through space. Since space allows for signal transmission without any guidance, the medium used in Wireless Communication is named Unguided Medium.

The range varies from 1ft away using Bluetooth to millions of kilometres for deep-space communication using radio waves, wireless communication generally works through electromagnetic signals that are transmitted by a device within the air, physical environment or atmosphere. The communication between any two devices occurs when the receiving device captures these signals, creating a wireless communication bridge between the sender and receiver device.

Photo-phone is a device where a voice signal is transmitted by modulating a beam of visible or infrared light which is received by a photoelectric cell, amplified, and reconverted into sound.

*Note: This was a crucial milestone as it was the first wireless device to be invented. It was invented by Alexander Graham Bell, although the photo-phone was an extremely important invention, the significance of Bell's work was not fully recognized in its time.*



Wireless communication has various forms, technology and delivery methods including:

- 1) Satellite communication
- 2) Mobile communication
- 3) Wireless network communication
- 4) Infrared (IR) communication
- 5) Bluetooth communication, Etc...

Although all of these communication technologies have a different underlying design, they all lack a physical or wired connection between their respective devices to initiate and execute communication.

## II. MODES OF WIRELESS COMMUNICATION

Any communication occurring via either of these mediums is termed as wireless communication.

- 1) Radio and Microwaves Free-space Optical
- 2) Sonic
- 3) Electromagnetic Induction

### A. Radio and Microwaves:

Radio and microwave communication carry information by the modulation of properties of electromagnetic waves transmitted through space. The electromagnetic waves ranging from a frequency of 3Hz (Radio Waves) to  $10^{19}$ Hz (Gamma Rays).

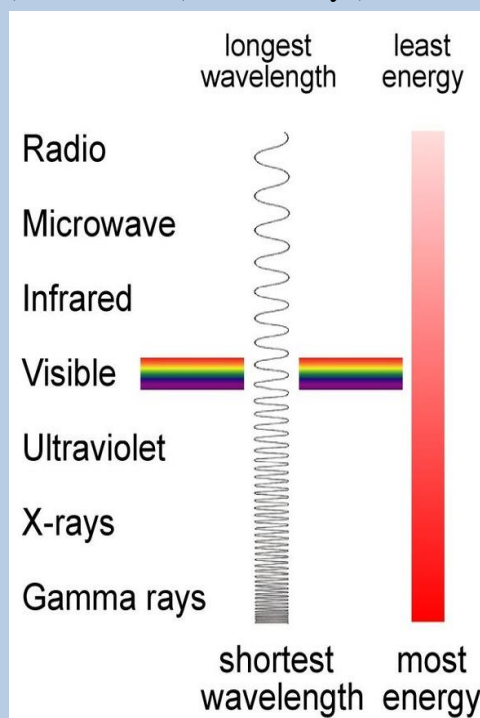


Fig. 1. Electromagnetic Spectrum

*Note: Light as we know the fastest in the universe, until recently, when the gravity waves were discovered. Though probably we would never be able to harness it like we harnessed light, we surely now know that light is certainly not the fastest in the universe.*

### *Free-space Optical:*

The visible light range of the spectrum is utilized here. Free-space optical communication (FSO) is an optical communication technology that uses light propagating in free space to transmit wireless data for telecommunications or computer networking. This contrasts with other communication technologies that use light beams travelling through transmission lines such as optical fibre or dielectric "light pipes".

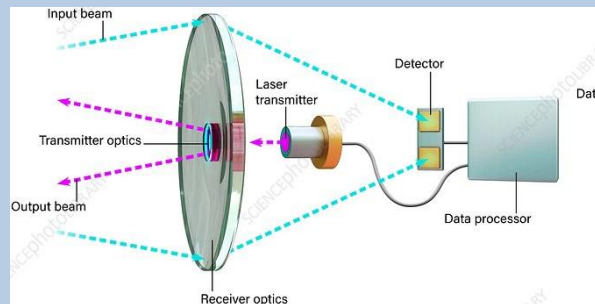


Fig. 2. Working of Free-Space Optics (FSO)

The technology is useful where any physical connections are impractical due to high costs or other considerations. Most often they are used in consumer IR devices which are utilized as an alternative for Wi-Fi networking to instantly transfer data amongst closely enabled devices such as laptops, printers and digital cameras. Or could be used in places where it's prohibitive to run cables across streets or any region, linking them via optical links.

### **B. Sonic:**

Sonic, especially in ultrasonic short-range communication involves the transmission and reception of sound. One of the uses could be a wireless communication-system undetectable by radiofrequency methods for converting audio signals, including the human voice, to electronic signals in the ultrasonic frequency range, transmitting the ultrasonic signal by using acoustical pressure waves across a carrier medium, including gases, liquids, or solids, and reconvertng the received ultrasonic acoustical pressure waves back into the original audio signal. This way any message can be propagated without any disturbances via any given medium irrespective of wired or wireless.

### **C. Electromagnetic Induction:**

Electromagnetic induction only allows for short-range communication and power transmission. It has been used in biomedical situations such as pacemakers, as well as for short-range Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects such as RFID tags.

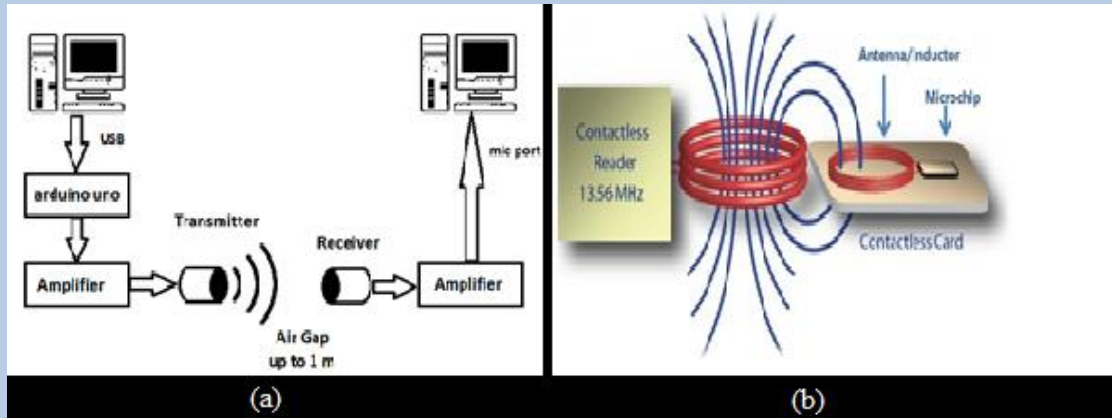


Fig. 3. (a) Basic Ultrasonic communication,  
(b) Working of Radio Frequency Identification (RFID) tags.

## I. WIRELESS REVOLUTION

Probably one of the longest-running revolutions starting from the 1990s running even now began when MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor or MOS transistor) invented by Mohamed Atalla and Dawon Kahng at Bell Labs in 1959. This component was and still is the core component or basic building blocks for wireless communication. This created a social revolution causing a paradigm shift from the wired to the wireless.

The wireless revolution had become advanced in radio and microwave when analog data was being able to transfer to digital, substantially increasing voice traffic along with various digital data such as texts, images and media. The MOSFET was further developed into LDMOS (Lateral Diffused MOS) to be used in RF power amplifiers to boost RF signals to ultimately enable the long-distance wireless network access, and RF CMOS used in radio transceivers to transmit as well as receive wireless signals at much lower costs.

As stated before, MOSFET is the building block for wireless networks including the 2G,3G,4G and even the 5G. MOSFET is the base in hardware starting from the base station to routers at home, and RF receivers in mobiles.

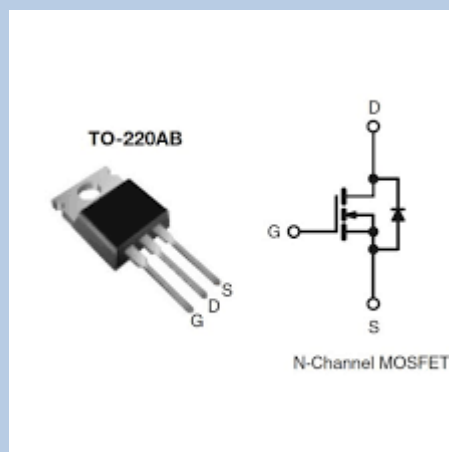


Fig. 4. MOSFET picture and its circuit representation

The primary factor behind rapidly increasing wireless networking is due to Edholm's Law which states that,

*"Edholm's law predicts that the bandwidth and data rates double every 18 months, which has proven to be true since the 1970s. The trend is evident in the cases of the Internet, cellular (mobile), wireless LAN and wireless personal area networks."*

RF CMOS integrated circuits allowed the sophistication, low-cost and portable end-user terminals, which gave rise to a wide range of small, low-cost, low-power and portable wireless communication systems.

This enabled the, " anytime, anywhere", communication and helped bring about the wireless revolution, leading to the rapid growth of the wireless industry. RF CMOS is used in the radio transceivers in all modern wireless networking devices and mobile phones and is widely used to transmit and receive wireless signals in a variety of applications, such as satellite technology (e.g. GPS), Bluetooth, Wi-Fi, near-field communication (NFC), mobile networks (e.g. 3G and 4G), terrestrial broadcast, and automotive radar applications, among other uses.

## II. TIMELINE & RECENT DEVELOPMENTS

1896- Wireless telegraph (Marconi), USA

*Note: the first-ever wireless message travelled over an open sea a mere 6 km which read "are you ready".*

1946-the first commercial telephone service (AT&T and South-western Bell), USA

1947-transistor (John Bardeen, Walter Brattain and William Shockley), USA.

*Note: this allowed the introduction and invention of a relation between the computer and communications.*

1962- the first communication satellite named Telstar, USA

*Note: this allowed instantaneous communications over long distance including calls and real-time international tv transmission*

1968- the launch of ARPANET (DARPA), USA

1979- first cellular network (Nippon Telegraph & Telephone- NTT), Tokyo

*Note: this was the beginning of 1G*

1990 — First web browser, *WorldWideWeb (WWW)*, developed.

1990 — Formation of IEEE 802.11 Working Group to define standards for Wireless Local Area Networks (WLANs)

1992 — First GSM phones approved for sale, USA

1992 — Text messaging, or short messaging service (SMS), was designed as part of the GSM cellular system, USA

1993 — IS-95 code-division multiple-access (CDMA) spread- spectrum digital cellular system deployed in the USA

1997- Birth of Wi-Fi, Australia

1999- Birth of Bluetooth, SIG (Special Interest Group)

*Note: SIG consists of*

*1) Ericsson Technology Licensing (founder member)*

*2) IBM (founder member)*

*3) Intel (founder member)*

- 4) *Nokia (founder member)*
- 5) *Toshiba (founder member)*
- 6) *Microsoft (since 1999)*
- 7) *Lenovo (since 2005)*
- 8) *Apple (since 2015)*

2002- first-ever camera phone was launched, USA

2007- the first iPhone is launched

2010- the 4G handset is introduced

Recently, the advances in various wireless communication protocols in technologies such as:

- 1) 5G,
- 2) RFID

Using electromagnetic induction,

- 1) Wi-Fi direct,
- 2) Li-Fi (*Light Fidelity*),
- 3) LTE (*Long-Term Evolution*) and
- 4) 6LoWPAN (*ipv6 over Low -Power Wireless Personal Area Networks*)

Using Radio and Microwaves,

Which have greatly boosted the potential capabilities of IoT (Internet of Things), and made it more prevalent than ever, which also accelerate the further integration of IoT with emerging technologies in other areas such as wireless recharging, sensing, data exchanging and processing.

### III. IN DAILY LIFE

With the latest developments in the wireless sector, the possibilities have increased a lot for everyone. Few of the advanced solutions for Wi-Fi being Li-Fi, where a regular LED is used to transfer the data and give you access to the internet as well. Wi-Fi Direct is used for data transport. It allows devices to connect directly through Wi-Fi, without the need of a Wi-Fi network or hotspot, and without having to set up the connection. You can also use Wi-Fi Direct to share files using third-party apps. 5G network increased the speeds of connectivity, helping further with IoT. It provides the chance to bring all the communications under a single roof, for example, in moving traffic cars can communicate with each other, asking for assistance while on the move, or can communicate directly with the online support.

This enables to reduce road rage, and immediately provide assistance to stranded vehicles.

The regular improvements will soon be of help to provide the whole of the earth to connect seamlessly. And assist in the space sector to establish communication with satellites much better and be able to send them to much farther distances, and probably finally getting the answer regarding the basic question of, “are we alone in this cosmos?”

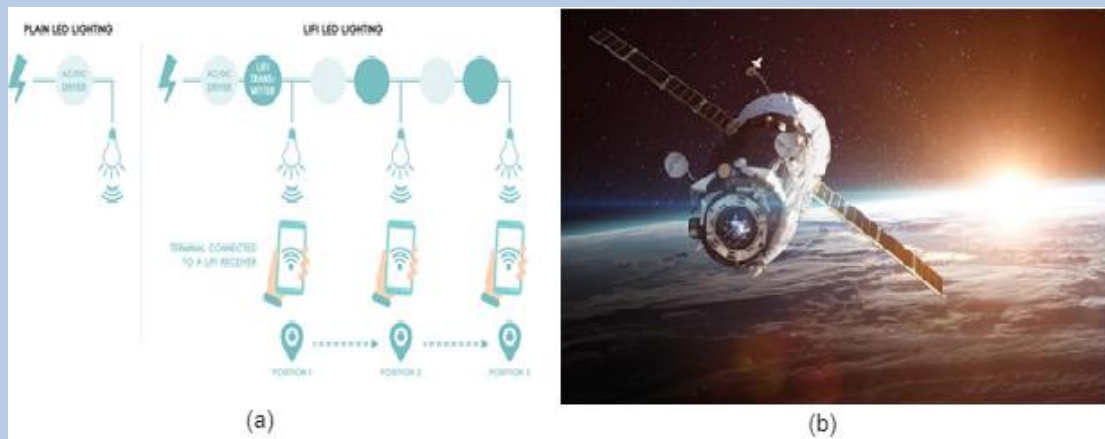


Fig. 5. (a) The Basic working idea of Light Fidelity (Li-Fi),  
 (b) Satellite Communication as everyone knows is literally and figuratively out of this world

#### IV. CONCLUSION

Communication has always been of the utmost importance for the survival of mankind, the transition from cave paintings to deep-space communication to millions of kilometres is quite phenomenal, and the journey of it has been quite extraordinary as well, from a time when we only had rocks to count to having a device so powerful that can connect you with anyone and get any information we want in fractions of seconds.

Wireless communication is the epitome of all that success; in more amusing words of one of the greatest minds of all time, Albert Einstein said, "*The wireless telegraph is not difficult to understand. The ordinary telegraph is like a very long cat. You pull the tail in New York and it meows in Los Angeles. The wireless is the same, without the cat.*"

The wireless revolution is still happening as you read, trying to make our lives easier and easier, from a phone booth to Smartphone's, from room-sized computers to laptops, so on and so forth...

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## ORGANIC LIGHT EMITTING DIODE

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**Abstract:** *Over 15% of world's total electricity is consumed for lighting and by 2030, it is expected that the amount of electricity used for this purpose will be 50% more than that of the present consumption rate due to an increase in global consumption. In order to meet the demand of the growing population there should be a device, which provides energy efficient lighting to consumers. In this article, the structure of an OLED, its working principle, comparison with LED, its uses/applications, limitations and future scope will be discussed.*

### I. INTRODUCTION

Our world of science and technology is huge and ever expanding. Occasionally, we come across a term called OLED with TV in its tow. So what does an OLED really mean? Is it a part of television or just a fancy abbreviation? Considering the present situation and keeping the future scenario in mind, we only have one solution to this, a device that is energy efficient can solve this problem and OLED is one such device that can help us.

These devices have been rapidly adopted in both mobile and television display market in recent years. Some of the unique features of this device are ultrahigh efficiency, large colour gamut, thin form factor ,lower glare, lightweight and efficient flexible light source which makes it more attractive for lighting and micro-display applications.

### II. STRUCTURE OF AN OLED

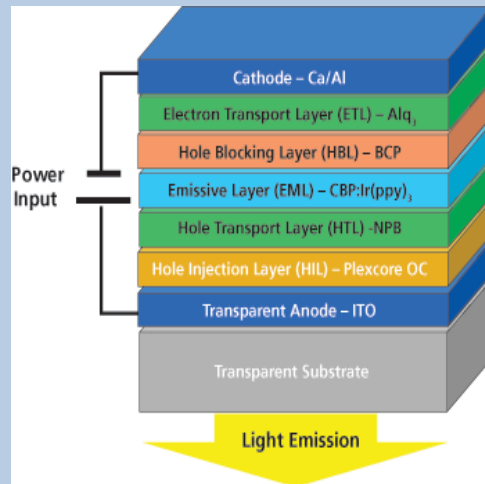
An OLED is a hetero structured device consisting of an electroluminescent, which is organic in nature sandwiched between an anode (usually made up of transparent Indium Tin Oxide) and a cathode (calcium, magnesium or lithium fluoride aluminium).

### III. WORKING PRINCIPLE OF AN OLED

When holes and electrons are injected from cathode and anode and when a voltage is applied across the electrodes:

1. Migrate through various organic layers to reach the EML to form excitations (a bound state of the hole and electron pair).
2. Subsequently will decay by undergoing radioactive recombination process releasing photon process.
3. The emitted color including the white lighting depends on the organic material, which is used as the emissive layer.

Addition of various layers such as the hole injection layer (HIL), electron injection layer the device performance can be improved. Operating voltages of such devices is higher when compared to the thermo-dynamic voltage (2.4eV). Chemical doping with electron acceptors /donors can reduce the operating voltages of such device.



#### IV. LED VS OLED

Parameter	LED	OLED
Pixels	In normal LEDs they are not self illuminating.	In OLEDs, the pixels are self-illuminating.
Power consumption	Power consumption of a LED is more.	Power consumption of an OLED is low (energy efficient).
Viewing angle	Viewing angle in a LED is 54(deg).	Viewing angle in an OLED is 84(deg).
Screen Thickness	Screen thickness in a LED is thin.	Screen thickness is thinner when compared to the thickness of a LED.
Response time	Response time is slow in LED.	Response time is fast in an OLED.
Brightness	Brightness of a LED is high.	Brightness of an OLED is low when compared to a LED.
Lifespan	Lifespan of a LED is more.	Lifespan of an OLED is less.

#### V.APPLICATIONS OF OLED

##### 1. Smart phones and Tablets:

It took longer for OLED devices to saturate the mobile device market, but since 2016, most leading-edge smart phones and tablets have been constructed using active-matrix OLEDs (AMOLEDs). These use an additional film of semiconducting material behind the primary panel to reach outstanding levels of activation speed; a prerequisite for ultra-high definition (UHD) handheld devices with high pixel counts. Liquid crystal displays (LCDs) are still broadly used to fabricate smart phones and tablets, but AMOLED technology is up to 1000x faster than equivalent LCD devices.

##### 2. Wearables :

Wearable OLED devices have made successful inroads since 2017, with the implementation of monochrome OLED light sources into fitness bands and small wrist-mounted displays for smart

watches. More recently, OLED micro displays have been integrated into virtual reality (VR) headsets owing to their exceptional refresh rates and reduced brightness levels. OLED devices can generate as much as half the nits of an LCD display while still reproducing HDR content onscreen, which is advantageous for reducing eyestrain.

### **3. Light panels:**

Some of the oldest OLED devices include self-emissive light panels with highly tunable spectral outputs. They have been used to create flexible and homogenous panels, but the market for OLED light panels is still emerging with very few OLED light sources available in commercial spaces.

## **VI. LIMITATIONS OF OLED**

Limitations of an OLED are:

1. Lifetime of a OLED is short because of the blue organic material
2. Poor sunlight readability
3. The current production process and it is costly to produce large displays, so they are limited to hand-held devices

## **VII. FUTURSCOPE**

1. Flexible OLED into automotive:

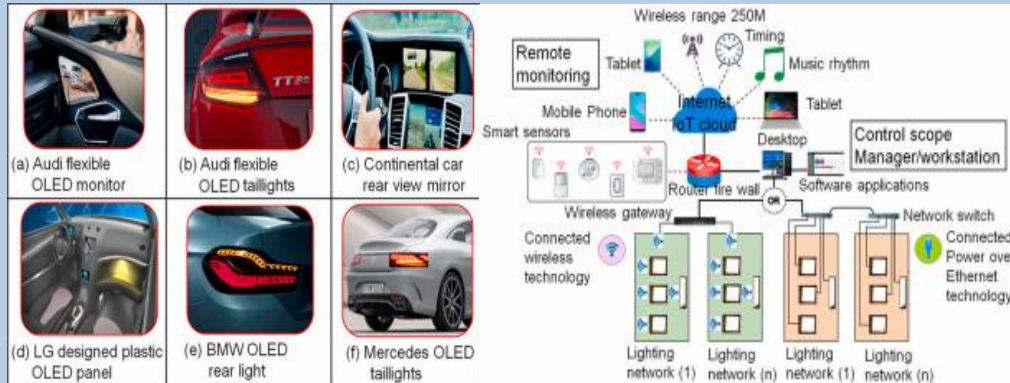
According to Technavio analysis, the global automotive OLED market is expected to grow rapidly and will post a CAGR close to 17% during the period of 2021-23. This flexible OLED transparent display can be integrated into the windshield of vehicle in order to add driver friendly functionality without adding any weight. These flexible OLEDs can be integrated in rear lights. HARMAN-Samsung is developing an advanced flexible and transparent OLED display to automotive industry and they can be used in

- i. Dashboard displays
- ii. Internal and external lighting
- iii. Digital rear view internal mirrors.

2. IOT connected lighting system:

Connected lighting, which is the convergence of SSL, low-cost sensors, smart phones and apps, and the IoT, is expected to enable new lighting system functionality and to open up another class of application. In the lighting realm, “things” comprise physical devices as intelligent luminaries and sensors as well as infrastructural elements as gateways. The introduction of IoT as the backbone for connected lighting systems enables seamless communication, contextual services and data sharing between devices (“things”). Lighting system connected to a network can be monitored and controlled from any centralized system or via a cloud. The energy cost could be reduced by about 90% using smart lighting in offices, business places, and industries. Connected lighting systems will help to know the better utilization and maintenance of the building space, including advanced occupancy detection,

light-level stability, personalized setting profile, and fixture outage reporting. Benefits of IoT technology in lighting are numerous.



*Schematic of the IOT connected SSL lighting System*

### 3. OLED market projection:

Automotive lighting is also projected as a promising sector. Residential, office, and outdoor lightings are likely to follow later once the cost reduces. Earlier, Yole development had presented a report on OLED lighting applications and associated market metrics for the period of 2013–2021. According to report, US\$1.5 billion OLED lighting market volume is projected in 2021 (up from nearly US\$30 million in 2015). Similarly, the worldwide market for automotive OLED lighting is expected to grow at a CAGR of roughly 93.1% over the next five years, and will reach US\$21 million in 2023 from US\$ 1.0 million in 2017 according to Market Study Report. Moreover, the global flexible OLED market is also projected to reach US\$ 2581 million by 2025, with a CAGR of around 42% between 2019 and 2025. In summary, OLED lighting panels are making it possible to create entirely new type of lighting objects (area light source, no blue light hazard, and flexible/foldable products), which will help to avoid direct pricing and performance competition with the LED products. Further, OLED technology and manufacturing processes need to improve in order for OLED lighting to be commercially viable in terms of performance and cost.

## VIII. CONCLUSION

With the applications of an OLED being never-ending and the limitations a few, this growing technology can change the phase of the world when used fully. Our world of technology keeps growing and growing until the future of ours, stands right next to us.

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## BRAIN TUMOR IDENTIFICATION USING MFCCM ALGORITHM FROM MRI IMAGES

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**Abstract**— A cell that develops out of control and standardizes the growth is known as tumor cell. One of the main reason, for a human death in every year is brain tumor. Around 50% of brain tumor diagnosed patient die with primary brain tumors yearly. Electronic modalities like X-ray, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are used to diagnose the brain tumors. Among all these electronic modalities, MRI is one of the most used and popular for brain tumor diagnosis. In the proposed technique, an automated approach has been proposed where MRI gray-scale images were included for brain tumor detection. This study proposes an automated approach that includes enhancement at the primary stage to reduce gray-scale intensities. Filter operation is used to eliminate unwanted noises and smoothing of gray scale image to assist better segmentation. Modified Fuzzy c-means (FCM) segmentation was used to segment the tumor region based on the clusters. Finally, the extracted feature information is used to identify the region of interests (brain tumor region). The experimental results shows that, the proposed approach provides better results compared to existing available approaches in terms of accuracy while maintaining the acceptable accuracy rate.

**Keywords**— Brain Tumor, Modified FCM Segmentation, Filter, MRI Image.

### 1 INTRODUCTION

BRAIN TUMOR is caused by the abnormal growth of tissues in the human brain or central spine that can disturb its function [1]. Brain tumors are classified as either primary or secondary. Most of the primary brain tumors are benign and they originate from cells within the brain. The secondary brain tumor is known as malignant, arises and then spread to the brain [1]. Brain tumors can be either benign which are non-cancerous or malignant which are cancerous. There are over 120 brain tumor relocations defined by the World Health Organization (WHO), predicted on the type of tumor cell and its location [2]. They are graded based on the cells where they are originated, and a number ranging from I (benign) – IV (most malignant) [2]. Grades I and II (lower grade tumors) and grades III and IV (higher grade tumors) can be life-threatening and thus specific diagnosis and necessary treatment is essential for a patient. In the pathology lab, tumor tissue examination is carried out by utilizing-

- Microscopic analysis
- Electronic modalities such as Computed Tomography (CT), Ultrasound, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and Single Photon emission tomography (SPECT) scans.

Among all the electronic modalities, MRI is one of the most popular modality used for brain tumor diagnosis. It precedes a high resolution and contrast images of the brain in the axial, coronal and sagittal axes providing a three-dimensional assessment of the lesion [3]. Compare to PET, SPECT scans, MRI does not use any radiation and it's non-invasive. Different hybrid algorithms are developed for tissue and tumor segmentation in MRI brain images [4]. In this paper, an automated approach has been proposed where MRI gray-scale images were included for brain tumor

detection. Brain MRI images were taken as input and medical image processing techniques such as contrast stretching enhancement, median filter operation, Modified FCM segmentation, feature extraction and segmented tumor (output image).

## **II RELATED Works**

The existing research work by [5, 6], incorporates MRI images for brain tumor analysis. The methodology starts with conversion of the images into gray scale then enhancement methods were applied. After that otsu threshold segmentation is applied and demonstrated with 91.6% average accuracy of brain tumor detection. The method proposed [7], provides the highest accuracy of brain tumor detection where watershed segmentation and morphological operations were used for tumor analysis. This method tested on three different datasets and achieved average accuracy is 97.34% although some unwanted regions also exist in the results. In [8], author introduced the morphological operations technique to detect the tumor from MRI image. Threshold segmentation is used to work on the preferred region of the image. NMF (non-negative factorization) was also used to extract the features of the tumor. The method proposed [9], the MRI images are segmented and clustered using k-means clustering and then morphological filtering was implemented for miss clustered tumor and hybrid clustering is implemented in [10]. In [11], author proposed a method to detect and localize brain tumor from patients. The proposed method includes three stages: pre-processing edge detection and threshold segmentation. Finally, k-means clustering was performed to identify the tumor region. But in their proposed method more regions exists besides tumor region misleads the results in diagnosis. Above studies shows that segmentation is the most vital part of brain tumor analysis. There exist different segmentation methods for tissue classification and tumor segmentation. The detection of the tumor region depends on the performance of segmentation. In our study modified FCM segmentation is used.

## **III PROPOSED METHOD**

The architecture of the proposed method is shown in the Fig. 1. The identification of brain tumor using MRI images consists of input MRI image, enhancement, filter operation, segmentation, feature extraction and segmented tumor.

### **A) MRI Image**

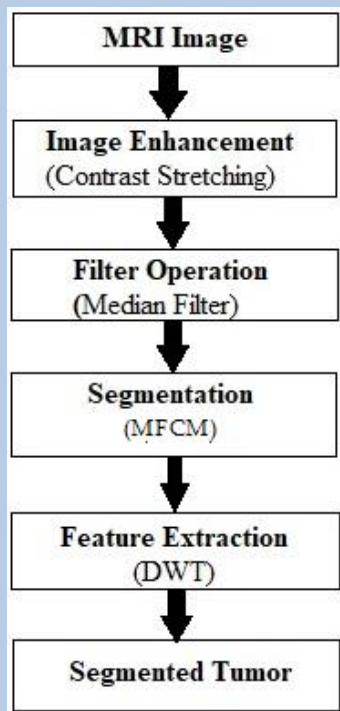
In the proposed technique, brain tumor dataset [12] are used for the implementation. The dataset contains 364 T1-weighted contrast enhanced images from 233 patients with three kinds of tumor: glioma, pituitary and meningioma tumor. This study tested 3 batches of images containing 20 images in each batch. In this study the images are stored in MATLAB of size 512 x 512 in tiff image format.

### **B) Image Enhancement**

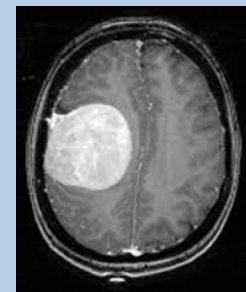
Image enhancement is used to improve the visibility quality of an image for human viewers. There are various enhancement methods like contrast stretching, histogram, adaptive histogram, etc. In the proposed technique contrast stretching is used as it comparatively performs better on the gray scale image as contrast increases without distorting relative gray level intensities. As a result, it does not yield any artifacts like histogram equalization.



Contrast stretching enhances the contrast of the image by stretching the range of intensity values of the image the desired range from 0 to 1.



**Fig 1.** Proposed block diagram for brain tumor detection



**Fig 2.**Original MRI Image

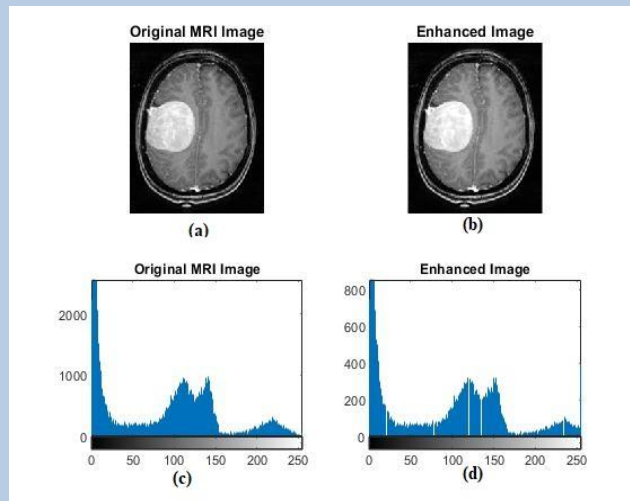
### C) Filter Operation

Filter operation is performed on the image to increase the smoothness, sharpness as well as edge enhancement and also remove the noise. In the proposed technique median filter is used instead of any other filters like mean filter and Gaussian filter. Its a fact that mean filter can reduce noise better but lacks preserving the edges, the Gaussian filter preserves the edge but makes the image blur. In compare to mean and Gaussian filters, median filter is effective as a fact that removes the noise at satisfactory level while preserving the edges. Moreover, it makes the image less blurry than the Gaussian filter. The median filter can move through pixels to pixels in an image then replace each value with neighboring pixels. There exist different denoising filters for eliminating noise in MRI brain images. The default sampling window of median filter is [3x3]. Fig. 3 illustrates the results of filter operation for this study test image.

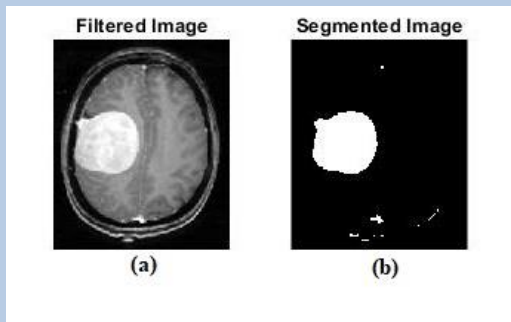
### D) Segmentation

The process of dividing the image into regions based on the similar features is known as segmentation. Basically, segmentation was performed to extract key features from the image. In this study, Modified fuzzy c-means [14] segmentation method is used instead of thresholding segmentation. This is due to threshold segmentation neglects spatial information of an image and selection of threshold is important to identify the exact tumor area, erroneous choice of threshold value may leads into over or under segmentation. Unified segmentation is implemented by combining PCA. In FCM segmentation wrong choice of threshold value is not possible because FCM is a cluster method which allows one piece of data to belong to two or more clusters. FCM is

based on minimization of objective function. This fuzzy c-means clustering method provides better results than the threshold segmentation. Fig. 4 illustrates the results of segmentation for this study.



**Fig 3.** (a) Original input image, (b) Enhancement (contrast stretching), (c) Histogram of (a), (d) Histogram of (b).



**Fig 4.** (a) Input from step two (filtered image), (b) Resultant image using FCM segmentation.

### 3.5 Feature Extraction

The process of dimensionality reduction that efficiently represents region of interest of an image as a compact feature vector is known as feature extraction. Discrete Wavelet Transform (DWT) is used to extract features from tumor region. The following features were extracted from tumor region (region of interest).

- Contrast
- Correlation
- Energy
- Homogeneity
- Mean
- Standard Deviation
- Entropy
- Root Mean Square (RMS)
- Smoothness
- Skewness
- Inverse Difference Moment (IDM)
- Variance.



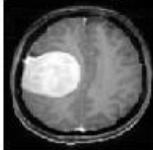

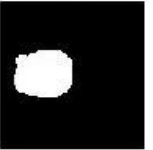
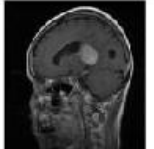
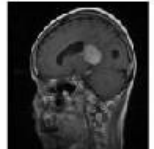







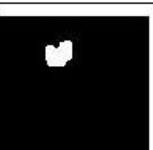
### 3.6 Segmented Tumor

Segmented tumor image is the final output image that contains only tumor region. This is achieved by the features that are extracted in feature extraction section. Some sizes were set for the feature measurement. A range of values of sizes were set for the features such as area, solidity, and density to detect the tumor region. When a region falls within the value range of each feature then, the tumor region is identified successfully.

## IV EXPERIMENTAL RESULTS

### 4.1 Experimental Outcomes

The possible experimental outcomes of this study, the proposed method results are shown in Fig. 6. It illustrated three brain tumor images in axial, sagittal and coronal orientation from the dataset.

Test Image (a)	Image Enhancement (b)	Filter Operation (median filter) (c)	FCM Segmentation (d)	Segmented Tumor Region (e)
				
				
				

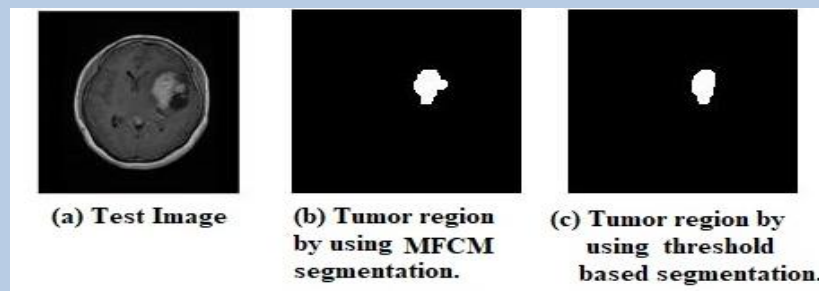
**Fig 6.** (a) Input Image (b) Image Enhancement (c) Median Filter Operation (d) MFCM Image Segmentation (e) Segmented Tumor.

The first column shows the test image (MRI image). This test image is then enhanced with contrast stretching enhancement method to increase the contrast of test image this is shown in the second column. Median filter is applied to the enhanced images to remove noise and improve smoothness of an image this is shown in the third column. MFCM segmentation is performed on the median filtered image to divide the image into two color region such as black and white. White spots that are shown in the image is the result of the MFCM segmentation shown in the fourth column. Finally, in the last column, only the tumor region is identified by using the extracted features. The tumor is displayed as the white portion in the image.

### 4.2 Comparative Results Analysis

The images in Fig.7 illustrate the comparison of the result between the FCM segmentation and the threshold based segmentation. The proposed approach has identified the precise tumor while in output image some tumor region is not identified. This may cause confusion about the type of

tumor. Whether it is a cancerous or non-cancerous tumor.



**Fig 7.** Comparative Tumor detection using MFCM segmentation method and threshold based segmentation method.

## V CONCLUSION

This experimental result concludes that the proposed method is comparatively better than the existing methods to identify the tumor in brain MRI images. In the proposed method, FCM segmentation is used instead of threshold segmentation as it neglects spatial information and erroneous selection of threshold value leads into over or under segmentation which leads confusion. The proposed method provides high accuracy and less computational time. In the proposed method, many features are extracted from tumor image these features are used to classify the type of tumor (benign or malignant).

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# GNSS RECEIVER TECHNOLOGY TRENDS AND VULNERABILITIES: APPROACHES

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**Abstract** — *The field of satellite navigation is developing rapidly in terms of availability of new systems, frequency bands and ultimately state of the art receivers. The software-defined Global Navigation Satellite Systems (GNSS) receivers are emerging as contenders to ASIC based platforms as a result of developments in RF front-ends and enormous computing power of parallel processors like GPUs. The need for Multi-GNSS SDRs is increasing due to the demand for applications like unmanned aerial vehicles (UAVs), IoT and the 5G (and beyond) communications. Moreover, software radio architectures allow any kind of customization in exploring the forthcoming scenario with a plurality of new navigation systems and signals.*

Keywords—GNSS, software Defined Radio (SDR), Jamming, spoofing and GPU

## I. INTRODUCTION

The Global Navigation Satellite Systems (GNSS) technology is known for precise positioning and timing capability that is of use in diverse fields of science and technology such as remote sensing, aviation, defence, etc. The term GNSS includes all existing and planned global, regional and Satellite Based Augmentation Systems (SBAS) by various nations. This includes, GPS (USA), GLONASS (Russia), Galileo (Europe) and COMPASS/Beidou-2 (China). The SBAS and regional systems are (WAAS (USA), EGNOS (Europe), Beidou (China), MTSAT (Japan) and GAGAN (India)) and Regional Navigation systems (IRNSS (India), QZSS (Japan), BeiDou-1 (China)). The SBAS systems provide services using Geostationary satellites aided primarily by either GPS, GLONASS and/or Galileo. Platforms for GNSS receivers include ASIC, Field Programmable Gate Arrays (FPGA) and Digital signal Processors (DSP) technologies and are used in mass market in most of critical applications that include survey industry, construction industry, guided landing approaches of airplanes, intelligent transport systems and in daily life for car navigation, location-based services (Google Maps, facebook), etc.

## II. EASE OF USE

### A. SDR platforms

The hardware-based receiver architectures are becoming obsolete and expected extinct within a few years (3-4 years) of their development due to rapid growth in satnav technologies in terms of availability of new signals and satellite systems. The lack of re-configurability of the current commercial-of-the-shelf receivers and the advent of new radio navigation signals and systems, a trend in GNSS receiver design called “Software Defined Radio (SDR)” has emerged as a contender for the ASIC receivers. Approaches towards realization of SDRs include Digital signal Processors (DSPs), General-Purpose Processors (GPP), Graphic Processing Units (GPU), and Field Programmable Gate Arrays (FPGA). The hardware SDR platforms with GPP (SORA, USRP, KUAR) and GPU (Nvidia, Intel, AMD and ARM) utilize desktop computers (applicable for real-time and non-real-time), thus have higher level of processing power. DSPs (applicable for real-time) are inefficient for parallelism and re-configurability. FPGA (applicable for real-time and non-real-time) with significant advancements are contenders over DSPs. The salient features of SDR



approach are flexibility, re-configurability, reproducibility, and scalability (addition of new signals). However, the ultimate ideal software receiver consisting of only an RF front-end and a microprocessor capable of operating with ultra-wide bandwidth remains still unrealistic as of today.

#### B. *Multi-GNSS SDR in current scenario*

SDRs are finding a great response in the current GNSS scenario. Particularly now that, multi-GNSS-SDRs with multi-antenna signal processing ability for resilient navigation, which will benefit business wise as technology enablers for new services and applications. The flexibility and re-configurability of SDRs makes them ideal tool for scientific experiments. One of the bigger trends in modern GNSS receivers, which one can foresee in near future, is the move to multi-antenna multi-GNSS receivers for attitude control and jamming/spoofing resistant.

#### C. *SDR IF-DATA Standards*

ION GNSS SDR Metadata Working Group (WG) is working to standardize the GNSS SDR IF metadata (this includes defining generic front-end parameters for RF/IF, sample rate, file format, antenna location/type etc.). The exemplary source code, test data sets and different IF front end details can be accessible at <https://sdr.ion.org/api-sample-data.html>.

#### D. *Signal processing techniques – Jamming and Spoofing*

The jamming/interference mitigation includes adaptive filtering, Wavelet and Wavelet Packet techniques. Pre-correlation techniques are applied at antenna level, Automatic Gain Control (AGC) or analog-to-digital converter (ADC), and output of ADC. Spatial filtering techniques are used at antenna level. Adaptive time, and adaptive frequency filters estimation signal in time domain are used at ADC level. However, it requires prior knowledge of jamming signal. Time-frequency filtering at the output of ADC mitigates the jamming in both time and frequency domain simultaneously. Among all the techniques, wavelets (WT and WPT) allow controlling the trade-off between time and frequency at any level of signal decomposition. However, thorough investigations are required for selection of parameters such as type of wavelet, composition level, threshold rules and thresholding function based on type of interference. Furthermore, space-time adaptive filtering techniques are also used in practice in hardware receivers for interference mitigation (using space diversity), but the feasibility to SDR needs further investigations. Next to security, integrity of the navigation solution is equally important. No doubt, a multi-GNSS receiver can enhance navigation solution in terms of accuracy and continuity.

The successful implementation of receiver level integrity monitoring will enhance not only the commercial value but ability of receiver for applications with stringent accuracy and availability requirements (*like civil aviation*). Due to the availability of many satellite signals of different systems, it is indispensable to check for the satellite signals that are not meeting Signal-In-Space (SIS) requirements which will lead to large error in position estimation. The GNSS SIS performance requirements for accuracy, integrity, availability and continuity are deliberated in ICAO Annexure 10, vol.1 document. Significant effort towards development of RAIM (Receiver Autonomous Integrity Monitoring) algorithms has been put by several authors and organizations (Stanford University, MITRE's Center for Advanced Aviation System Development (CAASD) etc.). Conventional RAIM algorithm considers single satellite failures of one constellation (e.g.

GPS). Dual constellation (GPS-GLONASS, GPS-Beidou etc.) and multi-constellation studies are also in progress through advanced RAIM (ARAIM) algorithms. ARAIM algorithms provide updates regarding probability of failure of satellites of these constellations. Research using machine learning techniques is underway to address signal processing tasks of GNSS to mitigate aforesaid GNSS vulnerabilities.

### III. STATE OF ART DESIGN OF GNSS SDR SOLUTIONS

The present state of art design of multi-antenna implementations was limited to signals of GPS L1C/A with number of antenna elements varying from 4 to 8, which is a real-time test bed with adaptive array anti-jamming ability accelerated by GPU. Efforts by several research groups on development GNSS SDR solutions using two or three constellations/systems can be found in the literature, given in table 1.

Table 1: Summary of Existing GNSS Software Defined Radios (SDRs)

Company/ univ./ Inst.	Processing		Platform		Navigation Satellite System				Frequency		Jam Res. & Iono. threat Mitigation	Anti- Spoofing
	Real-time	Post-proc.	PC	Other	GPS	GLONASS	Galileo	SBAS & IRNSS	Single	Multi		
Baseband Technology	√	×	√	×	√	×	×	×	√	×	×	×
Cornell University	√	×	√	√	√	×	×	×	×	√	×	×
Aerospace Research & Tech.Centre	√	×	×	√	√	×	√	×	√	×	×	×
Data Fusion Corporation	×	√	√	×	√	×	×	×	√	×	×	×
FastGPS	×	√	√	×	√	×	×	×	√	×	×	×
Fastrax	√	×	√	√	√	×	×	×	√	×	×	×
GPS Toolkit	×	√	√	×	√	×	×	×	×	√	×	×
Namuru II GPS	√	×	×	√	√	×	×	×	×	√	×	×
Ngene	√	×	√	×	√	×	√	EGNOS	√	×	**	×
OpenSource GPS	√	×	√	×	√	×	×	×	√	×	×	×
ipexSR	√	×	×	√	√	√	√	×	×	√	×	×
CRS inc. (IMPULSE)	√	×	×	√	√	×	×	×	×	√	×	×
Sogei	×	√	√	×	√	√	×	×	√	×	×	×
Danish GPS Center	×	√	√	×	√	×	×	×	√	×	×	×
Gnss-sdr.ru	×	√	√	×	√	√	×	×	√	×	×	×
Intecs S.P.A	√	×	√	√	√	√	√	×	×	√	×	×
Spirit	√	×	×	√	√	√	×	×	√	×	×	×
SX-NSR	√	×	√	×	√	√	√	×	×	√	×	×
Univ. of Calgary	×	×	×	√	√	√	√	×	×	√	×	×
Univ. Catalunya	×	×	×	√	√	×	×	×	√	×	×	×
Graz Univ, of Tech.	×	√	√	×	√	×	√	EGNOS	×	√	×	×

### IV. GNSS VULNERABILITIES – JAMMING AND SPOOFING

Position solution of multi-GNSS SDR receiver can be diverted by jamming (Interference) and spoofing (faking of false position). GNSS signals are 20dB below noise level and vulnerable to different types of intentional (jamming and spoofing) and unintentional interferences. The sources

of interference include multipath, ionospheric scintillations, solar radio pulse interference, and Radio Frequency Interference (RFI). Distance Measuring Equipment (DME)/ Tactical Air Navigation (TACAN) system used for aiding aviation fleet are also major factors impacting GPS L5, Galileo E5, and Beidou B2 signals. Intentional jamming of GNSS signal is illegitimate, but commercial low cost jammers are available over internet that jam signals at wide frequency bands including L1, L2, L5 and GSM also. In recent years, numerous attacks on commercial GNSS receivers were noticed. Some of these events include Lockheed Martin RQ-170 Sential UAV of U.S captured by Iranian military using GPS spoofer in 2011. South Korea maritime services wish to use 'ELORAN' instead of GPS due to heavy jamming from North Korea, as for about 16 days 1000 airplanes and 250 ships experienced GPS jamming. An unintentional interference affected the GBAS system operations resulting in unavailability of GPS assisted land approaches in Newark airport. This was later identified because of a Personal Protection Device (PPD) used by UPS driver next to the airport. In 2014, researchers from University of Austin attacked a \$80 billion yacht using a self-built spoofer. Therefore, it is evident that the current technology has been attacked and affected. Civil jammers are available ranging from \$100 on internet. Only professional high-end receivers incorporate some techniques to detect and mitigate interference and most of the receivers, even certified ones, still do not provide any detection or mitigation feature. European Union is taking measures in framing the standards for testing the receivers against threats (<http://www.gnss-strike3.eu>).

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# VLSI DESIGN AND CAREER OPPORTUNITIES IN INDIA AND ABROAD

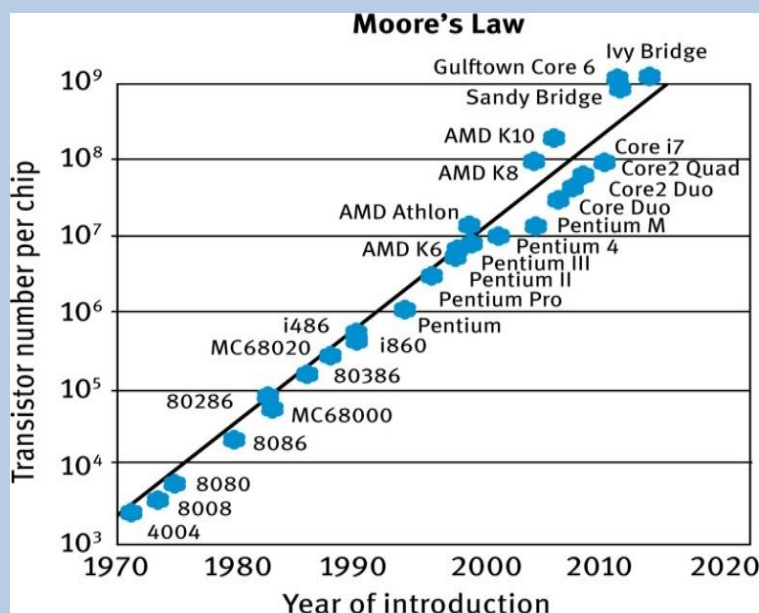
O.V.P.R. Siva Kumar, Professor, ECE, GCET.

## I. INTRODUCTION

Very Large Scale Integration (VLSI) is the process of creating an Integrated Circuit (IC) by combining thousands of transistors into a single chip. Now-a-days a Smartphone can do the job of a whole collection of gadgets. It's a phone, camera, camcorder, Walkman, watch, wallet (carrying digital cash), radio, GPS, TV, VCR, and computer all in one. Still, you may wonder how all these functions can fit into such a small mobile. The concepts of VLSI, several career opportunities and tips to enter into VLSI Career are described in this paper.

### What's Moore's Law?

Gordon Moore, co-founder of Intel Corporation predicted in the year 1965 that the “number of transistors in an integrated circuit will double every two years”. This is known as Moore's Law, which revolutionized the entire electronics industry for the last more than five decades. This had set the foundation for miniaturization of electronic systems.



The first microprocessor invented was Intel 4004 (4-bit) in the year 1971, which had 2300 transistors integrated in one chip. Compare this with Apple iPhone 11 in the year 2019, in which 8.5 Billion transistors were integrated in a single IC. This has been possible because latest chip fabrication technologies could consistently reduce the size of transistors, but with increased performance. The feature size (the **size** of the elements on a chip) of Intel 4004 microprocessor was 10micrometers ( $\mu\text{m}$ ), whereas the feature size of the processor in iPhone 11 is 7 nanometers (nm). It means the size was reduced by

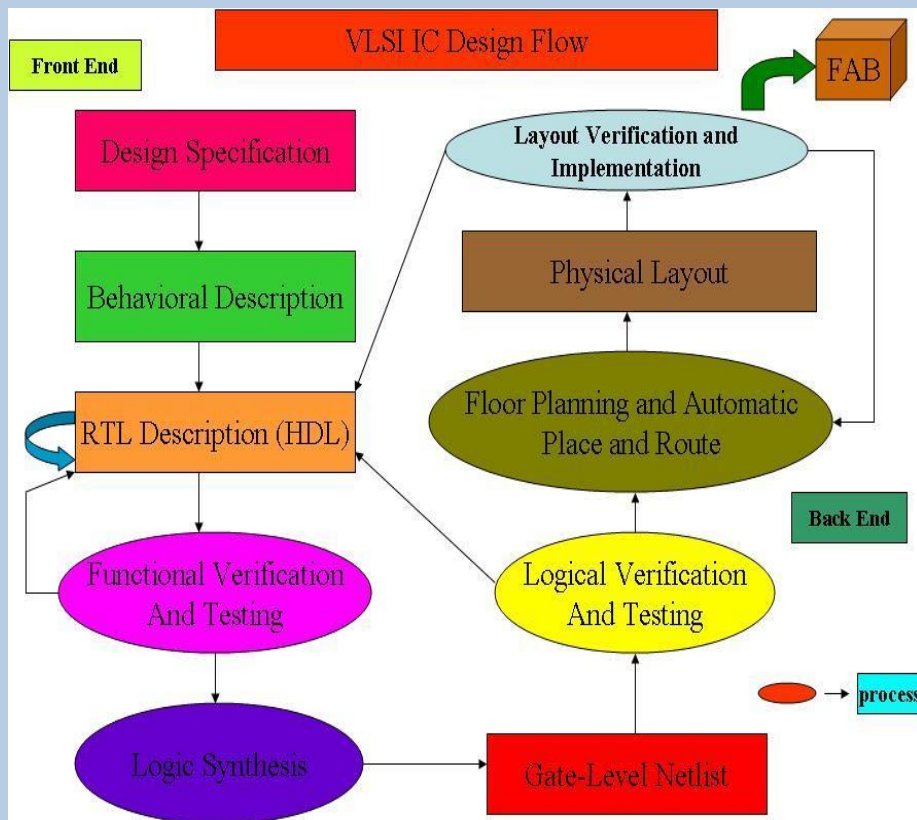
around 1428 times, but increased performance. Hence, we can now justify how our current Smartphone could be packed with so many features in such a small size.

**Factors of VLSI Technology:**

With the rapid technological developments in the last five decades, the status of VLSI technology is characterized by the following factors:

- A steady increase of the functionality in an Integrated Circuit.
- A steady reduction in the size of transistors and hence increase in their speed of operation
- A steady reduction of the power supply to transistors and hence reduction of the overall power consumption of a circuit.
- A steady improvement in the predictability of circuit behavior before and after fabrication.
- A steady increase in the variety and size of software tools used for VLSI design.

The below diagram summarized VLSI IC Design Flow.



**II. VLSI AS A CAREER OPTION**

**Is VLSI a good career?**

Worldwide Semiconductor revenues were US\$412 Billion in the year 2019. It means there is tremendous demand in the market for the IC based products. It is important to note that to setup a Semiconductor Fabrication Plant (in short “Fab” or Foundry), it requires huge investment of around US\$3 to \$5 Billion, as manufacturing is in the order of nanometer scale (smaller than dust particle size 1µm to 100µm) and it

requires a “Clean Room” environment.

The complexity of VLSI circuits being designed now-a-days makes the manual approach to design impractical. Electronic Design Automation (EDA) software from reputed companies Cadence, Synopsys, Mentor Graphics, Avant, Xilinx, Altera etc. makes it possible to implement VLSI circuits in a systematic manner.

A career in VLSI is completely based on application of the knowledge gained from electronics engineering core area. It is definitely challenging and will have highest level of job satisfaction and scope for accelerated career growth. As there is huge demand for knowledgeable and skillful engineers, the salary package is very attractive for the deserving candidates. Unlike IT domain, VLSI is automation resistant.

### **III. JOB OPPORTUNITIES IN VLSI INDUSTRY**

There are several job opportunities in the semiconductor industries in India and abroad in various categories of the VLSI IC Design Flow. In India there are three categories of jobs: a) Product oriented companies, ex. Intel, Qualcomm, AMD, ARM, NXP, Nvidia, Sandisk, Samsung Electronics b) Design Services related companies, ex. Soctronics, Mirafr, Si2chip, Aricent, Infosys, Wipro, Tata Elxsi, Sasken c) EDA software development and verification, ex. Synopsys, Mentor Graphics, Cadence, Xilinx. Most of these jobs in India are in the Fabless Semiconductor segment. It will be beneficial if you do post graduation in VLSI Design / Microelectronics in prestigious institutes in India (IITs/NITs) or abroad to get placed quickly in MNCs.

To properly align career goals and your training, you need to have a clearer understanding of the job titles and job profiles that a career in VLSI offers. More importantly, you should know about your strengths and personal attributes and choose the right job accordingly. Let us look at the various job opportunities and designations in the VLSI industry. **Artificial Intelligence (AI)** will likely be the catalyst that will drive another decade-long growth cycle for the semiconductor sector. The market for AI related semiconductors is expected to grow from a current US\$6 Billion in revenues to more than US\$30 Billion by 2022, a compound annual growth rate (CAGR) of almost 50%..

#### *1. Design Engineer*

In this designation, you are mainly responsible for design implementation. You need to be technically sound. This job does not demand high interpersonal skills, but still, you need to be effective in communicating your ideas. There are a few sub domains in this designation, which are classified according to the technology you will be working with.

#### **Design Engineer sub domains – According to the technology employed:**

- ASIC – Application Specific Integrated Circuit design
- FPGA – Field Programmable Gate Arrays
- AMS – Analog Mixed Signal design
- DFT – Design For Test
- Full Custom Designs – Transistor level
- PCB - Printed Circuit Board Design



## **Design Engineer – Designation specific titles** Front-end designer – ASIC/FPGA

- Back-end designer
- Synthesis and Timing Analysis
- Physical Design
- Layout design
- AMS designer
- DFT engineer
- PCB designer – Board design
- Library developer

### *2. Verification Engineer*

A Verification Engineer's job captures the verification stage of the overall chip design and manufacturing process. The engineer's task is to verify the design and make sure that the design works properly first time right. If the design is buggy, the cost of finding bugs in later stages of design increases by 10X. Hence, there is always a massive demand for this position with another factor being verification does not require a fully-fledged semiconductor lab. Almost 70% of the VLSI jobs in India are in the verification department. A lot of US-based companies outsource this job to countries like India and the UK.

For this job, you need to be extremely good at programming and have the attitude of "Never give-up". If you like software programming/coding/ scripting, this job is right for you. You are also expected to always be in sync with the current industry trends. According to the stages of development, the various sub domains of a verification engineer are classified as follows.

### **Verification Engineer's sub domains – According to the stage of development**

- Front-end verification – simulation
- Acceleration/Emulation – Validation
- Hardware Software co-verification
- Product validation – Validating the EDA tools
- Behavioral Modeling – modeling the design
- Verification Intellectual Property (IP) implementation – Test Bench (TB) developers

### **Verification Engineer – Designation specific titles**

- Front-end verification engineers
- Validation engineers
- Modeling engineers
- Verification Consultants

### *3. CAD Engineer*

This job entails you to be mainly responsible for managing the license and EDA tools. You will also evaluate EDA solutions and methodologies. Additionally, you will be asked to integrate various EDA tools

and develop workflows. You will work in tandem with design and design verification teams. Additionally, you will also be required to work with the EDA vendors and will be responsible for driving improvements in the work environments for other players of the System on Chip (SoC)/Chip design team.

You need to know how to interact with others. This job demands excellent interpersonal skills. You should always update yourself on the latest technologies and methodologies.

#### *4. Application Engineer*

This job title makes you responsible for the interface between the R&D and customers. You need to know how to interact with others. This job demands excellent interpersonal skills and a lot of traveling. If you feel that you are a highly communicative, good presenter, good at building relationships and good at technologies, etc., you are the right candidate for this job.

#### **Verification Engineer's sub domains – According to the customer's requirement**

- Field Application Engineer – Pre-sales
- Corporate Application Engineer – Post-sales
- Application Consultants

#### *5. Marketing and Sales*

Promotes the brand and sells the products. A good application engineer can quickly become a marketing or sales executive if he has an interest in sales.

### **IV. HOW TO BECOME A VLSI ENGINEER? WHAT ARE THE INDUSTRY'S SKILL REQUIREMENTS TO BE A VLSI ENGINEER?**

Though VLSI is treated as hardware design, VLSI engineers design the chips using special Hardware Description Languages (HDL) like VHDL and Verilog, as software programmers. So you need to be well versed in an HDL. VHDL is used in Europe, and Verilog is common in USA. Indian companies use both. You should also familiarize yourself with System Verilog and verification libraries like OVM/UVM. Basic knowledge of digital electronics is also a prerequisite.

It's also necessary to be well versed in OOPs concepts and CMOS concepts. Some scripting language skill is also essential. Python is quite a versatile language for this purpose. If you are not keen in programming, you can still choose back-end and circuit design jobs. Software industries mainly look for your IQ and programming skills. They do not differentiate candidates based on their knowledge in their engineering domain.

#### **What is the average salary of a VLSI engineer?**

The salaries in this profession are quite handsome and increase as you climb up the corporate ladder. Of course, like the compensation for any job, here too, it depends on your skillset, performance and location. In the initial 1- or 2-years period while you are learning the skills, the package may be average. However, subsequently it can zoom exponentially compared to your software counterparts. You can always use glass door to get the latest salaries for your designation in your geographical area.

## V. TIPS FOR GETTING INTO VLSI CAREER

There is a proverb: “**A journey of a thousand miles starts with a single step**”. In the same way, the single step that’s needed is that first you need to be strong in the concepts of Digital Design, MOSFET, basic Programming Skills, basic quantitative aptitude and clear written/oral communication. The interviews for fresher’s won’t check for perfection. However, they check if the candidates have the right attitude and can quickly learn the required technical skills based on strong technical concepts.

In the VLSI domain, if you are really passionate about electronics engineering, you would perform well and grow fast. It’s straightforward to differentiate yourself from others because you are competing only with the other electronics engineers.

I have just outlined the **personal attributes** that are highly required for these jobs. But it does not mean that only these attributes are enough to get into the industry and perform well. If you really want to differentiate yourself from others and perform in an outstanding manner, you need to be a good team player, flexible, knowledgeable, hard-working, positive, and energetic, irrespective of the work/job that you do.

## VI. CONCLUSION

If all the inputs given above are taken into account, then an average student also can aim for a good career in VLSI, provided he/she has strong commitment and ready to put in systematic effort.

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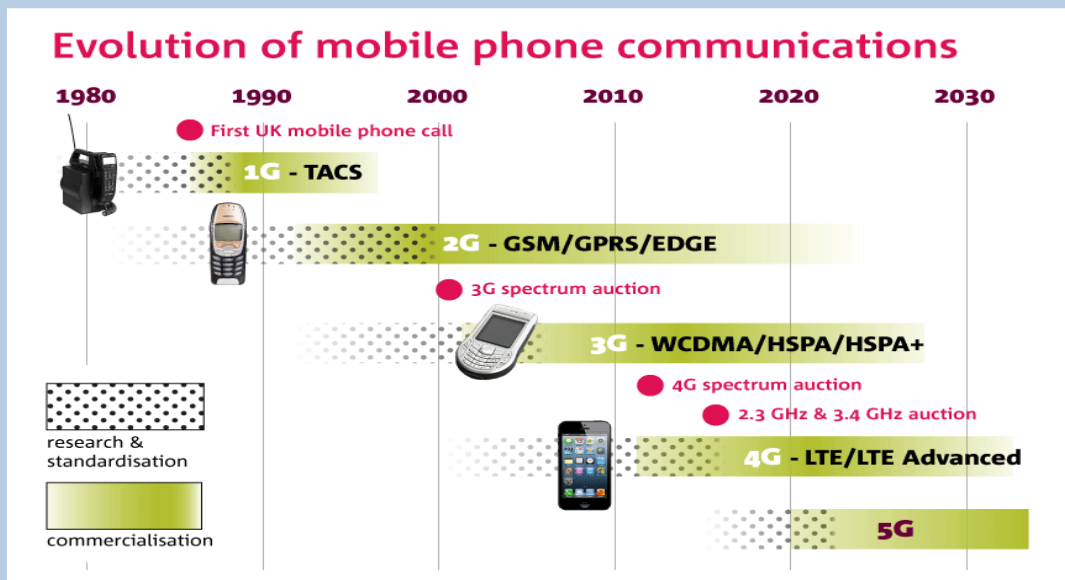
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# EVOLUTION OF WIRELESS PHONE TECHNOLOGIES

Dr. P. Srihari, Professor, ECE, GCET

The present discussion **focuses** on the evolution and development of various generations of mobile wireless technology along with their significance and advantages of one over the other

- Pre cell phone Mobile Telephony Technology such as radio telephony.
- Mobile radio telephone systems preceded modern cellular mobile telephony technology
- Since they were the predecessors of the first generation of cellular telephones, these systems are called 0G (zero generation) systems.



## ➤ 1G wireless Technology(1980-1990)

- Frequency: 150MHz / 900MHz
- Bandwidth: Analog telecommunication (30KHz)
- First Wireless Communication
- Analog Cellular Technology with a data rate(capacity) of 2Kbps
- Poor Battery performance
- Cell phones are bulky in size
- Poor voice quality



## ➤ 2G wireless Technology(1991-2000)

- Frequency: 1.8GHz,(900MHz) Digital telecommunication
- Bandwidth: 900MHz(25MHz)
- Digital Cellular Technology, Global System for Mobile



### Communication(GSM)

- Data rate(Capacity):64Kbps
- Allows text message services
- Supports web browsing(slower speeds)
- Quick and reliable for all other basic functions of a Phone

### ➤ 2.5G wireless Technology

- 2G cellular technology with General Packet Radio Service(GPRS)
- E-mails
- Web Browsing
- Phones with Camera

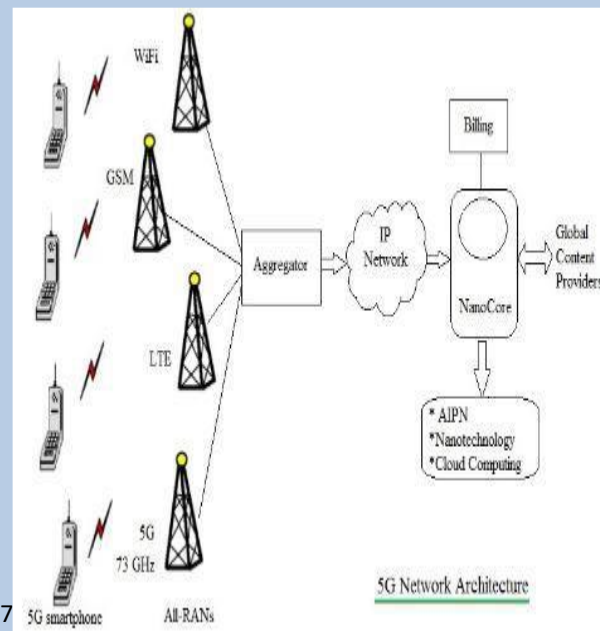
### ➤ 3G wireless Technology(2000-2010):

- Frequency:1.6GHz - 2.0GHz
- Bandwidth: 100MHz
- Digital broadband with increased Speed
- Technologies used: Code Division Multiple Access (CDMA), Universal Mobile Telecommunication Service (UMTS), Enhanced Data GSM Environment (EDGE)
- Data rate(capacity):144Kbps to 2Mbps
- Smart Mobile Phones (Expensive)
- Video calls
- Fast Communication
- Mobile TV
- Supports calls, texts, web browsing, email, apps, video streaming and file downloads
- Connection speeds can vary depending on location



### ➤ 4G wireless Technology (2010 onwards):

- Frequency: 2 – 8 GHz
- Bandwidth: 100MHz
- High speed
- Technology; Long Term Evolution(LTE),
- Wi-Fi
- Data rate(capacity)-100Mbps-1Gbps
- Essential features:



- ❖ Mobile Multimedia
- ❖ Anytime, Anywhere
- ❖ Global Mobile Support
- ❖ Integrated Wirelss solutions
- ❖ Customised personal services
- Good Quality of service and high security
- Bigger battery usage

➤ **5G wireless Technology**

- Capacity(data rate): 1Gbps - Unlimited
- Faster sata transmission than 4G
- Supports
  - ❖ Interactive Multi Media
  - ❖ Voice streaming

	1G	2G	3G	4G	5G
Period	1980-1990	1990-2000	2000-2010	2010-	Latest
Bandwidth	150/900MHz	900MHz	100MHz	100MHz	1000X Bandwidth per unit area
Frequency	Analog Signal (30KHz)	1.8Ghz(Digital)	1.6 to 2GHz	2-8GHz	3-300GHz
Data Rate	2Kbps	64kbps	144Kbps- 2Mbps	100Mbps- 1Gbps	>1Gbps
Characteristic	First wireless Communication	Digital	Digital Broadband, Increased speed	High speed, all Internet Protocols	
Technology	Analog Cellular	Digital cellular	CDMA, UMTS, EDGE	LTE, WiFi	



## Comparison

<b>1G</b>	<ul style="list-style-type: none"><li>• Voice Signals Only</li><li>• Analogue Cellular Phones</li><li>• NMT, AMPS</li></ul>
<b>2G</b>	<ul style="list-style-type: none"><li>• Voice &amp; Data Signals</li><li>• Digital Fidelity Cellular Phones</li><li>• GSM, CDMA, TDMA</li></ul>
<b>2.5G</b>	<ul style="list-style-type: none"><li>• Enhance 2G</li><li>• Higher Data Rates</li><li>• GPRS, EDGE</li></ul>
<b>3G</b>	<ul style="list-style-type: none"><li>• Voice, Data &amp; Video Signals</li><li>• Video Telephony / Internet Surfing</li><li>• 3G, W-CDMA, UMTS</li></ul>
<b>4G</b>	<ul style="list-style-type: none"><li>• Enhanced 3G / Interoperability Protocol</li><li>• High Speed &amp; IP-based</li><li>• 4G, Mobile IP</li></ul>

Future

- 6G

Integrate 5G  
with Satellite  
Network for  
Global  
Coverage

Ultra fast  
Internet  
Access

- Smart Home
- Smart Cities

## PEROVSKITE SOLAR CELLS

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**Abstract:** Perovskite solar cells, first fabricated in 2009, hold many advantages over the typical solar cell. These cells with greater superconductivity, absorption coefficient and efficiency, hold great potential in the electronics field, allowing scientists to look beyond their drawbacks despite the latter being many.

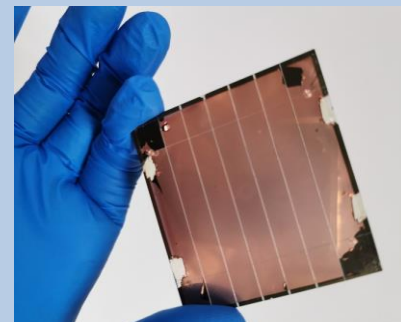
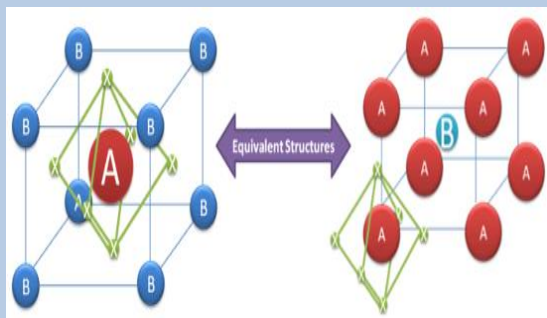
### I. INTRODUCTION

The manufacturing of a traditional Silicon solar cell is an expensive, multi-step process. The requirement of high temperatures ( $>1000\text{ }^{\circ}\text{C}$ ), high vacuum and an extensively clean environment limits the potential of manufacturing them. Perovskite solar cells, therefore, are much advantageous with their simple processing methods and high internal-defect tolerance.

### II. PEROVSKITE CELLS

A) *What is a Perovskite?*

A Perovskite structure is any compound that has the same crystal structure as the Perovskite mineral, Calcium Titanium Oxide ( $\text{CaTiO}_3$ ). The general chemical formula of compounds made of this mineral is  $\text{ABX}_3$ . The compound can be visualized as a cube whose **centre is occupied by a cation A** and **corners occupied by cations B**. The **faces of the cube are occupied by anions X** which are comparatively smaller.



B) *What is a Perovskite Solar Cell?*

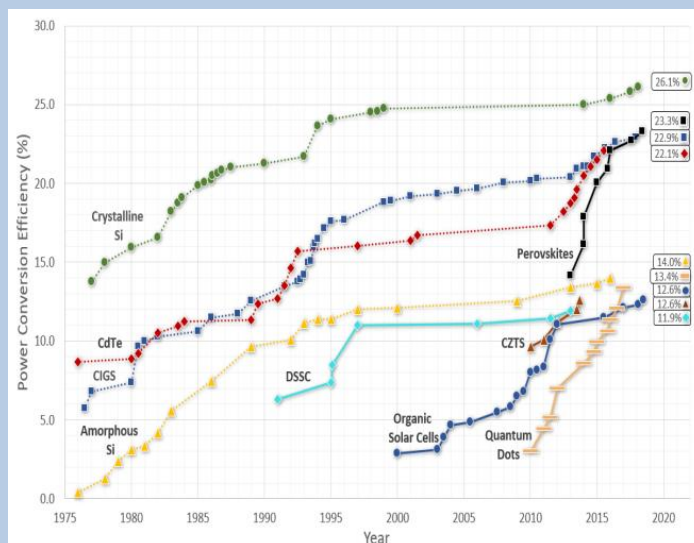
Perovskite solar cells are a type of thin-film solar cell made from Perovskites. The most commonly used compound for Perovskite cells are **Methylammonium Lead halides** due to their abundance and low production cost.

### III. ADVANTAGES OF PEROVSKITE SOLAR CELLS

Properties of Perovskites include:

1. Superconductivity
2. Giant magnetoresistance
3. Spin-dependent transport (spintronics)
4. High absorption coefficient &
5. High efficiency

Perovskite solar cells have also managed to demonstrate greater photon energy utilisation, and have the potential to go even further. Their inexpensive fabrication methods, combined with their thin, lightweight, flexible and semi-transparent solar modules, provide them a huge number of advantages over typical compounds like Silicon.



Perovskite solar cells have increased in power conversion efficiency at a phenomenal rate compared to other types of photovoltaics. Although this figure only represents lab-based "hero cells", it heralds great promise.

### V. PEROVSKITE SOLAR CELL vs. SILICON PV SOLAR CELL

<b>PEROVSKITE SOLAR CELL</b>	<b>PV SILICON SOLAR CELL</b>
Consists of Perovskite compounds	Consists of Crystalline Silicon
Made through a process called "Solution Processing", which is the same practice used to print newspapers	Crystalline Si is extracted from the earth, processed and then used to make high-quality solar cells
Comparatively easy fabrication process	Tougher fabrication process
Completely man-made	Semi-natural
High absorption coefficient	Low absorption coefficient
Toxic	Non-toxic
Mass-production is cost efficient	Mass-production is relatively costly
Supply can meet demand	Demand often exceeds supply
Lifetime is comparatively shorter.	Lifetime is comparatively longer

### V.LIMITATIONS OF PETROVSKITE CELLS

Effective and promising as they may sound, Perovskite cells have disadvantages which limit their exposure in global markets and research fields. Major limitations include non-durability, instability and toxicity. Perovskite cell instability is mainly due to intrinsic and extrinsic factors- the prior involving

bond-strength, ion migration and stoichiometry, and the latter including degradation due to air, moisture and temperature. When a Perovskite cell breaks down, there is release of PbI (Lead Iodide), a carcinogenic compound, into the ground. This can enter our food pyramid ten times more effectively than other lead contaminants that are already present as the result of the human activities.

## **VI. APPLICATIONS OF PEROVSKITE CELLS**

These cells are used to power low-power wireless electronics in the field of IOT (Internet of Things). Perovskite solar cells convert ultraviolet and visible light into electricity with very high efficiency, implying that they might be excellent tandem partners with absorber materials such as crystalline silicon that efficiently convert lower-energy light.

## **VII. CONCLUSION**

Perovskite cells have achieved a significant amount of influence due to their extremely attractive advantages over the years. Despite their drawbacks, scientists are determined to study this cell and its advantages in order to make necessary changes and minimize the inconveniences caused by it.

Overall, the material holds great potential in the field of electronics and green energy resources.

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## PAPER BATTERY

V. Sumana Sarvani, 18R11A04K1, ECE, GCET. Email Id: [sumanasarvani10@gmail.com](mailto:sumanasarvani10@gmail.com)

**Abstract:** *With paper bags and other eco friendly stuff being brought into today's digital century, why not a paper battery? Yes, you have heard it right, a paper battery, which could be a solution for compact energy storage.*

### I. INTRODUCTION

With the world science and technology developing in an exponential phase and even with the largest of the largest devices being designed into a compact size, nothing seems impossible. Thus, here comes our paper battery into the picture. As the name suggests, the paper battery has quite a resemblance with paper. It is a device made up of cellulose paper, with carbon nanotubes emboldened on it. It is incorporated with an infusion of carbon nanotubes and paper, which consists of an ionic liquid as an electrolyte. This device can be shaped and cut as per our required needs without causing any damage to its functioning and efficiency

### II. ORIGIN OF PAPER BATTERY

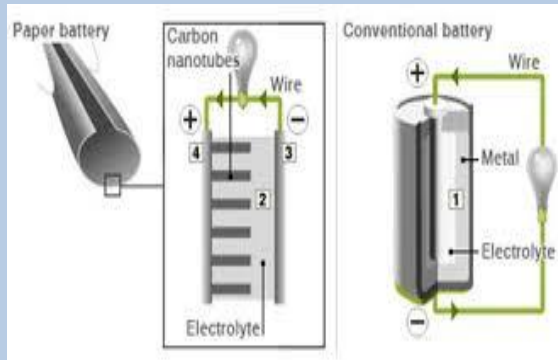
The idea of constructing paper batteries was first proposed by Robert Linhardt, a chemist at Rensselaer Polytechnic Institute in Troy, New York. Yi Cui, a materials scientist at Stanford University, Palo Alto (California) came up with a solution when a problem arose regarding the materials adhering to its surface. Though the combination of cellulose paper being layered with conductive nanotubes was a durable material, the components could not stay intact when flexed.

Yi and his team of researchers resolved this problem by creating a carbon nanotube ink, suspending it in water and an organic surfactant. So when the nanotubes were glued to the cellulose paper and heated, they tightly bonded adhered themselves to the fibres of the paper, forming a sheet of high conductivity.

The internal working of paper battery is quite similar to that of conventional one. The conventional batteries, which we use in our daily life, produce electrons with the chemical reaction of a metal and electrolyte. So when we dip the paper battery in ion-based liquid, electricity is generated due to the movement of electrons from the cathode to the anode terminal. This is because of the chemical reaction between the electrodes of paper battery and liquid. As the ions flow quickly, within a matter of seconds, the energy is stored in the paper-electrode during the recharging

### III. WORKING OF A PAPER BATTERY

These paper batteries are connected each other in a very close manner to increase their output. This means that there is also a possibility of shorting between the two terminals, i.e. the anode terminal and cathode terminal. If the anode terminal comes in contact with cathode terminal, then there will be no flow of current in the external circuit. So to avoid the occurrence of a short circuit, a paper separator is used to create a barrier between anode and cathode.



#### IV. ADVANTAGES OF PAPER BATTERIES

Paper batteries prove to be very beneficial with unusual properties being folding, cutting, moulding, creasing and shaping for various sorts of applications. Since they can generate electrical energy of 1.5 V, they can be used for devices that use low power like calculators, wrist watches and wireless communication devices like Bluetooth headphones, keypads, mouse, etc. These paper batteries also have a less impact on the environment, for they are more economical, biodegradable, and biocompatible.



#### V. LIMITATIONS OF PAPER BATTERIES

With so many advantages, there are always a few limitations in tow.

1. The carbon nanotubes used in paper battery are very expensive due to use of it in procedures like electrolysis and laser ablation.
2. The paper battery wastage when inhaled can cause damage your lungs.
3. Cellulose has low shear strength thus it is more prone to tearing

#### VI. APPLICATIONS OF PAPER BATTERIES

With the modern day technology being designed into lightweight and compact sizes, these batteries can perfectly facilitate the requirements in terms of space. They can also be used in various fields like automobiles and aircrafts to build hybrid vehicles and in medical sciences for artificial tissues, drug delivery systems, and so on.



## **VII. CONCLUSION**

Paper batteries have already paved their way into various fields. It is only a matter of time for them to become an every household commodity. Despite their drawbacks, these batteries prove to be very useful and also happen to be eco friendly. They might be small but their use can be limitless because with human imagination, nothing is impossible.

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## FINFET TECHNOLOGY

Dr. S Suryanarayana, Professor & HoD, ECE, GCET.

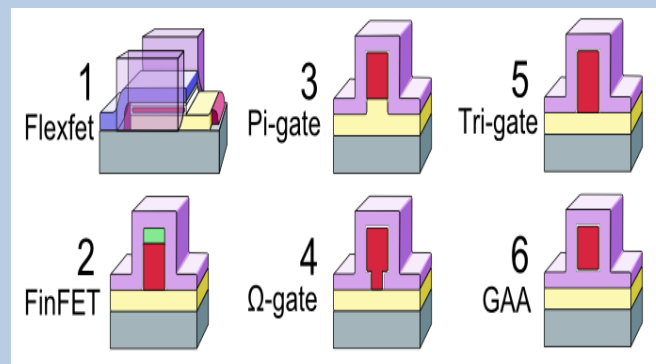
**I. Introduction:** Relentless scaling of planar MOSFETs over past years has increased transistor density and performance of Integrated Circuits (ICs). Scaling down the technology node in MOSFETs is very challenging due to drastic increase in subthreshold leakage current ( $I_{off}$ ). Due to very narrow channel lengths, in deeply scaled MOSFETs, the gate is unable to shut off the channel completely in off-mode operation, which leads to increase  $I_{off}$  between drain and source. So Multiple-Gate Field-Effect Transistors (MGFETs) are introduced to reduce this short channel effect. This makes MGFETs superior to planar MOSFETs in short channel performance metrics, such as subthreshold slope (S), Drain-Induces Barrier Lowering (DIBL) and threshold voltage ( $V_{th}$ ) roll off. MGFETs are classified into Double-Gate FETs (DGFETs), FlexFETs, FinFETs, Tri-Gate FETs and Gate-all-Round FETs (GAAFETs) as shown in fig: 1.

Among all MGFETs, FinFETs have emerged as the most desirable alternative to MOSFETs due to their simple structure and easy to fabricate. FinFET research papers are explaining about the structure of FinFETs only, but no design circuits, yet.

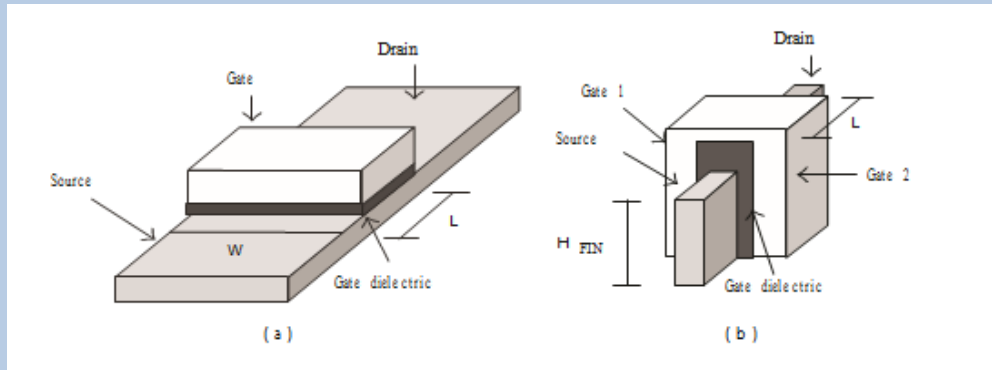
In this article evolution of FinFETs is presented with respect to the drawbacks of planar MOSFETs. Later study the structure of FinFETs by comparing it with other transistors is given. After that, the types of FinFETs available till now and their structures and electrical symbols are being presented. Finally, the advantages and drawbacks of FinFETs by taking area, delay and power consumption into consideration.

### II. Structure of FinFET:

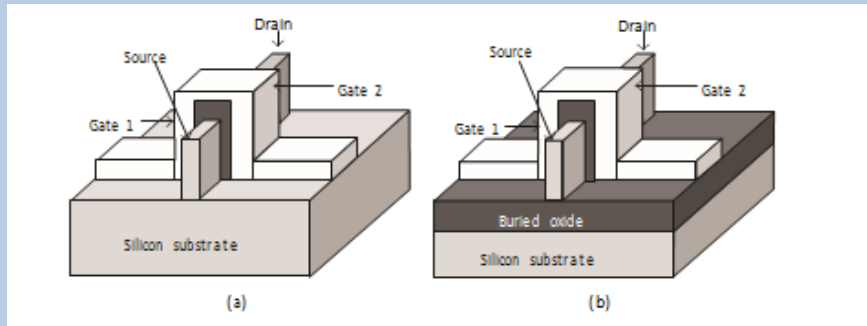
The fig:2 compares the structures of both MOSFET (fig:2a) and FinFET (fig:2b). The drain and source of FinFET is a thin wafer of silicon which is very similar to a fin of a fish, for which it gained the name. In a conventional MOSFET, the channel is horizontal while in FinFET, the channel is vertical. Hence the height of the channel determines the width of the FinFET. In a FinFET, two gates are there, namely, Front-Gate and Back-Gate. By having two gates all the short channel effects can be overcome, which were caused by conventional MOSFETs. Although FinFETs are implemented not only on bulk wafers (fig:3a) but also on Silicon-On-Insulator (SOI) wafers (fig:3b). In bulk FinFETs all fins share a common substrate whereas the fins of SOI FinFETs are physically isolated. However, FinFETs on both types of wafers are quite comparable in terms of cost, performance and yield.



**Fig 1: Basic models of different Multi-Gate FETs**

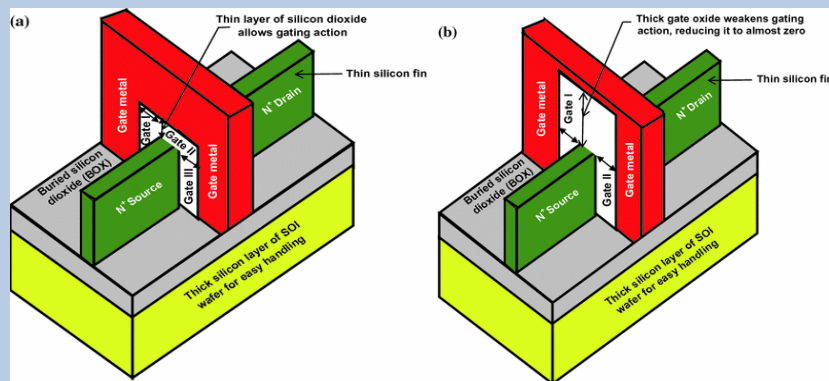


**Fig 2: Structural comparison between (a) Planar MOSFETs and (b) FinFETs**



**Fig 3: Structural comparison between (a) bulk FinFET and (b) SOI FinFET**

Tri-gate FETs are very similar to FinFETs (fig:4). Thin layer of silicon di-oxide on the top of the channel allows the gating action which is called a tri-gate FET. Whereas the thickness of that layer is very less in a FinFET. So, Tri-Gate FETs have slight width advantage over FinFETs. Hence Tri-Gate FET is termed as a variant of FinFET, with a third gate at the top of fin.

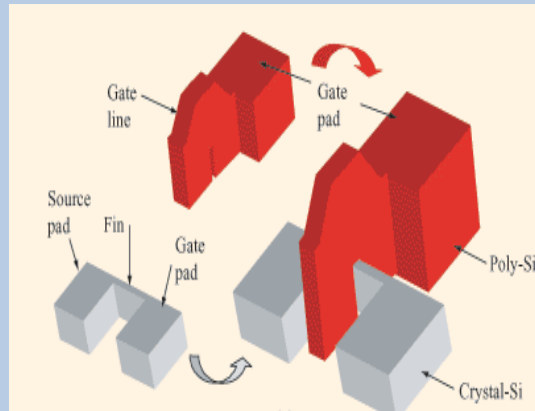


**Fig 4: Structural comparison of (a) Tri-Gate FET (b) FinFET**

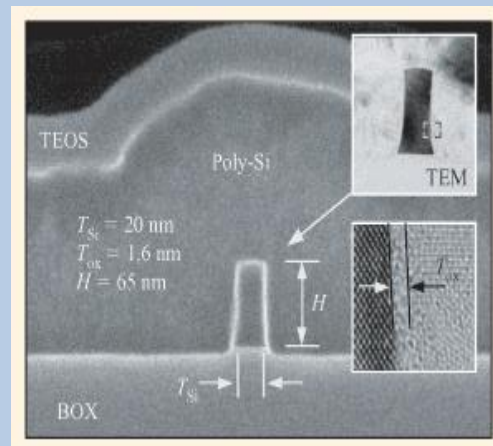
**III. Fabrication of FinFETs:** Fabrication of FinFET is very challenging because fabricating thin and uniform fin plays a very key role. And fabrication should also take care of source-drain series resistance. There are two methods of fabrication of FinFETs. They are:

- (a) Gate-First process
- (b) Gate-Last process

In Gate-First process, the gate stack is patterned first and then the drain and source regions are formed. Whereas in Gate-Last process, the source and drain regions are formed and then the gate is patterned and placed around the fin. Generally, FinFETs are fabricated on SOI wafer. In Gate-Last process, fabrication starts with patterning and etching of thin fin on SOI using hard mask. This mask is retained on the fin throughout the process to protect the fin. The Gate stack formation is very similar to that in MOSFET fabrication. After fabricating gate stack, carefully it is placed on the fin(Fig:5).



**Fig 5: Figure showing how gate is placed on fin**

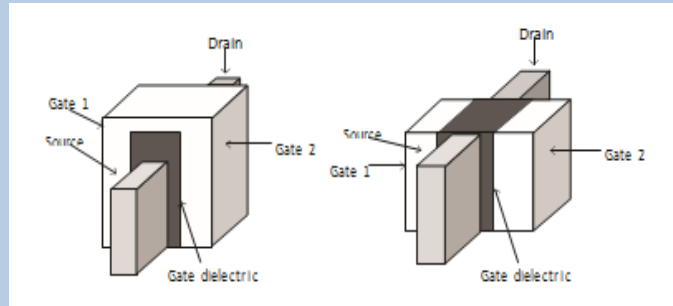


**Fig 6: Figure showing fabrication of fins using Transmission Electronic microscope (TEM)**

The fin thickness (Fig: 6) is half or one-third of gate length. So, the fin will be of very small dimension. Generally, fins are fabricated by using E-beam lithography or by using optical lithography by following extensive linewidth timing. To create thin fins very close to each other, sidewalls image transferring technique is implemented which improves the layout density.

#### IV Classification of FinFETs:

FinFETs are mainly classified into two types namely, Shorted-Gate (SG) FinFET and Independent-Gate (IG) FinFET. In SG FinFETs, both the gates are physically shorted (fig: 7a), whereas in IG FinFETs, both the gates are physically isolated (fig: 7b). Thus, in SG FinFETs, both the gates are jointly used to control the channel.



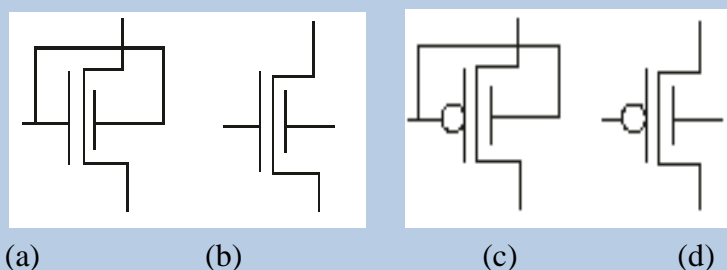
**Fig 7: Structures of (a) SG FinFET and (b) IG FinFET**

As a result, SG FinFETs show higher on-current ( $I_{on}$ ) and off-current ( $I_{off}$ ) compared to IG FinFETs. Whereas, IG FinFETs offer flexibility to apply different voltage levels to its two gates. But IG FinFETs has a disadvantage of area penalty due to placement of two separate gate contacts.

These SG FinFETs can be further classified based on asymmetries in the device parameters. Generally, the work functions of both the gates are same in FinFETs. If FinFETs are fabricated with selective doping of the two gate stacks then due to the asymmetry in work function of both the gates, the SG FinFETs are divided into normal SG FinFETs and Asymmetric gate-work function SG FinFETs (ASG FinFETs). All ASG FinFETs have two orders of each and every parameter which can be modified.

#### V Electrical symbols of FinFETs:

As MOSFETs were categorized into nMOSFET and pMOSFET, FinFETs are also classified into nFinFETs and pFinFETs. As we have two types of FinFETs, so the FinFETs can be classified into four namely, SG nFinFET, IG nFinFET, SG pFinFET and IG pFinFET. The symbols are shown in fig: 8.



**Fig 8: Electric symbols of (a) SG nFinFET (b) IG nFinFET (c) SG pFinFET and (d) IG pFinFET**

**VI Advantages and Drawbacks of FinFET Technology:** As FinFETs are the newer version for the MOSFETs, there are many advantages of FinFETs over planar MOSFETs. SG FinFET is the best in area and propagation delay but incurs much higher leakage current and hence more power consumption. IG FinFET will have promising leakage current than delay and area.

## STARLINK SATELLITE CONSTELLATION – WILL IT WORK?

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**Abstract:** *This article involves a brief overview of Starlink Satellites: their need and their requirements, their method of operation and their purpose. The advantages, disadvantages, consequences and the measures, taken to prevent the damages done, are also briefly discussed.*

### I. INTRODUCTION

**Starlink** is the name of a satellite constellation constructed under the guidance and planning of the American company **SpaceX**.

#### a) *What is a satellite constellation?*

A satellite constellation is a system consisting of a group of artificial satellites working together. This system can provide a permanent global or near-global coverage, so that **at least one** satellite is accessible at a particular instant of time.



#### b) *Working of a satellite constellation*

Each Starlink satellite weighs 227 kilograms and is roughly the size of a table. Like any other satellite, this satellite's internet works by beaming information through the vacuum of space. This makes it 47% faster than an optical fibre cable, which must be physically laid down to reach far-flung places.

Satellites in a constellation are usually placed in sets of complementary orbital planes. They may also use inter-satellite communication and connect to globally distributed ground stations.

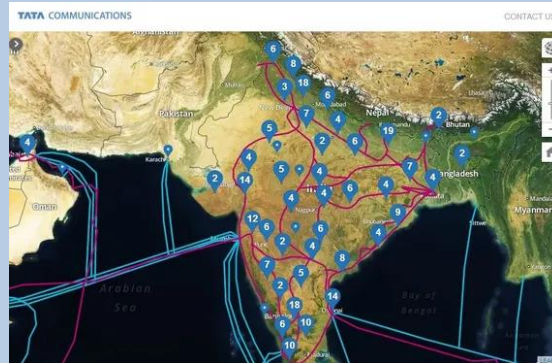
### II.ABOUT SPACEX

SpaceX stands for Space Exploration Corporation. It is a private space exploration, transportation and aerospace manufacturing company. Elon Musk, an engineer, industrial designer and technological entrepreneur, founded it. This private organization had more than 100 launch contracts including some successful ones like **Falcon9**, **Falcon Heavy** (in collaboration with NASA).



### III. PURPOSE OF STARLINK SATELLITES

More than 99% of the internet traffic relies on high quality optical fiber cables to connect to various countries. These cable networks are laid and maintained by governments and various giant companies.



The process of internet service involves many steps, thereby increasing the cost with each step. Users, at the end of this chain, are forced to bear the brunt of heavy expenses due to the unavailability of direct contact between them and the owner. SpaceX, in January 2015, publicly announced that they intend to manufacture and launch a communication satellite network having a potential to support sufficient bandwidth, to carry up to 50 percent of all backhaul communications traffic, and up to 10 percent of local internet traffic in high-densities. Elon Musk stated the motive behind this billion-dollar project was the highly unmet demand for low-cost global broadband capabilities.

### IV. ADVANTAGES OF STARLINK SATELLITES

The main advantage of this project is that it establishes a direct connection between the user and the owner, thereby reducing the cost of satellite internet. Another advantage is that it can compensate for most of the optical fibre communications, thereby reducing redundant expenses. The extreme cost-effectiveness and commerciality of this project might be of great potential in terms of satisfying the above stated motive. Musk said the Starlink network would be able to provide "minor" internet coverage after 400 spacecraft were up and running, and "moderate" coverage after about 800 satellites became operational.

### V. HOW ARE STARLINK SATELLITES DIFFERENT

In November 2016, SpaceX was given permission by the Federal Communications Commission (FCC) to launch 4,425 satellites that would operate in Ka and Ku frequency bands at an altitude of 1,200 km. This was an NGSO or Non-Geostationary orbit satellite system, in the Fixed-satellite service. Following in March 2017, the company fixed plans with FCC to field a second orbital shell of more than 7,500 V-band, non-geosynchronous orbits to provide communication services.

This was very unconventional in several ways because:

They intended to use the rarely used V-band of the communication spectrum.

They wanted to operate in a region referred to as "VLEO" or Very Low Earth Orbit where the atmospheric drag is quite high.

(a) These 7,518 satellites would be called as Starlink constellation and they would orbit at a relatively less height of about 340Km.

(b) An average satellite's orbital decay lasts for 25 years. However, a Starlink satellite's decay is only for 5 years. This is due to the high atmospheric drag present in the lower orbital of the earth.

(c) Starlink is also the very first Krypton propelled spacecraft ever flown, whereas most satellites orbiting the Earth use hypergolic fuel/ Oxidizer combinations.

## VI. TROUBLES AND DISADVANTAGES

There was a small controversy regarding the launch dates, leading to an irrevocable prediction by the FCC. The prediction stated that in six years, half of the Starlink constellation would be in the sky. Despite the filed petition for a waiver from companies like Boeing, alongside SpaceX, US FCC refused to step down and ruled that there must be a full system in orbit before nine years from licensed date.



SpaceX has managed to acquire permission to launch up to a 42,000 satellites at different orbital ranges for various commercial, exploration and research purposes. This mega-constellation of satellites is not just the most amazing, but also, the scariest part of this project.

The Starlink constellation's Phase-1 maiden launch was done on 22 February 2018. 1,584 satellites were launched into an orbit at a height of 550 km followed by many other successive launches. The enthusiasm and curiosity received by this project initially soon turned into concerns due to issues like light pollution and night-sky observation difficulties. On reporting, the company started to look for alternatives. Another embarrassing aspect was that of satellite positioning. The company shared limited information about the satellite positioning, excluding the fact that the position of a satellite could only be determined for about 32 hours after its launch. After this, it could no longer be determined. These uncertainties led to one of the satellites almost collide against a European satellite. Although no harm was done, **the issue was inescapable** and SpaceX's reluctance to publicize the positioning data did not help improve it any further.

## VII. TROUBLESHOOTING AND CONSEQUENCES

This project has managed to provide another indirect advantage of employment, by recruiting up to a thousand people from various areas of expertise like Signal Processing, RFIC and ASIC for the satellite development program and is still continuing to do so. The key to prevent this high-speed collision space horror is the precise tracking of satellites. Air force's space surveillance is popularly known to be unreliable.

Another solution that these satellites hold within themselves is their Autonomous Avoidance System (AAS). This system causes the satellites to move away from the path of collision whenever any object is in proximity. This method also requires less input from the people on the ground. However, it makes the

satellites highly unpredictable in terms of the path they would choose. Most satellites have a path prediction of about 7 days whereas the Starlink satellites only have about 32 hours, because of AAS. Because of their orientation and the fact that they catch the Sun's light, well beyond twilight hours, **Starlink satellites are brighter than 99 percent of the objects in the current orbits.**

For instance, the images of comet Neowise (occurs once in 6800 years, which is currently shooting across the outer Solar System, have been disrupted by Elon Musk's SpaceX Starlink Satellites. An effective solution to this problem was that, the company coated their later satellite with black paint to dim its intensity. This helped reduce the nuisance caused to observational astronomers.

Currently, this project seems to be having these sorts of haphazard consequences:

- 1) The whole deal might live up to its original idea, in which case it will be smooth sailing
- 2) The large influx of satellites might overwhelm our tracking capabilities altogether, causing us to lose track of every other object in the orbit-An ultimate space apocalypse.

At this point, not many rigorous studies have been conducted to come to definite conclusions, but the following may improve the situation:

- 1) Frequent information exchange between various space organizations and SpaceX
- 2) SpaceX's document filed (in 2017) with FCC consisting their "space debris mitigation plan". It stated, *"The Company will implement an operations plan for the orderly de-orbit of satellites nearing the end of their useful lives (roughly five to seven years) at a rate far faster than is required under international standards. [Satellites] will de-orbit by propulsively moving to a disposal orbit from which they will re-enter the Earth's atmosphere within approximately one year after completion of their mission"*.

## IX. CONCLUSION

The above solutions may, or may not work out. Irrespective of the consequences, it is safe to assume that this situation may stand as a good example, depicting the large array of things that an engineer, manufacturer, entrepreneur and a scientist must bear in mind before undertaking a large-scale project.

Despite its pure intentions, this project, as time progresses, births flaws and consequences, which may look small but are inexcusable. As fellow engineers, we all may wish for its success, but currently, this grand idea is nothing but a waiting game.

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# RECENT ADVANCEMENTS IN SOLAR CELL TECHNOLOGY

Dr. Vallisree S, Associate Professor, ECE, GCET.

## I Introduction

The increased consumption of fossil fuels such as coal, liquefied petroleum, oil and natural gas seem to cause greenhouse effect and global warming. Renewable energy sources can be viewed as an alternative solution for the limited availability of fossil fuels. Among all the renewable energy sources, solar energy is the most promising renewable energy owing to its extensive availability. Hence it is considered as the most promising long term clean energy solutions. When we hear the word Solar Power, anyone naturally thinks about the roof top solar panels which have dominated the solar market until this point of time. Solar energy harvesting finds its applications in almost all areas such as Solar powered roads, Solar skin design, Wearable solar, Solar batteries etc. Solar powered LED bulbs that can be used for lighting the roads and having the thermal heating capacity to melt snow during winter weather. Solar skin designing (figure 2) is making solar panels to match the appearance of the roof without compromising on the efficiency. Wearable Solar is finding its applications in different gadgets like watches, clothes (solar textiles, solar fabrics). Solar powered toy robots and other gadgets which make it even interesting for the kids to learn and operate on solar powered gadgets to understand and appreciate the solar technology. Even house owners have been deploying solar panels for solar heaters and other household purposes as it is becoming cheaper day by day. Photovoltaic tracking systems eventually tilt and shift the angle of solar arrays in accordance with the intensity of the sun.

## II Recent Advancements in Photovoltaic's:

Stanford University in collaboration with Department of Energy has come up with a device for purifying water when exposed to sunlight. MIT researchers have revealed a technical concept on utilizing the thermal heat emitted by the solar panels for improving the efficiency of solar cells. Floatovoltaics (floating solar panels) are gaining popularity as they can generate huge amount of electricity without the use of any land or real estate property. They can be installed over reservoirs and other water bodies which in turn reduces the evaporation of water. Also, researches showed that the floating solar panels mounted over reservoirs and water bodies (figure 1) can produce power by 10% more than the traditional solar cells.



Fig. 1: Floating Solar Panel



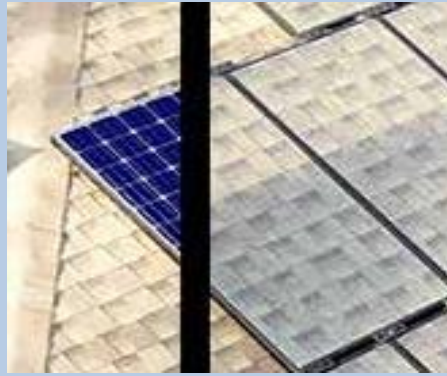


Fig. 2: Comparison of a standard solar panel installation shown on left and solar skins on right.  
(Image Credits: Massachusetts Institute of Technology (MIT) News).

### **A. Origin of tandem solar cells**

The solar cells are grouped into 4 different generations based on the technology and materials. First generation solar cells are single material silicon solar cells with p-n doping to form a p-n junction. The second generation photovoltaic cells are basically thin-film solar cells based on thin film materials to reduce the cost, however produces less efficiency. The commonly used materials for this technology include amorphous Silicon, polycrystalline silicon, Cadmium Telluride, Copper Indium Gallium Selenide/Sulfide etc. The advantages of thin film are reduced material usage, reduced mass so that it can be used for fitting in lights and textile or fabric industry. Thin epitaxial semiconductor deposits on Silicon wafers having higher efficiency also falls under this category which are used in space applications. Third generation focuses on solar cells such as photo electrochemical solar cells, polymer solar cells and dye-sensitized solar cells which are still in the research stage. The fourth generation solar cells focus on composite solar cell technology combining the varieties of solar cells in previous generations. The multispectrum layers are stacked together to absorb all portions of the visible light spectrum. There will be intermediate layers to pass on the infra-red light to lower layers of the multi-junction solar cells.

### **B. Multi-junction solar cells**

Multi-junction solar cells in simpler terms are nothing but stacking or organizing the solar cells in different possible electrical and mechanical configurations. Researchers have been looking for ways to improve the efficiency and reduce the cost of solar cells which is the life of photovoltaic systems. Best research cell efficiencies have been reported by National Renewable Energy Laboratory. Researchers are focusing on combining silicon technology with thin film solar cells in order to minimize the cost and improving the efficiency of solar cell. Before the fabrication process, lots of theoretical studies are being carried out by industries/institutions for analyzing the feasibility and predicting the maximum attainable efficiency. Some of the top universities undergoing research on tandem or multi-junction solar cells are Australian National University, Solar Energy Research Institute of Singapore (SERIS), TU Delft University etc. Now, let us discuss how the materials are chosen for the solar cell? The band gap and the light absorption capability of the material play a vital role for deciding the suitable light absorption material for the individual solar cell along with several other factors. A typical multi-junction solar cell is combining two-three solar cells in series configuration and the top cells should absorb some portion of the visible light spectrum and the connecting layer

should have the capability to pass on the remaining light to the bottom module. The bottom module should absorb the remaining portion of the spectrum. Also, few of the researchers have been working on finding a suitable top cell absorber material (top module) with Silicon as bottom module which absorbs the infra-red portion of the spectrum. Materials such as  $\text{CuInS}_2$ ,  $\text{Cu}_2\text{ZnSnS}_4$  and amorphous silicon and  $\text{Sb}_2\text{S}_3$  can be considered as suitable absorber materials for the top cell. CIS and CZTS possess band gap of  $\sim 1.5$  eV and have absorption coefficient of  $10^4$ - $10^5$   $\text{cm}^{-1}$ . The other two materials  $\text{Sb}_2\text{S}_3$  and a-Si:H possess band gap of approximately 1.7 eV which are more suitable for absorber top cell materials. Recently perovskite solar cells is seen as one of the best choices for top cell and tremendous research is in progress to address the stability issues in perovskite solar cells so that it could be a more suitable top cell absorber materials for tandem solar cells with Silicon as bottom module.

### **III Conclusion**

The recent advances in solar energy harvesting and the applications of solar power in various fields makes this as one of the emerging areas of research. Also, the different generations of solar cells and the recent focus towards the development of multi-junction tandem solar cells by various research institutes and organizations to attain the cost benefits would be one of the interesting emerging areas of research which helps in meeting the energy needs of the society in an environment friendly manner.

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## REMOTE CONTROLLED ECO-FRIENDLY BLACKBOARD CLEANER



**M. Eswar Hemanth**

**An innovative project implemented by M. Eswar Hemanth, student of IV B.Tech in the classroom of Department of ECE, GCET** Blackboard is essential for every educational institution. The manual method of erasing the blackboard with a duster is a time consuming and tedious process. It breaks the concentration of both lecturers and listeners. Chalk dust produced while erasing the blackboard causes serious health problems to both students and teachers. **Remote Controlled Eco-friendly Blackboard Cleaner** overcomes these problems by providing an effective alternative. It reduces the time and manual effort consumed to erase the blackboard.

Remote controlled eco-friendly blackboard cleaner is a machine which cleans a whiteboard or a blackboard automatically with press of a button of a remote device. This machine uses RF and DC motor to move the duster in horizontal (X-axis) direction to cover the whole whiteboard area. DC Fans are used to suck the chalk dust particles produced. As an additional feature, the GSM module sends an SMS as a reminder to the faculty about the upcoming scheduled class.

The project was designed and implemented by M. Eswar Hemanth of ECE IV year (Section A, Roll No. 16R11A0427) under the guidance of Prof. O.V.P.R. Siva Kumar. He conceived this project in the interest of faculty's health and it took a great effort to scale up a small prototype into a real time project. Many factors were considered and hurdles were overcome in the course of implementation of this project. However, he never gave up. In the end, he successfully completed this project with the support of college management and faculty from ECE department and Mechanical Engineering department. Despite of an on-going pandemic, he worked very hard to ensure the smooth implementation of the project in Geethanjali College of Engineering and Technology.



# STUDENT ARTWORK



SRILEKHA MOPIDEVI [ECE 3B : 478]



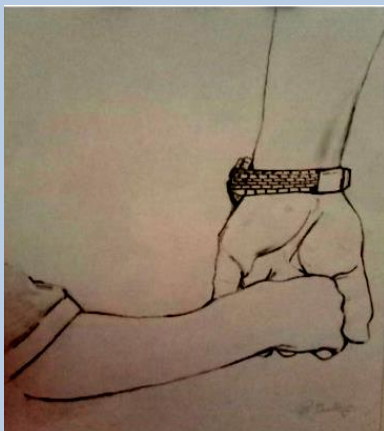
CHANDRAHAAS.T [ECE 3D: 4J7]



SAHAJA REDDY [ECE 2C]



KALYANI. M [ECE 3D: 4H3]



SANDYA [ECE 2C]



SHRAVANI DURGA.D [ECE 3C : 4A0]



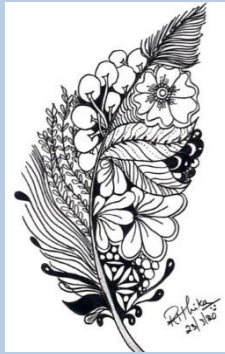
**G. NIDHI REDDY [ECE 2D: 4G1]**



**JAYASRI [ECE 2C]**



**SAI CHANDRA LEKHA  
ECE 2B: 452**



**RITHIKA REDDY  
ECE 3C : 4B0**



**PAVITRA  
ECE 3C : 414**



**SRIJA VAKITI [ECE 3C: 4E0]**



**SUMANA SARVANI.V [ECE 3D: 4K1]**

## **FREE SOFTWARE AND THE CONCEPT OF GLUGS**

### **I. THE FREE SOFTWARE DEFINITION:**

“Free software” means software that respects users' freedom and community. Roughly, it means that **the users have the freedom to run, copy, distribute, study, change and improve the software**. Thus, “Free software” is a matter of liberty, not price. To understand the concept, you should think of “free” as in “free speech,” not as in “free beer”. When users don't control the program, we call it a “Non-free” or “proprietary” program. The Non-free program controls the users, and the developer controls the program; this makes the program an instrument of unjust power.

A program is classified as free software if the program's users have the four essential freedoms:

- a) **The freedom to Run the program as you wish, for any purpose (freedom 0).**
- b) **The freedom to study the working of the program and manipulate it so that it meets the user's requirements (freedom 1). Access to the source code is a precondition for this.**
- c) **The freedom to Redistribute copies so you can help others (freedom 2).**
- d) **The freedom to Distribute copies of your modified versions to others (freedom 3).** By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this.

### **II. WHY WE NEED FREE SOFTWARE IN OUR COLLEGES:**

The two main reasons are:

- The use of free software promotes the independence of students making them members of a strong, capable, cooperating and free society. The most fundamental task of educational institutions is to teach good citizenship, including the habit of helping others. In the area of computing, this means teaching people to share software, which is economically beneficial for them.
- Free software can not only save money but also push students to develop their coding skills, as there is a greater scope of accessibility, thus enabling them to manipulate and change the code according to their requirements.

### **III. THE GLUG IN OUR COLLEGE - GIT GLUG:**

Some of the Linux and Free software enthusiasts in our college have formed the GIT GLUG(Geethanjali Innovative Thinkers GLUG) on 26th September, 2019 under the guidance of our lecturer Mr. Appala Raju. This club was inaugurated by Prof. Hari Kumar (DEAN- E & CE). Since then we have conducted



various activities and workshops with the help and support of the college management . Here's a list of activities conducted by the GIT GLUG:

- A two-day workshop on “Data Science Using Python”
- A peer learning session on GIT and Linux Administration.
- A webinar on “Privacy on Digital Platforms”.
- An online peer learning session on GIT using CLI.

Members of the GLUG committee also built a website to showcase its activities and invite the college students and faculty to join them.

GIT GLUG website : <http://gcetglug.swecha.io/gcetglug/>

- Srilekha Mopidevi  
18R11A0478 ECE - 3B

Follow us on Instagram @ \_git\_glug

### **STORIES FROM OUTER SPACE**

Have you wondered how to buy space, as in outer space? Tricky question right! Maybe Elon Musk wondered the same when SpaceX decided to privatise Space. Then came spaceships, space cars, space stations and many more! So do people at Virginia Galactic. That's what they do; they try to make things easy for us when we decide to buy a small piece of space. If you know “Tony Stark” – The Iron Man who privatized world peace with the Iron Man suit, in the end decided to never give surprises!. Unlike him, we are just at the start – because with the power to fly or run really fast, buying a place on Mars, or a ring of Saturn wouldn't be too hard. Maybe that's what privatization will eventually mean to us....

Privatising Space means letting people or group of people buy or sell space but to what length? Unfortunately, we can't scale the whole universe can we?

- G.Shree Chandana  
19R11A04A9 ECE-2C

For more blogs about outer space, follow G.Shree Chandana's blog!(try to put one downward pointing hand here)

<https://dustyterky.blogspot.com/2019/09/privatising-space-have-you-wondered.html#more>

## OCEAN-A LIVING ORGANISM?

Right from our childhood we have been taught that the ocean is a non-living thing which constitutes of all the aquatic life. But, what if this is wrong? what if the ocean as we think is not just an ecosystem where the aquatic life thrives, but rather a giant living organism? That is what a group of researchers from California State University are saying.

A group of researchers from the University of Illinois, are saying that Ocean is a giant living organism or as they say it- a Mega Organism. They also said that it has its own respiratory system, immunity system and also a complex nervous system that has conventional thoughts!!

For centuries, scientists have been arguing over the definition of a living thing and recently they have decided that all the things that respire are classified as living things. Now, the task of defining the respiration cycle of each living organism began. A group of researcher's thought that even the ocean might have a respiration cycle and that turned out to be true, they concluded that like we humans have a heart beat (which is on an average 72 times per minute) even the oceans have a heart beat i.e., 1 beat for every 1000 years. They said that the cycle starts from the ice melting in the Arctic ocean, flowing all the way through the Pacific to the Southern ocean and flowing back through the Atlantic and finally reaching the Arctic.

Gustavo Caetano-Anolles, A physiologist from University of Illinois says that, the ocean has an immunity system much more effective and quick than ours. "As we humans have WBCs to fight against bacteria and viruses the ocean has bacteria to fight against the dirt we release into the oceans" says Dante. In human beings, whenever there is an attack by viruses or when we are injured the WBCs rush to the site of injury and fight with any bacteria or virus and die when their job is done. In the same way, whenever there is an oil spill or when industrial waste is discharged into the ocean the bacteria eat it up and when there is no more oil or waste they die and this is how bacteria is protecting the oceans.

Another group of scientists have said that the ocean has its own unique nervous system. "We started this study to answer one basic question -How do living beings respire? and in the process discovered something extraordinary and unbelievable".



All living beings constitute of living cells. One of the basic component of these cells are the "Mitochondria". This is where the cells get their energy, hence these are also nicknamed the "Power houses of the cell". The process of respiration in all living things happen at the Mitochondria. Here the electrons in oxygen molecules are displaced with that in the Mitochondria and hence energy is produced. To observe this process in a sea algae the scientists have removed all the possibilities for the algae to breathe and tried to choke it to death, but to their utter surprise that didn't happen. The algae evolved and started growing hair like structures in search of oxygen and when this was put under the lens they found that this was no ordinary hair like structures but rather they are "electron conducting pipes". This is evidence that this algae has developed a nervous system in order to cope up with the oxygen deficiency. This proves that when its existence is at stake algae starts to evolve, The oceanic floor is covered with these family of algae which provides evidence that the ocean too can have a nervous system far greater than ours and as scientists think it might be having a conventional thought process.

So now when we get to know that the ocean can think, we all obviously get one thought-"Does it know that we are exploiting it? Will it protect itself by eliminating its exploiters?". Well, we all need to keep in mind that the ocean can be as destructive as calming it seems to be. So once again when you throw something into the ocean, keep in mind that the ocean has a mind!.

M. Srilekha  
18R11A0478 ECE-3B

## POETRY

### THE PARADOX

This is the most valuable asset in our life,  
To make the best use of it is what people thrive.

Once it flies away we'll never get it back,  
This actually creates and builds our beautiful memory rack!!

The most precious gift obtained is understanding through experience,  
These are the ones in life which create positive differences.

Happy ones make us laugh and get really whacky,  
The sad ones cause heartbreaks and make us sound cracky.

But 'Enjoy every moment', it's very precious they say,  
'Live for the future', work for it is some other people's way!!

Ultimately, the precious asset is undoubtedly the TIME,  
If we don't experience things with it, I guess it's a crime!

I say - Live in the moment, making the best for the future,  
Learning through time and experience is what makes us evolve as a CREATURE !!

Life is beautiful so enjoy your journey to reach your destination.  
Time is such a paradox which indeed creates a lot of fascination!

- R. Prerna

19R11A04J2 ECE-2D

## W.I.P

Two roads diverge in a wood,  
none leading to my address.  
If I could choose I really would,  
but I'm only a work in progress.

Breaths quicken as passing eyes stare  
I worry not for it's okay.  
I take my time to be aware  
amidst a thousand leaves decayed.

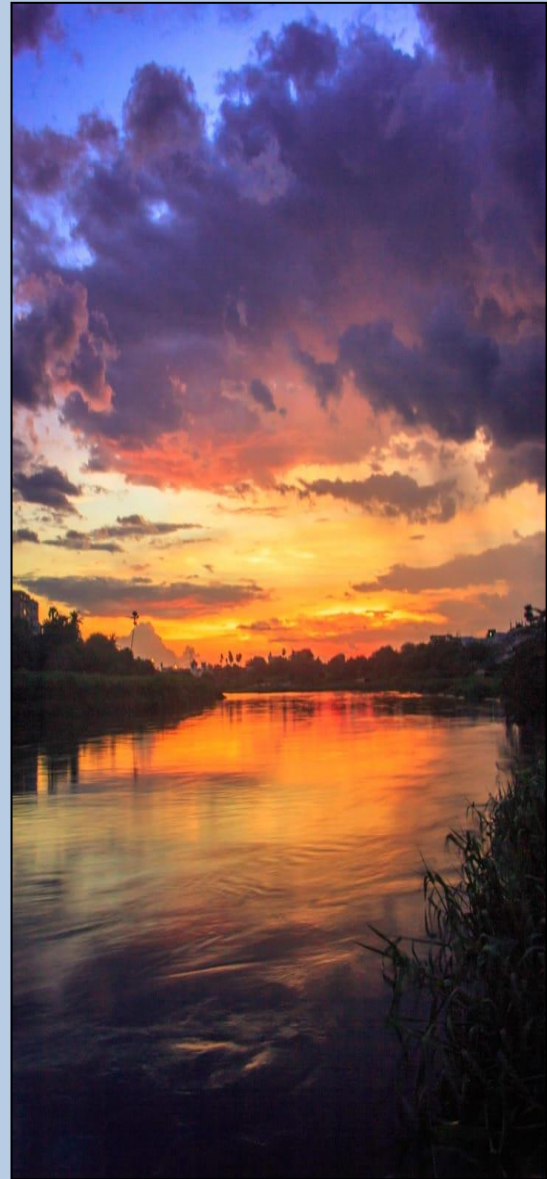
Words break bones, dreams called lies;  
they really leave nothing unsaid.  
But I am more than a compromise-  
an actor of the stage ahead.

So I take no shame in hiding a heart  
drowned in chaos-tasting gin,  
But I am no sweet summer's child;  
I keep the stillness within.

Two roads diverge in a wood  
and I couldn't care more or less,  
for I choose to take no one's path  
Because I am a work in progress.

--- Srijita Vakiti

18R11A04E0 ECE-3C



Picture credits: Nithin

## A NATION'S STRUGGLE

In the eyes of the world,  
It might be just another day.  
But to the souls of the nation,  
It was the fruit for the deeds done back in the day.

A story of a different time,  
When bondage wasn't a bigger crime.  
So in the midst of slavery,  
We rebelled with our heads held high with bravery.  
Though our wills were bent into servitude,  
We stood back up with an attitude.  
200 years of bricks and boulders,  
The white folks made us carry on our bare shoulders.

We believed that the revolt was worth it,  
For the future generations might live with a benefit.  
And so was the story of our nation,  
The lives that have been sacrificed, will not be forgotten.

- V. Sumana Sarvani  
18R11A04K1 ECE-3D

## RISE

Clusters of causalities, collapse  
Chemicals can't catch up, krypton  
Claps for those who contest, combat  
Queen has been crowned, corona.

Biblical blasphemies blaring, bow down  
Best of us banished, brush of death  
Beggars of basics, be blessed  
Bombs now born is us, borne, blast-off.

Who's a hooligan, who's haughty, who  
Hearts with holes heave heavily, how  
Honesty is now a hunch, heist  
Him first or you? Who knows, hide.

Tripping on taut strings, temptations  
Tapping on immunities, testing times  
Tighten your fist and fight, tough truth  
Tackle this and stand tall, trust, thrust forward.



- A. Vaishnavi  
18R11A0497 ECE- 3C

## Senior Says...

K V NIKHIL

ECE (15R11A0485)

2019 Pass out

Backend developer at Cognizant



### **1. How did this institution make you a better person, other than academically?**

College taught me time-management skills. I was a member of DoPY and PIRATES so I learnt lots of organization and management skills in order to keep up with my schedule.

I was not much of an extrovert. Events like VAISESHIKA and BHASWARA helped me step out of my comfort zone and improve myself a lot in areas like presentation and public speaking. So, I am really grateful for that.

### **2. What is the most probable job that one can expect after graduating? Please elaborate on this.**

An average graduate (until 2019) can expect one of the three positions- Marketing Sales-Executive/ Software Engineer/ BPO. Very few companies come with core-related jobs in mind.

You can expect a salary package ranging from 1.8 LPA to 3-4 LPA. The highest salary you can expect can range between 7 to 12 LPA. It must be noted that all of the high salary packages mentioned can be through off or on-campus interviews.

### **3. What do you think are the greatest advantages that students have in this period of COVID-19? What suggestions would you give to students who are graduating amidst this crisis?**

Time. Great advantage. If someone is preparing for MTech/MS, this is the best time to get into the zone and prepare as much as possible.

### **4. Timing is one of the most important factors in order to maintain a successful college life. In your opinion, what should be the main goal/milestone of a student for each year of the college?**

Use your First Year as much as you can. Work hard, play hard. That is the most you are going to get. A good GPA here will compensate for your grade decline, if any. Second Year is where the interlinking of subjects begins. Focus on gaining lots of conceptual knowledge. Participate in college events.

Third Year is the right time to search for practical knowledge/ applications of your core subjects. Start your mini-projects and plan your major ones. Go out for workshops. Think about what you will do after college.



Fourth year is the last so focus on interview skills and projects. Be ready to step out and pursue what you believe in.

**5. What do you think about connecting with alumni? Does our college have an alumni association?**

Networking is fundamental. It helps you easily accomplish many tasks that normally need preparation-financial and personal. There have been many cases of alumni staying abroad helping their juniors with accommodation and finance, or Alumni hiring talented juniors or recommending them for higher studies.

We do have an alumni association; (smiles) I am actually the joint secretary of the association now. Our association was always present, but it was never officially established.

We finally managed to make it official last year! Our main intention is to keep a track of all the alumni and make sure to maintain healthy connections with the college and students.

**ALUMNI ARE IMPORTANT.**

**6. Thank you so much for the interview! We loved the opportunity and look forward to such discussions further.**

The pleasure was all mine! I am happy that I was of any help to the students. I would love to discuss more again sometime!

**For the full interview, visit our blog page: <https://medium.com/@technochronicle.magz>**

## SEMESTER HIGHLIGHTS



*Team work makes dream work*

College fests are more than just memories. As we entered the month of March, the walls of our college roared with blinding lights, colorful posters, and flyers of the upcoming events.



*Coordination and Collaboration!*

Fests are the times when “few earn stages to shine.” It lends a platform where we can enhance our social and communication skills while having fun at the same time



*Always look up!*

The paper and poster presentations that happened during one of our college’s prestigious technical festival *Bhaswara* gave us an amazing opportunity to explore our leading Skills.



The Project Expo too, had its guns locked and loaded with their exquisite display of mind baffling projects. The place indeed looked like an Engineer’s wonderland.



*Thinking out of the box!*



### **Let's turn up with music!**

As the bright sky slowly dimmed into a darker shade, with stars hung twinkling mischievously, the atmosphere changed into more of a lively one.

As the dawn broke... the preparations for the college's most awaited event, *The Vibes* began. Decked up to its fullest capacity was the campus, with alluring streams of colors spread all over, as Carnival happened to be this year's theme.



### **Words of Wisdom...**

And then came the last day of the major festive events, *VIBGYOR*. This event gave us a spectacular showdown, from glitzy ramp walks to fiery dance performances.

Each feat was a sight to see as they were equally breathtaking and beautiful. From facilitating the best management to nearly perfect stage acts, this event left nothing amiss.

### **can you feel the music!!**



### **I'm better when I'm dancing!!**

While many occurrences make your life quite interesting, recollecting your college memories will always put a smile on your face.

## Team Geethanjali for win!!



Because deep down, amongst all those classes, fights, rivalries, fests, and fun, there are always going to be those nostalgic reminiscences of when you truly enjoyed and lived your life.

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