In Phase
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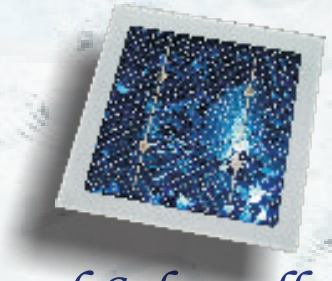

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From the editor...

Electronics and communication surrounds us no matter where we go. We cannot imagine living without our gadgets, be it cell phones, laptops or IPods. Who knows what this fascinating field will present us in the future. To ensure that we are not left out in the race, the race for a better and comfortable future, we present to you the latest issue of "In Phase".

In this issue, we focus on "Storage Devices" which are indispensible for the evolution of the cyber age. The demand for more efficient, dense and compact systems has lead to an up gradation from magnetic disks to optical drives and now to Blue Ray and HVD. In this issues cover article, we present an overview of the evolution of storage devices.

Starting this issue, we have added a new column titled "Industrial Research in India". India is rapidly becoming an economic power and a research hub. The column is an endeavor to make our readers aware of the exciting research carried out in India. In this issue, we focus on HP's "DAS" technology and look forward to further co-operation from the industry. Furthermore, a circuit design contest has been added starting this issue. The column is aimed at providing the electronic enthusiasts an opportunity to test their circuit design skills. Every issue we will put up an innovative design problem to solve and there are lots of prizes to be won. Furthermore, we focus on issues such as "Virtual Reality" and Green Gadgets in this issue.

In Phase has received appreciation from all corners and as a result for the first time complementary print versions of the magazine were also released. We would like to thank you for your support and appreciation till date and to ensure that we keep moving in the right direction, write back to us with your articles, comments, and to let us know how we are doing.

Talla Vamsi
Editor-in-chief
(Final Year B.Tech)

Call for Articles

We are looking for technical as well as non technical and experience sharing articles from students, alumni, faculty members and industry professionals. Articles pertaining to completed/ongoing projects, views, discussions, topic introductions, applications and professional or educational experiences are most welcome. Articles must be 1500 - 3000 words in length and should be written keeping in mind the diverse range of targeted audience including people with little as well as extensive knowledge of electronics. Please email us at inphase@iitg.ernet.in for any clarifications or suggestions.

Contents

Virtually Real yet Really Virtual

Nitesh Sinha & Shweta Ghai

Virtual reality (**VR**) is a technology which allows a user to interact with a computer-simulated environment, be it a real or imagined one. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Sounds boring, isn't it? But I prompt you to read till the end and think again.

We are living in an era characterized by 3D virtual systems created by computer graphics. In the concept called Virtual Reality (VR), the virtual reality engineer combines computer, video, image-processing and sensor technologies so that a human can enter into and react with spaces generated by computer graphics.

In 1969-70, a MIT scientist went to the University of Utah, where he began to work with vector generated graphics. He built a see-through helmet that used television screens and half-silvered mirrors so that the environment becomes visible through the TV displays. It was not yet designed to provide a surrounding environment. It was not until the mid 80's that virtual reality systems were more defined. The AMES contract, started in 1985, came up with the first glove in February 1986. The glove was made of thin Lycra and was fitted with 15 sensors that monitored finger flexion, extension, hand position and orientation. It was connected to a computer through fiber optic cables. Sensor inputs enabled the computer to generate an on-screen image of the hand that followed the operator's hand movements. The glove also had miniature vibrators in the finger tips to provide feedback to the operator from grasped virtual objects. Therefore, driven by the proper software, the system allowed the operator to interact by grabbing and moving a virtual object within a simulated room, while experiencing the 'feel' of the object. After these veering

steps, there was no looking back. Innumerable gadgets and technologies employing Virtual Reality came into being.

Let us take a 'virtual' tour of the various applications of Virtual Reality

- The Datasuit is an instrumented full-body garment that enables full-body interaction with a computer constructed virtual world. In one use,this product is worn by film actors to give realistic movement to animated characters in computer generated special effects.

- The Eyephone is a head mounted stereo display that shows a computer made virtual world in full color and 3D. The Eyephone technology is based on a experimental Virtual Interface Environment Workstation (VIEW) design.

- VIEW is a head-mounted stereoscopic display system with two 3.9 inch television screens, one for each eye. The display can be a computer generated scene or a real environment sent by remote video cameras. Sound effects delivered to the headset increase the realism. It was intended to use the glove and the software for such ideas as a surgical simulation, or 3D virtual surgery for medical students. In the summer of 1991, US trainee surgeons were able to practice leg operations without having to cut anything solid.

- NASA Scientists have developed a three-dimensional computer simulation of a human leg which surgeons can operate on by entering

"Surgeons use the glove and the Eyephone technology to create the illusion that they are operating on a leg."

the computer world of virtual reality. Surgeons use the glove and the Eyephone technology to create the illusion that they are operating on a leg.

• Other virtual reality systems such as the Autodesk and the CAVE have also come up with techniques to penetrate a virtual world. The Autodesk uses a simple monitor and is the most basic visual example for virtual reality. An example where this could be used is while exercising. For instance, the Autodesk may be connected to an exercise bike with which you can then look around a graphic world as you pedal through it. If you pedal fast enough, your bike takes off and flies. The CAVE is a new virtual reality interface that engulfs the individual into a room whose walls, ceiling and floor surround the viewer with virtual space. The illusion is so powerful that you won't be able to tell what's real and what's not.

But this fondness of the virtual world poses some real problems, at least today. Currently, areas of concern range from cumbersome equipment to negative physical and psychological effects experienced by some users.

Because computers currently are not fast enough to process large amounts of graphic information in real time, some observers describe virtual environments as "slow-moving".10 The human eye can process images at a rate much faster than a computer can generate them. In a virtual environment, frames are displayed at a rate of about 7 per second, an extremely slow speed when compared to a television, which generates 60 frames per second.11 Users find the resulting choppy or slow graphics lesser than appealing.

Slow graphics also produce a phenomenon known as simulator sickness. Some virtual reality users experience disorientation and nausea somewhat akin to motion sickness. Simulator sickness occurs because the eyes are accustomed to real-world speed and so the virtual reality's slower graphics negatively affect about 8 to 10 percent of all users. However, as the motion more closely mimics real-time speed, fewer people will experience such ill effects.

Another equipment shortfall is the head-mounted device (HMD). In general, HMDs are large and awkward, and many users find them uncomfortable. Although virtual reality innovators generally view this as a relatively minor problem, they are working to improve design.

Conclusively, what we can state is that the concept of VR has become in many ways a repository for our culture's dreams of escape from the limitations of the material body. VR may one day make possible the long list of physically impracticable dreams which includes experiencing an expansion of our physical and sensory powers, getting out of the body and seeing ourselves from the outside, adopting a new identity, apprehending immaterial objects, being able to modify the environment through either verbal commands or physical gestures and seeing creative thoughts instantly realized. While the actual technology has not yet been able to fulfill these desires, the dreamed of possibilities have clearly established a life of their own within our present cultural imagination.

(Nitesh Sinha is a 3rd year B.Tech student & Shweta Ghai is a Ph.D student of ECE Department, IIT Guwahati)

ECO-FRIENDLY Green GADGET

Manisha Shrivastava

We had an article on e-waste in our last issue. With e-waste becoming an increasingly important environmental issue more companies are realizing that they can be a part of solution rather than a problem .Today the whole idea of going green has caught up the companies who have taken initiatives in making the world a better and safer place to live in. The shift if not wholly, has partially been due to number of initiatives that have been taken which forces the companies to take a step forward for financial gain. California Clean Tech Open, an annual contest with a package of $100,000 to help a company go green is one such step. Another one is offered by a leading eco-friendly product site under which any businessman can apply for an eco-friendly makeover and can win a $5000 spending spree. So there has been an increasing awareness among companies. Recently, the Pepsi Bottling Group inc. (PBG) selected 'Redemtech', a world leader in IT asset disposition and techno change management services to handle its electronic wastes. It will be responsible for recovering, refurbishing, redeploying, reselling and recycling electronics at all PBG's locations.

Being 'green' is not just being aware about the environment; it is also about efficiency, power consumption and applying those green principles to see how they affect the environment. It also concerns about how a company product can meet those challenges with good business sense and focuses on energy efficient technology and services. It directs to make products which are toxic-free and eliminates the use of harmful chemicals in product design. While no company has, so far, released a computer completely free of BFRs and PVC, several have recently launched products with restricted amounts of toxic BFRs. Following the lead set by companies like Sony Ericsson, and Nokia, Apple has also announced that its new line of iPods will be free of BFRs, PVC and mercury. Apple is committed to a complete phase-out of PVC and BFRs from all of its products by the end of 2008. With the new iPods being the cheapest models yet, this is clear proof that high-performing electronics products can be affordable, popular and effective without using toxic chemicals. The company's performance in tackling climatic changes also counts.The global Information and Communication Technology industry is estimated to be responsible for approximately 2 percent of global carbon dioxide (CO_2) emissions, and the rapid proliferation of energy-hungry electronic gadgets is a part of this. It's vital that the electronics industry plays a leading role in producing more energy-efficient products. Aside from the efficiency of their products, companies must ensure the use of renewable energy and must be committed to reduce emissions. Top scorers on energy-efficiency of individual products include Apple, Nokia, Sony Ericsson and Samsung, with Toshiba providing a further example of a company that is improving its climate policy. Being green is to end the stories of unprotected child laborers scavenging mountains of cast-off gadgets created by society's gizmo-loving ways. Philips stands out as the company with the worst position on e-waste and recycling.

It ranks 12th with 4.3 points, retaining its penalty point for negative lobbying on Individual Producer Responsibility in the EU.

The three basic demands that companies are expected to fulfill before getting the title of 'green company'
---clean up their products by eliminating hazardous substances.
---take back and recycle their products especially when they become obsolete.
---reduce the climate impact of their operations and products.

Today a cut throat competition can be seen among companies to get the tag of 'green company' .According to Greenpeace website companies are scored on disclosure of their greenhouse gas emissions, commitment for absolute cuts in their own emissions and support for mandatory global gas emissions reductions that are needed to tackle climate changes. On the basis of energy efficiency a range of products are selected from each company and then assessed to see how far they exceed the current de facto global stand, the US Environmental Protection Agency's Energy Star sets some minimum standards for energy efficiency of all electronic products. The overall percentage of renewable energy in a company's total energy also counts. The climatic impact is also important, since information and communication technology sector currently accounts for 2% of global greenhouse gas emission which is equal to aviation industry.

Greenpeace guide, first launched in August 2006 and now in its 9th edition, has been a key driving force in directing many companies to make significant improvement in their environmental policies. Intel recently announced that its new Xenon 5400 processors use transistors made from hafnium, thus avoiding the use of toxic Brominated Flame Retardants (BFRs). Again there was an announcement by people Apple that its new line of ipods would be free of BFRs, PVC and mercury.

According to Greenpeace latest survey, Nokia gained the lead scoring 7/10, largely due to its improved take back practice. Samsung, a top scorer on energy efficiency takes 2nd place with 5.9 points, Fujistu Siemen's company jumps to 3rd with 5.9 points, who promised to make its product PVC plastic and BPRs free by 2010.Sony Erricsson and Sony ranked 9th and 8th .Sony Erricsson and Apple are best performers on energy efficiency basis meeting the Energy Star requirements. Sony Erricsson and Nokia have made all its models PVC free, having already banned antimony, beryllium, pthalates from models from January this year. Languishing at bottom of ranking is Sharp with 3.1, Ninetendo with 0.8.Philip's scores well on chemicals and energy criteria, but scores zero on e-waste since it has no global take back policies. If we go by the Greenpeace analysis Apple by not improving the environmental performance of new version of iphone have missed a big chance, although its score improves slightly due to new iMacs which reduces the use of PVCs AND BFRs. Dell scored relatively poorly, Toshiba, Samsung and LGE scored low on climate change criteria, although Toshiba has laptops free of toxic chemicals.

With most companies scoring low ,only a company that phases out toxic chemicals, increases the recycling rate of e-wastes, use those recycled stuff in new products, improve on its climatic impacts can hope to go green. Only companies that undergo life cycle analysis of their entire product from production to distribution and reclamation policy can readily hope to meet this goal. So, today a challenge stands for electronic manufacturer to take the responsibility of entire lifecycle of their product right from manufacturing to the very end of their product's lives and then to their final cleanup. Manufacturers need to embrace a truly comprehensive approach. Only then can we have a true green electronic product in the market.

(Manisha Shrivastava is a 2nd year student of ECE Department, IIT Guwahati)

EOG based Text Communication System for the physically disabled and speech Impaired

Talla Vamsi, Suhas Mishra and J.S. Sahambi

1. Introduction

Communication is one of the necessities for a human being to remain a part of the society. But unfortunately people who are quadriplegic and non verbal, suffering from cerebral palsy, stroke, traumatic brain injury or Galilean-Barre Syndrome have difficulty in conveying their intentions, since they have limited voluntary motions. Some people can move their head; some can move their eyes or tongue. Nowadays to assist the disabled, there are numerous technologies available, which make use of one of the above mentioned surviving functions. Nonetheless, in most of the cases the eye movements are unaffected and thus, using them has the potential to develop a communication support method.

Several practical devices have used eye movements as communication support. Detection of eye movement using infrared reflectance of the cornea is difficult to use over long periods of time because the eyes tend to become dry and fatigued. The video-oculogram, which detects eye movements from pictorial images of the eyeball, is expensive because it requires a video camera to monitor eye movement in real time.

An electric wheelchair controlled by eye movements using EOG has been developed as a movement support device. An EOG based hospital alarm system has been successfully tested. An eye gazing system for detecting any point where the eye gazes on the screen has been developed for communication assistance.

The system proposed here detects 4 directional eye movements and blink using EOG signal acquired by means of band filtering of 5-electrode input signal. The signal is then appropriately converted into binary format and used to control the LED array on an optimized reference visual board. The proposed system is highly efficient both in terms of speed and accuracy.

2. EOG signal acquisition

2.1. Signal and system characteristics

Electrooculography (EOG) is a technique for measuring the resting potential of the retina. The resulting signal is called the electro-oculogram. Usually, pairs of electrodes are placed above and below the eye and to the left and right of the eye.

The EOG signal relevant to our application has a frequency between DC and 27 Hz and amplitude between 10 to 100μV. Like other bio-signals, EOG is also corrupted by environmental interferences and biological artifacts. Therefore the primary considerations that have been kept in mind during the design of the EOG biopotential amplifier are proper amplification, sufficient bandwidth, high input impedance, low noise, stability against temperature and voltage fluctuations, elimination of DC drifts and power-line interference.

2.2. Signal acquisition

The block diagram of the signal acquisition scheme implemented in the current application is as shown in Fig. 1. The first stage of EOG bio potential acquisition is the instrumentation amplifier, which would provide the initial amplification while reducing the effect of signals such as power-line interference and skin muscle artifacts owing to its high Common Mode Rejection Ratio (CMRR). Two instrumentation amplifiers one for each of the Horizontal (H) and Vertical (V) channel are employed for this purpose.

Since the EOG signal content varies between DC and 27 Hz, a band pass filter is used after the signal

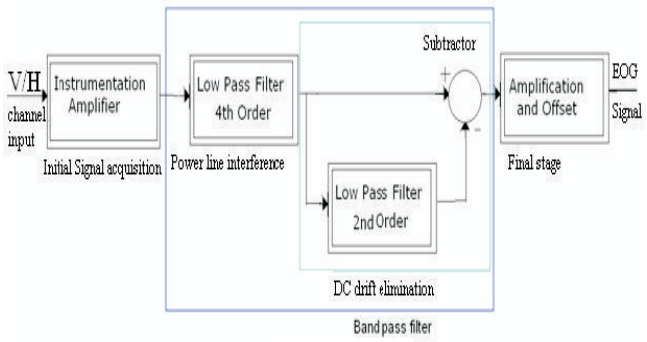


Fig. 1. Block diagram of EOG signal acquisition system

pickup stage, with cutoff frequencies of 0.1 Hz and 32 Hz. The electrical interference from the surroundings of the system are always present and the interference induced on the body common to the biopotential sensing electrodes is called the common mode interference and its frequency is 50 Hz in India. This power-line interference is suppressed conventionally by the use of notch (low pass) filters of high orders, with a cutoff frequency of 50 Hz. For appreciable suppression of the power line interference we deployed a low pass filter of high order (4^{th} order) with a cut off frequency of 32 Hz.

The last stage involves amplification and offset addition. The signal is amplified to obtain appreciable voltage range and offset is added in

order to interface with the micro controller.

2.3. DC drift Elimination scheme

DC artifacts that corrupt the EOG signal are due to the following factors such as: variations in skin thickness, skin conductivity, electrode placement, and the drying of the electrode gel over time. Conventionally DC drift was eliminated using a high pass filter of 0.1 Hz cut off frequency but this scheme was very inefficient since it meant the loss of information in the lower frequency ranges. Hence this scheme is not so popular and instead of this DC drift elimination scheme as shown in the block diagram (Fig.1) has been employed. It eliminates the DC drifts completely instead of suppressing them. Instead of employing a conventional high pass filter, a second order low pass filter in the feedback path and a subtractor is used.

2.4. Amplification and Offset addition

The amplification provided in the first stage is insufficient to obtain appreciable pulses. Now the signal is conditioned according to our requirements to interface it with the micro controller.

3. Application to text communication system

3.1. Interfacing the EOG signal acquisition module with Micro-controller

Actual deflection for each channel varies with placement of electrodes and various other factors; hence the optimum reference voltages of the comparators are empirically determined. The comparator outputs are binary pulses, which are high when the eyeball moves in a particular direction.

The binary signal thus obtained after comparator is used as an input for the decision making block. The decision making block has been implemented using a micro controller since it is cheap and easy to handle. Also, as we shall see in the next section the reference visual board has been optimized for maximum performance hence a micro controller is apt for this application.

3.2. Reference Visual Board

The reference visual board shown in Fig. 2. is required to assist the person in selection of the desired alphabet. The board has been specially designed to increase the speed of communication. The board is divided into 9 blocks as shown (above) in Fig. 2. One LED is reserved which corresponds to each alphabet. Glowing LED shows the current position of the cursor on the board. To select a particular alphabet the user has to move to the corresponding LED using right, left, up or down

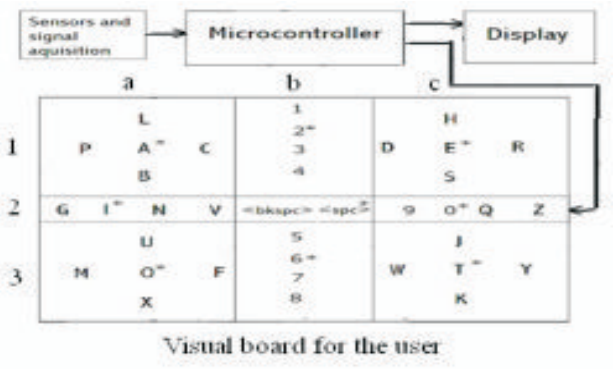


Fig. 2. Block diagram showing interfacing between different components of the system

movement and blink his eyes once to transfer that character on screen. In case of a blink a special LED is glowed to denote that user wants to communicate that character. A LCD screen or a computer can be interfaced to display the characters communicated.

The reference board has been designed on the basis of modeling (zero and first order) of English language. A large chunk of data was analyzed to ascertain the frequency of occurrence of each alphabet and the correlation of all alphabet pairs. The highest occurring alphabets were placed at the center of each block (denoted by an asterisk in Fig. 2). The remaining alphabets were placed in accordance with their correlation with the central character. This design is highly appropriate since this would ensure high communication speed for large combinations of everyday words as opposed to the use of a reference board based on keyboard

4. Working and testing of the system

Experiments were performed in real life conditions to examine the usability of the proposed EOG system. the subject was instructed to attempt to generate sentences comprising of common day to day words like ”GOOD”, “MORNING”, “WATER”, “HELP”, etc.

The system was tested for a large group of common day-to-day sentences to illustrate the significance of optimized reference board.

6. Conclusion

The EOG signal has been successfully acquired through a two channel acquisition process and common artifacts and inter-channel interferences have been suppressed. It was suitably processed and applied to demonstrate an efficient and cheap text communication system. We were able to obtain a speed of 16.2 letters/min and accuracy of 98-99% as a result of adequate training of the user.

Published at Proceedings of BME Days 2008 Conference, Indonesia.

Evolution of Storage Devices

Vishal Bhola

A **storage device** is a device for recording (storing) information/data, but is it that simple??

In the next following review will see the complex variations that this very term underwent and its face as we see it today as an indispensable component of Information Technology. It is projected that storage technology will experience larger investments for R&D as compared to the server technology. Well, that does indicate the position that storage technology enjoys!! The complexity of storage devices has risen to such a level that many individual modern devices surpass the capabilities of previous generation Pcs.

Ever since mankind begun, man has been searching for the ways to store information for him and the following generations. This dates back to pre-historic times where(don't be amazed) man used manganese oxide, charcoal and all that he could find to paint information about their life on rock walls, caves and ceilings. At around 2000 BC Egypt started the use of papyrus (an early form of paper) to store information. Tally stick in medieval England, documents on bamboo (China), palm leaves in India are examples of innovation that people saw until paper was invented sometime between 150 BC and 105 AD in China. But due to reluctance of China to share its secrets, it was only after commercial trades that the invention spread to the Middle East.

Punched Tape http://gadgets.fosfor.se/history-of-data-storage/

A milestone in the history of information storage was marked by the invention of printing in 1440 AD. But it was only after the 17th century that devices which need some kind of aid to read were invented. Punch cards, phonograph, magnetic tape, telegraphone are some of the examples.

Punched cards came into existence as early as 1725 however the early applications of punched cards all used specifically designed card layouts. Around 1928 "general purpose" punch cards were introduced with The IBM 80-column punching format. The next big thing was Magnetic Tape. Originally developed in Germany, the magnetic tape consists basically of a magnetic coating on a long and narrow strip of plastic. Based on the concept of magnetic wire recording, the primary use of magnetic tapes was to record sound. In no time the technology was extended to video recording and later on to computer data storage. The popularity of magnetic tape was based on the fact that one roll of the same could store as much data as could be stored on 10000 punch cards.

Then came the era of disk drives and the first one in this category and perhaps the most important one is Hard Disk- a non-volatile storage. A hard disk uses rigid platters rotating about a spindle (central axis). The storage and retrieval of digital data takes place on a magnetic planar surface with the help of read/write heads about a common armature. Typical hard disks today, can store about 40GB-1000GB and yes, that marks a remarkable improvement from the first one introduced by IBM in 1956 which had a capacity of "5MB".

Hard disk drive

"The technology was later expanded to get many variants like CD-ROM (data storage), CD-R(write once audio and data), CD-RW(re-writable media), VCD(video), CD-I and many more."

With rotation speeds ranging from, 5400 to 10,000 rpm, it can access any of its information in a fraction of second. Though HDDs were initially put to use with general purpose computers, we now have even digital recorders, digital cameras and even mobile phones with HDDs.

We also witnessed some technologies introduced specifically for development of computer industry and some of them are still in use. The flexible magnetic disk (or diskette), which revolutionized computer disk storage in

Floppy Disk http://justinnewitter.com/stock/Floppy_Disk1.JPG

the 1970s is one of such devices though nowadays, it's rarely used. Diskettes/ floppy disks or floppies as we call them are composed of a circular piece of thin, flexible magnetic storage medium encased in a square or rectangular plastic wallet. They became omnipresent in the 1980s and 1990s with their use in Personal computers. Invented by IBM, floppy disks in 8-inch(8KB of data), 5¼-inch, and the newest and most common 3½-inch(256 MB of data) served many years as popular means of data exchange. This invention also marked the end of punched cards.

Next came the era of optical storage devices. The first optical drives CD/CD-ROM came in the beginning of 1980's. CD perhaps has undergone the maximum number of variants as off now and since they are the most widely used storage technology today, so they do deserve a special mention. The standard CD (or the audio CD because it was initially meant for audio storage only) stored audio data as per the Red Book standards. The Red Book was released by Sony and Philips in 1980. Audio tracks at a sampling rate of 44.1 Khz were stored using 16 bit PCM encoding. The number of such tracks can range from 1 to 99. Standard CDs have a diameter of 120 mm and can hold up to 80 minutes of audio. There are also 80 mm discs, sometimes used for CD singles or business card CDs, which can store up to 24 minutes of audio. The technology was later expanded to get many variants like CD-ROM (data storage), CD-R(write once audio and data), CD-RW(re-writable media), VCD(video), CD-I and many more.

A very interesting thing about CDs is the way they store data. CDs record data in the form of tiny bumps or lands pressed onto the lower surface of the plastic disc arranged as a single, continuous, extremely long spiral track of data. The spacing between the tracks, the pitch, is 1.6 µm. A laser beam of wavelength 780 nm is used to read these data. The change in height between bumps and lands results in a difference


Compact Disk http://www.yamahamultimedia.com/yec/tech/images/sample_cd.jpg

in intensity in the light reflected. This change in the intensity of reflected light is read as data with the help of a photodiode. However, most of the CDs cannot be written using lasers. CD-R discs have colored dyes that can be burned and CD-RWs contain phase change material that can be written a multiple number of times. A typical CD-ROM may store up to 650-700MB of data however data compression allows more data storage. CD-ROMs follow Yellow Book standards for data storage.

A DVD is an evolution of the modern CD which uses a different laser of wavelength 625-650 nm and thus has a red color. This enables the DVD to store much more information than a CD of same size. A standard DVD can store up to 4.7GB of data with dual layer DVDs storing up to 8.5 GB DVD can hold cinema like video, better audio than an Audio CD, photos and any sort of computer data.

"It is projected that such discs would store about 3.9TB of data."

A DVD is thus the best blend of home entertainment, computers, and business information and that too in a single digital format. Well maybe that's the reason together with the support it received from all the major electronics brands that it became the most successful consumer product in about 3 years of its introduction.

During this time another storage device was introduced (also the "first electronic storage" device)- Compact Flash(CF). A CF combines flash memory in a single standardized enclosure with a controller for reading/writing. Flash memory devices are non-volatile and solid state; operating at 3.3V or 5V they consume only 5% of the power required by small disk drives and offer reliable

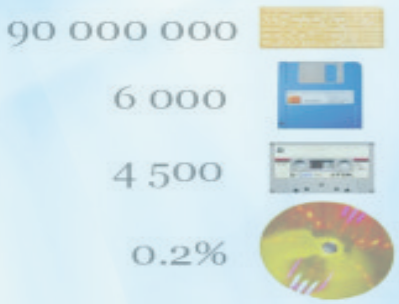
performance at a wide range of temperatures. They find use in Digital Cameras, PDAs etc. Build on concept of Flash memory few more devices viz. Multimedia Card (MMC), Memory Stick and SD-card were introduced for easy access and removal with a PC.

The year 2006 witnessed two more optical discs built on the lines of CD/DVD. These were the HD-DVDs (15GB/layer) and the Blue-Ray disc(25 GB/layer). Both these devices use a blue laser of wavelength around 405 nm and thus posed competition to each other. Finally Toshiba withdraw HD-DVDs effectively making rival Blue-ray Disc the dominant format for high definition video discs.

The FUTURE is here

With the Blue-Ray discs already in the market offering 50GB of data storage on the same disc the CDs and DVDs might be outcast in near time. However, as current storage techniques reach the upper limit of possible data density (due to the diffraction limited size of the writing beams) holographic storage has the potential to become the next generation of storage media. Holographic Versatile Disc (HVD) use collinear holography collimating red (for writing) and green lasers (for reading) in a single beam. It is projected that such discs would store about 3.9TB of data. To give the reader an idea, here's a comparison between different storage media

Storage devices have evolved from punch cards to present day HVD. All over the world, scientists are involved in finding new and innovative ways to store information. This is done since it is believed that in future we would require much denser and efficient



systems. The prospective technologies such as holography, quantum dots, nanostructures and many more are being researched and some day all this research would enable us to store tremendous amount of information in tiny tiny devices.

(Vishal Bhola, is a 3rd year student of ECE Department, IIT Guwahati.)

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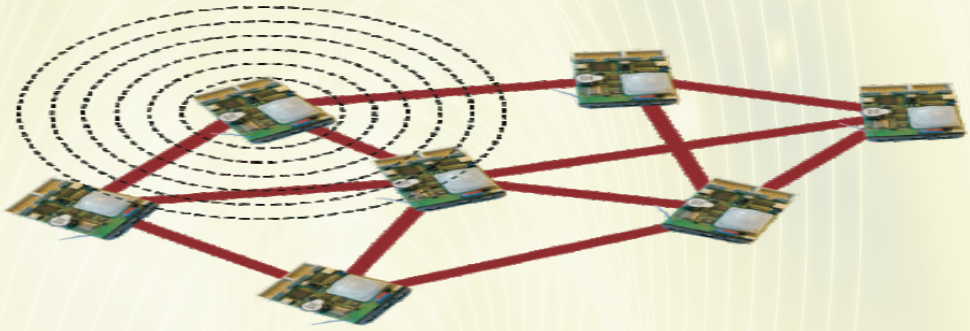
http://gadgets.fosfor.se/history-of-data-storage/

Integration of Wireless Sensor Networks with IPv6

Neelesh Shrivastava

*I*n layman terms, a wireless sensor network (WSN) can be described as a group of nodes connected together and communicating over a wireless communication channel. The nodes, specifically known as motes here, are a combination of a microprocessor, a radio transmitter & receiver and various sensors like temperature, pressure and humidity. In addition to these, external circuitry can also be attached as per the needs of the application and facilities like ADCs are also provided in certain motes. The communication is based upon **ZigBee** which is a set of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2006 standard for wireless personal area networks (WPANs). Interestingly, it derives its name from the mode of communication used by honeybees. This introduces us to another term – Personal Area Network. Scaling down from WAN, MAN and LAN comes PAN – Personal Area Network which is a network of devices close to a person. The range of PAN is usually a few metres, though it can be extended if the application demands.



Let us move over to the other domain mentioned in the title of this article – IPv6. It stands for Internet Protocol version 6. What we mostly see around us is all IPv4 as IPv6 hasn't made much headway in India. The difference between the two versions is the size of the addressing space. While IPv4 provides 32 bits for the addressing space which means a maximum of 2^32 addresses, IPv6 provides 128 bit addressing space i.e. a maximum of 2^128 addresses which is practically inexhaustible. Although ensuring address inexhaustibility was not the motive behind the development of IPv6. Rather, the large number allows a better, systematic, hierarchical allocation of addresses and efficient route aggregation. The address is split into two halves, the least significant 64 bits denoting the host/interface ID (IID) and the most significant 64 bits denoting the network prefix. Thus, actual address space utilization rates will likely be small in IPv6, but network management and routing will be more efficient. Interestingly, there hasn't been an IPv5 because it had been assigned to an experimental flow-oriented streaming protocol (Internet Stream Protocol) intended to support video and audio.

The target areas for WSN are such applications which require limited data speed and minimal computation but at the same time put severe constraints on accessibility, power consumption, memory requirement and network stability. Connecting WSNs to the internet can bring along a revolutionary changein the field of communication as they find application in a wide array of fields such as military surveillance, weather monitoring, healthcare systems, traffic control, home automation and many more.

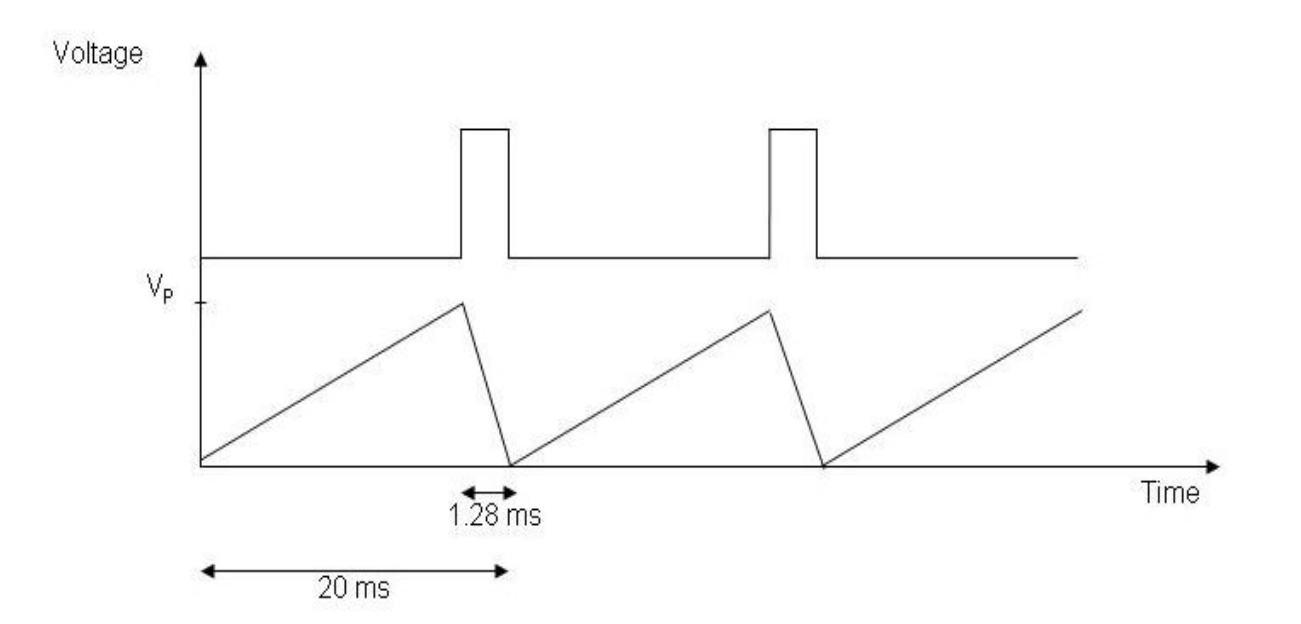
The reason for selecting IPv6 over IPv4 for this purpose is that every node can be assigned a unique IPv6 address which can then be accessed directly by any other node connected to the internet. Just imagine, a user can check the temperature at the glacier in Antarctica or inside a volcano sitting at his home.

As easy as it might sound, the task comes with its own set of technical difficulties, the most prominent one being the difference in the packet size of the two networks. The high speed IPv6-based wired network places a minimum MTU (maximum transmission unit) at 1280 bytes whereas the slow, radio based wireless network has a maximum size of 127 bytes as per the IEEE 802.15.4 standard. A maximum frame overhead of 25 octets spares 102 octets at the media access control layer. An optional but highly recommended security feature at the link layer poses an additional overhead, for example, 21 octets are consumed for AES-CCM-128 leaving only 81 octets for upper layers. Furthermore, since the IPv6 header is 40 octets long, this leaves only 41 octets for upper-layer protocols, like UDP. The latter uses 8 octets in the header which leaves only 33 octets for application data. To overcome the hurdle of packet size difference, an interface or rather in more technical terms, an adaptation layer is required between the two inherently different networks. This adaptation layer is known as 6LoWPAN layer. 6LoWPAN stands for IPv6 over Low power Wireless Personal Area Networks. It takes care of issues such as packet fragmentation & reassembly. The overhead calculations above show that header compression is compelling to the point of almost being unavoidable. It is one of the most intensely researched areas these days along with issues pertaining to addressing management, routing considerations (specially mesh routing) and mobility.

(Nilesh Shrivastava, is a final year B.Tech student of ECE Department, IIT Guwahati.)

In Phase Design Contest

Design a circuit whose output waveform is as shown below:-



Preferably use discrete components for the design. Use power supply= 9V.
Simulate the circuit using SPICE and submit the SPICE file to inphase@iitg.ernet.in
Exciting prizes to be won and the best/innovative entry will be published in the nest issue of In Phase. **

** People associated with Cepstrum are not eligible to participate.

Document Authentication System
Preventing and Detecting Fraud of Paper Documents

HP Labs India has been established with the principal focus on creating new technologies for addressing the IT needs of the next billion customers for HP. A large majority of these new customers arise from rapidly growing markets such as India. Effectiveness of IT has been limited in these markets due to issues related to IT complexity, affordability and infrastructure. At HP Labs India, we derive our inspiration by being deeply immersed in the local customer environment and understanding major global technology trends. HP Labs India works at the intersection of deep technical research, direct impact on HP's business and solving hard and significant customer challenges.

Executive Summary

Paper documents are widely used to support business transactions. These include grade and degree certificates for obtaining employment, bank and financial statements for applying for loans and identity and address proofs for several requirements. Some of the reasons for the continued use of paper documents for these transactions include:

- the affordability of paper - paper is low cost
- the familiarity of paper - people are used to it
- the simplicity of paper - one does not require special equipment to write or read paper

Fraud and Forgery is an issue that plaques paper documents. Document fraud is a major concern for governments and enterprises around the world. For example, a KPMG study which polled senior managers across 1000 companies in India came up with the following findings:

- 39% of the respondents acknowledged that their enterprises had been subject to fraud in the last year
- Forged documents was among the top 3 reasons for fraud encountered by these companies
- 13% of the respondents identified forged documents as the major reason for fraud related losses in their business (in rupee terms)

Fraud prevention makes processes overly complex, increases the transaction costs, and makes due diligence of transactions cumbersome and time consuming. However incidents of forgery and fraud using paper documents has increased with the availability of cheaper printing and copying technologies.

So how can enterprises identify the authenticity of a given document given that manual verification of these documents is a tedious task, involving multiple levels of human interaction and is expensive and time consuming. Can we provide the same degree of security for paper documents that we can achieve in the electronic world?

We believe our technology innovation addresses these questions.

How do you Prevent Paper Fraud?

Traditionally, information on paper with a wet signature and a rubber stamp has been accepted as a reliable supporting document for all kinds of transactions. The strength of authentication using signatures is not very strong. Rubber stamps are also easy to replicate.

Determining the authenticity of the document is not just a technical challenge, but also a logistic one. In some countries there are as many as 20,000 authorities issuing birth certificates alone. Other agencies issue driver's licenses, degree certificates, etc. Tens of thousands of verifiers dealing with tens of

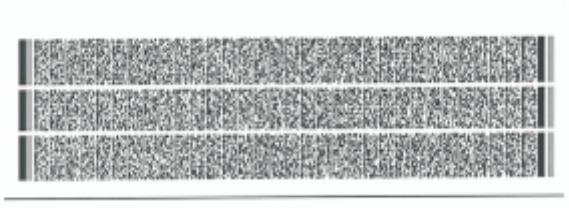


Figure 1: A 2D Barcode

thousands of issuing authorities is not a practical solution. Creating a dedicated online infrastructure for these agencies would be extremely expensive or in some cases even infeasible.

Existing authentication methods are complex, incur large transaction costs and are time

consuming. Hence, the need for a system that can provide speedy, reliable and cost-effective verification of paper documents.

Our innovation addresses the problem by allowing enterprises to continue to use their existing methods of generating paper documents with the addition of machine readable data printed on them in the form of 2D barcodes. The Document Authentication System (DAS) we have created can be provided as a means to verify documents either issued by an enterprise or be a centralized system that can verify documents issued by a set of enterprises.

Document Authentication System

Machine readability of data from paper can be enabled through symbologies such as 2D Barcodes. 2D Barcodes are capable of storing multilingual information and images subject to size limitations. All such content can be recovered reliably on scanning and decoding of the barcode.

Why 2D barcodes?

- Can hold significant amount of data, typically of the order of 500 bytes per square inch.
- Can be printed on paper by normal printers and scanned by normal scanners.

The integrity of the document is validated using the content decoded from the barcode. The DAS incorporates security features to ensure that the contents of the barcode are not tampered with. The client side software prints out a verification statement which contains the information decoded from the barcode along

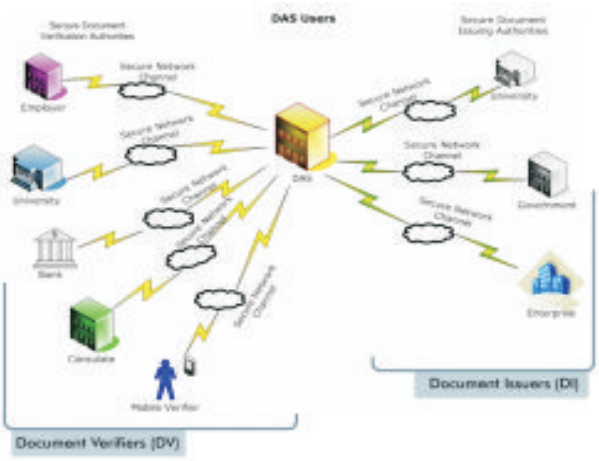


Figure 2: DAS system can serve multiple Document Issuers (DI) and Document Verifiers (DV)

with a statement from the server indicating that the barcode's contents are authentic. Comparison of this information with the

Figure 3: Educational Transcript of IIITB with 2D barcode printed at the back

information on the original document can be used to detect forgery or manipulation very early in an attempted fraud. The verification statement, containing full information, can be processed by itself without even comparing it with the original human-readable text. It is also often desirable that a centralized system should protect the privacy of the end users whose documents are being verified. The DAS system handles privacy protection too.

How a DAS can be used to Authenticate Documents? And example of Issue and Verification of Educational Transcripts

Lets take the example of transcripts that are issued by educational institutions that need to be verified by potential employers. This is based on a pilot we have running with the International Institute of Information Technology (http://www.iiitb.ac.in) where they have issued the grade transcripts for their students using our technology as a pilot.

The text of a transcript like the one given in Figure 3 can be presented as a 2D barcode and printed at the bottom or behind the page in a few square inches. This is done when it is issued by the authority, in this case an educational institute, whom we term as a *Document Issuer (DI).*

The centralized DAS systems created by HP Labs, India would accept information from many *Document Issuers (DIs*) and serve users on a network, which could be the Internet (see Figure 2).

Figure 4: The verification statement for the IITB transcript

A barcoded document can be verified when presented as an authoritative document, for example, while applying for a job to an employer. The entity requesting the verification is a *Document Verifier (DV)* which in this case is a company. The barcode can be machine read using commonly available scanning devices and transmitted over a secure network.

The DAS would then verify that the content being held by a computer in the office of a *Document Verifier (DV)* was issued on the specified date and place by an authorized *Document Issuer (DI).* The DV would get a verification statement that contains the true authentic content of the document. Manual comparison of this with the document being verified would help determine the authenticity of the document.

The same method can be used to remotely issue documents and alleviate the need for a physical signature. This could be applicable in the context of government documents issued by kiosks.

Other Features of a DAS

Some of the other features of a DAS include:

a) The DAS itself will not hold content which can be misused by an agency/staff running it.
b) It does not compromise the privacy of the individuals concerned.
c) It incorporates error correction techniques, while enabling data to be extracted from even damaged barcodes.
d) It can deal suitably with documents issued prior to the creation of a DAS.

Advantages of a DAS

The advantages of a DAS include:

a) It is not expensive or complex to implement
b) It automates verification, thus reducing time and cost for transactions
c) It uses standard printing and scanning equipment without the need for any specialized devices

While enabling networked security for paper documents, DAS does not take away the positive aspects of the paper medium: low cost and user-friendliness. Adding a 2D barcode to the bottom or behind a printed document does not significantly increase the cost of generating such a paper document. The issuing institution will need to spend less time and resources in handling queries on the authenticity of a document it has issued, while the end users can be absolutely sure of the authenticity of the document in question.

About HP Labs India

HP Labs India has been established with the principal focus of creating new technologies for addressing the IT needs of the next billion users of IT. A large majority of these new customers arise from rapidly growing markets such as India, China, and other Asian countries. Effectiveness of IT has been limited in these markets due to issues related to IT complexity, affordability and infrastructure. At HP Labs India, we derive our inspiration by being deeply immersed in the local customer environment and understanding major global technology trends. HP Labs India works at the intersection of deep technical research, direct impact on HP's business and solving hard and significant customer challenges.

For More Information

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Final year student Saurabh Sriom talks about his internship experience @ Spain

Almost all of us look forward to our third year summer internships from the moment we have heard about it from our seniors in the very first year of our BTech. So finally when I got the confirmation from the Universidad Politecnica de Valencia, that the funding for my internship has been cleared, I was over the moon! The computer science department of the university housed the PRHLT (pattern recognition and human languages technology) group where I was supposed to work on a speech recognition system.

Having done my second year internship here at IIT Guwahati, I had the luxury of choosing the area of work that I was interested in. I took up a project here to develop a robust speaker recognition system. Based on my experience from the second year, I was called upon to work as part of a team that was developing a whole new speech recognition toolkit, very much like the HTK developed by the CMU and having an efficiency and accuracy comparable to the marvel brought by the CMU.

With a great project lined up for me, I arrived in Spain looking to make my contribution in this ambitious and challenging initiative taken by the university. Now, everyone is aware that Europeans are not the best exponents of the English language, but Spaniards took this notion to another level! From the moment I reached Madrid to the time my guide received me at the Valencia railway station not a single person spoke English and all I could do was mime to communicate. Well, having English speaking room mates and people in the lab where I worked being fluent in English did go a long way in making me feel home for the three months spent there.

I remember specifically during my first day at work, when both of my guides were done explaining my targets during the internship and discussing some of the possible approaches that I could adopt, my guide told me that I didn't need to work just because I'm being paid, he said he wanted me to enjoy the work as much as I can and that would be the best way to make an efficient effort. The friendly environment in the lab contributing the feel-good factor made it a very conducive environment for research.

Coming to my work, I was supposed to work using a software iATROS developed by one the PhD students there. iATROS was a software which was capable of dealing with both online and offline speech recognition. It was an HMM based continuous speech recognizer, which performed the speech recognition based on the training sentences taken from the Wall Street Journal corpus. Based on the recognized words its output included a word graph. My job here was to improve the performance of the system by developing a speaker independent speech recognition system. The problem with the speaker dependent systems is that the training data for each and every speaker has to be added and that would require lots of time and memory and thus is dispensable.

To solve the above problem we zeroed in on the speaker adaptation technique, which again could be applied in two ways. For the first method, the system had the correct word transcript of the adaptation data, and thus is called supervised adaptation. The second method, which is the unsupervised adaptation, uses the transcript generated by the speech recognizer itself. The probability of error in this transcript reduces its reliability for the adaptation process and it was here that the other part of my work began. Using another software which was again developed by the PRHLT group, confidence measures were

"Work hard, party harder."

evaluated for each recognized providing us with the probability of each recognized word being correct. From here we set a threshold and hence only the words having a very good probability of being correct (according to the threshold set by us by experiments) were used for the adaptation. The combination of these two software developed by the lab and then experiments with different parameter values to obtain the best results formed the core of my work in the university.

At the end of some very interesting experiments, we finally had the results showing a significant improvement in the performance of the system. With the final seminar approaching I was delighted to having played my part in improving a system designed by the lab. The ting that struck me the most was the attitude of the developers of the software who wanted it to be an open source and free to all software. Their thinking being that the fund for their PhDs comes from the people's money and hence this is their way of paying them back. So instead of selling iATROS, the PRHLT has conceded the wish of the developers which according to me is a great gesture on part of the lab as well as the developers.

I am guessing all this tech talk would make you think that it was the typical geeky IITian internship for me, well folks, I've got news for you! While all this research was going on along came the Euro'08 wave that sent Espania crazy. It was great fun working all day at the lab and then hanging out with the same people cheering on the Spaniards as they conquered everything in front of them and winning the coveted European crown which had been missing from this sensational footballing nation since the last 44 years. The final whistle of 'el finale' against Germany stands out as one of the most memorable moments of my intern period. The electric atmosphere after being crowned champions overtook what so ever problems that anyone in the entire nation had. Add to that the fact that most of my batch mates being and cheering for Germany just makes the memory sweeter!

The day ended in the lab but it was then that life began in Valenica, with about 40000 students studying there it was almost etched in our schedule to hang out in bars with the friends we made there. Being a beach city, I got a taste of water sports which in itself is an adventure to remember. Discos and beach parties was what the nights were about and once it was dawn it was time to get back to the project. This led me to be sure that the phrase 'work hard, party harder' was coined by Spaniards! The Eurotrip just added to this amazing experiences and meeting IITGians at all corners of the Amsterdam streets was something to remember. It felt great that IITG had literally conquered Europe for the summer of 2008, having friends all over the continent and coming across IITGians as frequently as you would when you take a stroll in the campus (and maybe more!).

Needless to say, I left Valencia with a touch of sadness in my mind. Being in the company of some of the friendliest people you can work with for the best part of three months made me sure this is the sort of place that I would love to work at. What stood out for me was the fact that even my guide, being the busy person he was still had time for all the chatter after work and specifically the friendly banter between us for supporting rival football clubs! The thing that I value the most during my experience in Valencia is the idea that enjoying your work is the key to delivering the best to your ability and to setup an environment like that at your workplace really bodes well for your future.

Intel's new architecture for processors

Harpreet Singh

Since times of the earliest computing machines, which require processors to function, Intel has ruled the world of processors. Starting with the first Pentium processors (the P5 variety) which were introduced in 1993, and then reaching up to the Core 2 Duo, Intel has travelled a long distance. Covering a lot of milestones on the way along, it has now become the chief provider of microprocessors and processors. AMD (Advanced Micro Devices), the other processor manufacturing giant (mostly concentrating on Laptops), lost another part of its market share to Intel. With each passing day, Intel's processors are getting better and better. The recent hit in this direction was the complete revamp of the microprocessor architecture.

Let's take a look at the history of processors produced by Intel. As earlier stated, the first of the series of processors was P5 series. This 5-V processor was fabricated in 0.8-micron bipolar complementary metal oxide semiconductor (BiCMOS) technology. The P5 processor runs at a clock frequency of one of 60 and 66 MHz and had 3.1 million transistors. The next version of the Pentium processor family, the P54C processor, introduced in 1994 were fabricated in 3.30-V, 0.6-micron BiCMOS technology.

The thing that makes Intel so successful and places it on lines of one of the biggest dealer in microprocessors is its continuous upgrade of its technology. The architecture was designed to fulfill the needs of the machines of the time they were fabricated. Now with the changing times when the needs change, Intel knew that the old design needed an overhaul. The Intel Pentium processor, just like its predecessor the Intel486 microprocessor, is fully compatible with the installed base of over 100 million compatible Intel architecture systems. Also, the Intel Pentium processor adds to the performance of new and existing software through a reimplementation of the Intel 32-bit instruction set architecture using the latest, most advanced, design techniques. Optimized and dual execution units provide one-clock execution for "core" instructions, while advanced technology, such as superscalar architecture, branch prediction, and execution pipelining, helps multiple instructions to execute in parallel with high efficiency. Separate code and data caches combined with wide 128-bit and 256-bit internal data paths and a 64-bit, burstable, external bus allow these performance levels to be sustained in cost-effective systems. The application of this advanced technology in the Intel Pentium processor brings "state of the art" performance and capability to existing Intel architecture software as well as new and advanced applications.

A brief explanation of the architecture enables us to take a preview in the features that make Intel processors state-of-the art. The Pentium processor has two primary operating modes and a "system management mode." The operating mode determines which instructions and architectural features are accessible. These modes are:-

1) **Protected Mode**

This is the native state of the microprocessor. In this all instructions and architectural features are available, which enable the processor to deliver the highest level of performance and capability. This is the recommended mode for all new applications and operating systems. Among the benefits of protected mode is its ability to directly execute "real-address mode" 8086 software in a protected, multi-tasking environment. This is known as Virtual-8086 "mode" (or "V86 mode"). Virtual-8086 "mode" however, is not actually a processor "mode," it is in fact an attribute which can be enabled for any task (with appropriate software) while in protected mode.

2) **Real-Address Mode (also called "real mode")**

This mode makes the programming environment of the Intel 8086 processor available, with a few extensions. Reset initialization is used to place the processor in real mode where, with a single instruction, it can be easily switch to protected mode.

· **3) System Management Mode**

The Pentium microprocessor also provides support for System Management Mode (SMM).This SMM is entered through activation of an external interrupt pin (SMI#), which shifts the CPU to a separate address space while saving the entire context of the CPU. SMM-specific code may then be executed transparently. The operation is reversed on returning.

Armed with the tools of understanding the layout of the processors, we are ready to head for the journey to the latest processor introduced by Intel. Named “Intel Nehalem”, this micro-architecture is for here to stay. This micro-architecture succeeds the Core micro-architecture. The first processor released with the Nehalem architecture is the desktop Core i7, to be released in Q4 2008, followed by mobile and server Nehalem in 2009 and 2010. Nehalem consists of the most important new architectural changes to the x86 micro-architecture since the debut of Pentium Pro in 1995. Owing to its ability of different components for different tasks, Nehalem is considered to be highly scalable

Improved performance and less power consumption seem to be the catch of almost every new device invented today. Intel's Nehalem is no different. Focusing on performance, Nehalem is supposed to have a larger core size for the same job. Comparing with other processors, Nehalem is believed to have a 1.1 times to 1.25times the single-threaded performance or 1.2x to 2x the multithreaded performance at the same power level. If desired to have the same performance, it consumes 30% of less power. Core-wise, clock-for-clock, Nehalem will be providing a 15%-20% increase in performance. Observers found that a Nehalem "Gainestown" processor has 1.6 times the SPECint_rate2006 integer performance and 2.4 times the SPECfp_rate_2006 floating-point performance of a 3.0 GHz Xeon X5365 "Clovertown" quad-core processor. There are several variants of Nehalem. It will come in variants for servers, desktops, and notebooks. The four-socket server CPU is being codenamed Beckton, the two-socket server CPU is codenamed Gainestown, and the single-socket desktop CPU is codenamed Bloomfield.

Seven code names have been associated with the Nehalem micro-architecture in an article in the PC Watch magazine. These include 2 server processors, 3 desktop processors, and 2 mobile processors. The server processor, Beckton, will be having 44 bits of physical memory address and 48 bits of virtual memory address. The Havendale will have 2 different IGP versions and at least 6 different parts, probably 6 different frequencies. It is also supposed also replace both dual-core and quad-core Penryn CPUs. Intel has stated that there will be at least four different variants of Nehalem CPUs. One variant is Core i7 while two others are slated for 2009 as dual- and quad-core.

With the advancement of new technologies, computing and processing is believed to scale new heights. Today, when energy is one of the major concerns that our world faces, Nehalem might just be the solution that the electronic world needs. Advent of new technology like this is bound to boost computing to a great extent. Now, when other companies feel the heat of the growing Nehalem business, it's predicted that a counter-processor will soon be released to tap in the growing flow of investment in the processor bazaar. Though Intel has been eating most of the cake of the processor market, but after inventions like this, can you blame it? Think about it.

(Harpreet Singh, is a 3rd year B.Tech student of ECE Department, IIT Guwahati.)

Be the master in suppressing noise!

Rajib Panigrahi

`When I use a word,' Humpty Dumpty said, in rather a scornful tone, `it means just what I choose it to mean -- neither more nor less.'
– Alice in Wonderland

Processing in digital domain is easy. However there is no free-lunch. So you pay in innumerable ways. One of these is the phenomena called *spectral leakage*? Pure sinusoid function in frequency domain should give an impulse with all the energy concentrated at a single point. A single point in frequency domain means ONE frequency. Hence this is what we desire. But in real life we take chunks of signal (not infinite length). When you take DFT of a chunk of a signal, DFT assumes that that chunk repeats itself. So, if you take a bit more than one exact cycle of sine, then you get something odd in digital domain. This leaves you with something unsharp in frequency domain. Hence, the Fourier transform of a limited duration sine wave produces a waveform that can be described by a Sinc function (Fig.1). The Sinc function has a mainlobe which contains the peak and has a width upto the first zero crossing , and a set of sidelobes comprising the oscillating remainder on both sides of the mainlobe. The composite function of the mainlobe and the sidelobes is termed the impulse response (IPR) of the system. The location of the centre of the Sinc function is related to the frequency of the sine wave. If there are more than one sine wave present in the signal being analyzed, they will appear in the output at other locations. The resolution is related to the width of the mainlobe. The presence of sidelobes reduce the ability to discriminate between Sinc function.

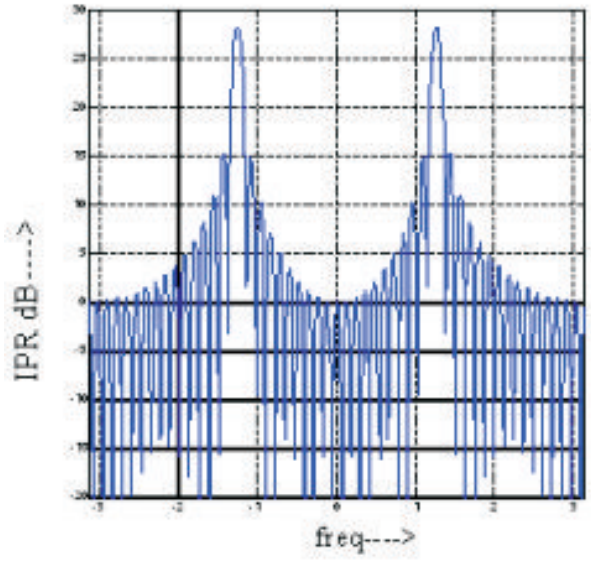

Fig.1: FFT of time-limited sinusoidal signal

Sidelobe of the IPR have traditionally been reduced by applying an amplitude weighting function to the data prior to the FFT. An example is the Hanning weighting function which gives the impulse response shown in Fig. 2. The Hanning peak sidelobe is much smaller than for the sinc function and the sidelobe envelope decreases at 18dB per octave. However, the lower sidelobes have been achieved at the expense of the mainlobe width which determines the ultimate resolution of the system.

This problem can be overcomed by using an effective apodization that varies from point to point in IPR of the system. Different types of apodization techniques have been explained in next Part.

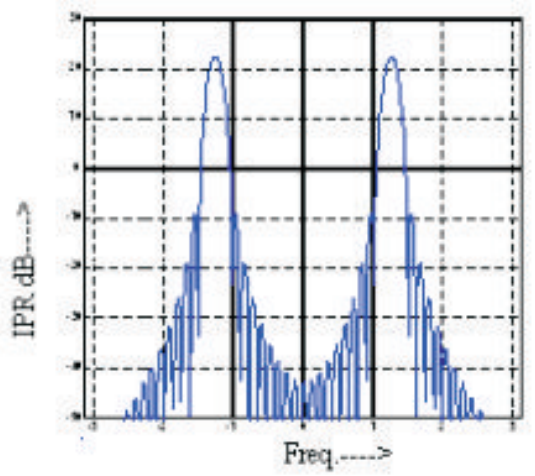

Fig. 2: Amplitude weighted by Hanning window

DUAL AND MULTIAPODIZATION

One nonlinear procedure for obtaining an IPR with good mainlobe resolution and low sidelobes is to do the following.

Compute two versions of the IPR, one using uniform weighting (resulting in the Sinc IPR as shown in Fig.1), and a second one using a different weighting such as Hanning.

At each sample, select the minimum value from the pair of IPRs.

This procedure is called as dual apodization (DA). If the IPR consists of a single sinc function, then the resultant dual-apodized IPR, shown in Fig. 3, has the narrow mainlobe of the Sinc IPR and the small sidelobes of the Hanning IPR [1].

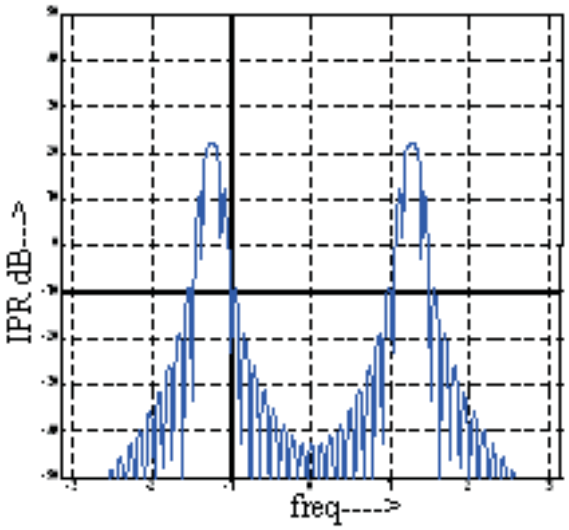

Fig. 3: Dual Apodization

COMPLEX DUAL APODIZATION

DA makes a decision based only on the magnitudes of the IPRs; however, additional information resides in the complex values of the IPRs. To make use of the complex values we operate on the real (*I* or in-phase) and imaginary (*Q* or quadrature) components of the IPR separately. If the value of a component has a sign that is different for the Sinc IPR than for the Hanning IPR**,** then there must be some weighting function intermediate between uniform weighting and Hanning weighting for which the value of the component would be zero. Making use of the sign change is a way to effectively make use of a family of IPRs while only having to compute two of them.

The following algorithm, which makes use of this principle, is called as complex **DA (CDA) [2].**

1. Compute two versions of the IPR, one using uniform weighting and the other using Hanning weighting,
2. At each sample, if the *I* components of the two IPRs have opposite sign, select the value zero; otherwise select the *I* value which has the smaller absolute value of the two. Do likewise for the *Q* components.

CDA provides lower sidelobes than DA because the sidelobes for the two IPRs are opposite in sign (Fig. 4).

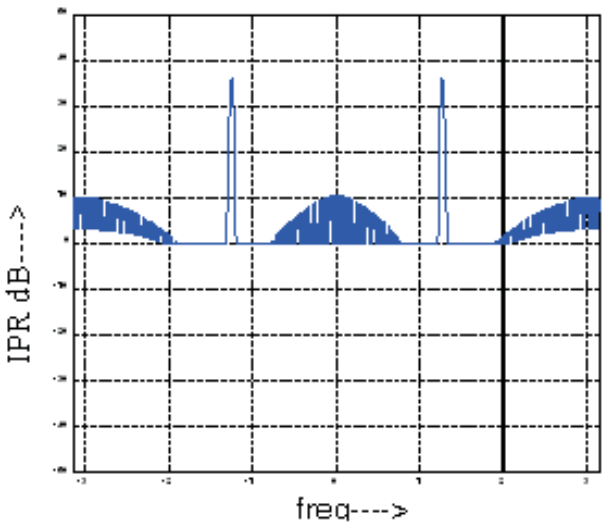

Fig. 4: Complex Dual apodisation

SPATIALLY VARIANT APODIZATION

In this section a more general algorithm is described, which is called as spatially variant apodization (SVA) which allows each sample in an IPR to receive its own frequency domain aperture amplitude weighting function from a continuum of possible weighting functions . SVA can effectively suppress sidelobes induced by finite aperture signal without broadening the mainlobe of the IPR. This is accomplished by taking advantage of the special properties of cosine-on-pedestal weighting functions when dealing with sampled IPRs. The cosine-on-pedestal function can be written as

$$A\,n \quad 1 \quad 2w\cos\frac{2\,n}{N} \qquad 0 \quad n \quad N \quad 1 \qquad (1)$$

This family of weighting range from uniform weighting to Hanning weighting. Hanning weighting is a special case of cosine-on-pedestal which nulls the first sidelobe (w = 0.43). Similarly, any unweighted aperture sinc-

of the family of cosine-on-pedestal weighting functions [1].

Taking the length-N FFT of a cosine on pedestal weighting yields the Nyquist-sampled IPR:

$$a\ m \quad w_{\ m,\ 1} \quad {}_{m,0} \quad w_{\ m,1} \qquad (2)$$

Where ${}_{m,n}$ is the kronecker delta function. Let *g(m)* be the samples of either real (*I*) or imaginary (*Q*) component of a uniformly weighted Nyquist-sampled IPR. Using the 3-point convolver given in (2) to achieve a given cosine-on-pedestal aperture weighting, *g(m)* is replaced by

$$g\ \ m \quad w\ m\ g\ \ m\ \ 1 \quad g\ \ m \quad w\ m\ g\ \ m\ \ 1 \qquad (3)$$

The task, therefore, is to find the *w(m)* which minimizes $\left|g\ \ m\right|^2$ with respect to *w(m)*, and solving for *w(m)*:

$$w\ m \quad \frac{g\ \ m}{g\ \ m\ \ 1 \quad g\ \ m\ \ 1} \qquad (4)$$

Constraining *w(m)* in (4) to lie in the interval [0, 0.5], and inserting it into (3) yields the output IPR:

$$g(m) \quad \begin{array}{ll} g\,m, & wm \quad 0 \\ 0 & 0 \quad wm \quad \frac{1}{2} \\ g\,m \quad \frac{1}{2}\ g\,m\ \ 1 \quad g\,m\ \ 1, & wm \quad \frac{1}{2} \end{array} \qquad (5)$$

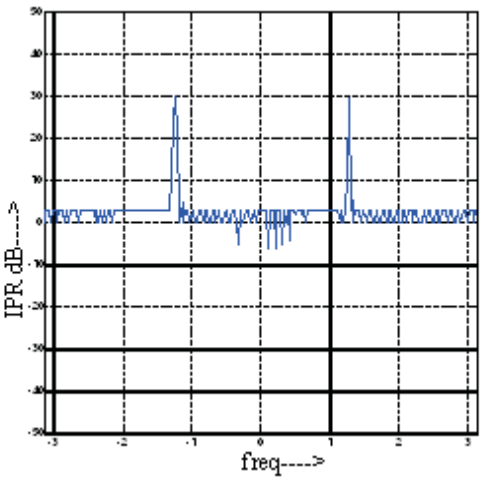

Fig. 5: Spatially Variant Apodization

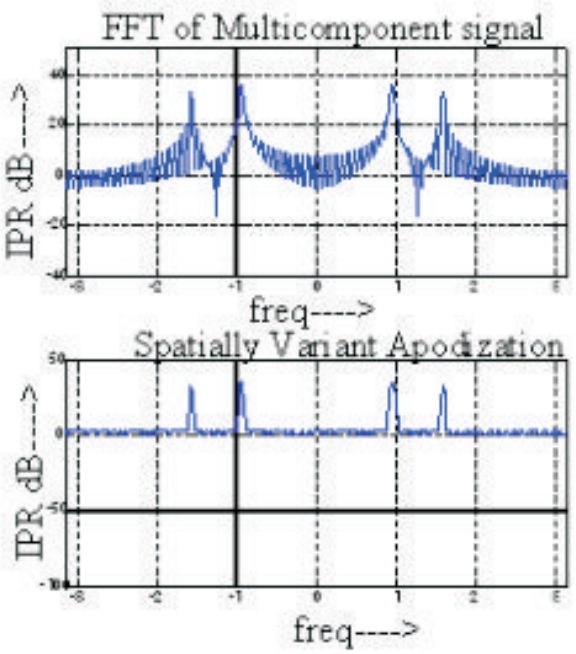

Fig. 6: An example of multicomponent signal

The effect of this algorithm on a single Sinc function is shown in Fig. 5. An example of multicomponent signal is considered in Fig. 6

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(Rajib Panigrahi is a Ph.D scholar of ECE Department, IIT Guwahati)

WILLIAM SHOCKLEY..... THE NOBEL LAUREATE

Gordon Moore, one of the founders of Intel, was also a member of the team, which led by William Shockley was the first to make the transistor. Most of the semiconductor companies founded later on can be traced back to the first company started by William Shockley. Alas, the genius scientist and Nobel Prize winner was not an ideal manager. The following is an excerpt from a speech given by Gordon Moore, in which he talks about his early days working with Shockley.

Like many other scientists and engineers who have ended up founding companies, I didn't leave Caltech as an entrepreneur. I had no training in business; after my sophomore year of college I didn't take any courses outside of chemistry, math, and physics. My career as an entrepreneur happened quite by accident.

There is such a thing as a natural-born entrepreneur... But the accidental entrepreneur like me has to fall into the opportunity or be pushed into it.


William Shockley (1910-1989)

I went to the Applied Physics Laboratory at Johns Hopkins University. But the group I was working in was, for various reasons, breaking apart. So I decided to look for something else. Lawrence Livermore Laboratory interviewed me and offered me a job, but I decided I didn't want to take the spectre of exploding nuclear bombs, so I turned it down. Then one evening I got a call from Bill Shockley, who had gotten my name from Lawrence Livermore's list of people who had turned them down. Now, Shockley is a name that has a Caltech association. After earning his BS here in 1932 he went on to invent the transistor. He had been working at Bell Laboratories, and now he wanted to set up a semiconductor company out on the West Coast (a lot of Caltech connections here - the operation was financed by Arnold Beckman) with the idea of making a cheap silicon transistor. Shockley knew that a chemist was useful in the semiconductor business; they had chemists at Bell Labs, where they did useful things. And I was a chemist, so Shockley caught up with me. Still not an entrepreneur, I decided to join this operation.

I was employee number 18. This was a startup operation. All of us except Shockley were young scientists, in our late twenties. I had no management experience or training. Unfortunately, neither did Shockley. He had run a research group at Bell Laboratories, but this was to be an enterprise rather than a research group, and he had no real experience in running a company. I suppose maybe I should have been suspicious when none of the people who had worked with him at Bell Labs joined his new venture, but I didn't even begin to think about that then.

One day he told a group of us: "I'm not sure you're suited for this kind of a business. We're going to find out. You're going to go out there and set up a production line and run it. You know, *do* the operation, not direct it." This didn't go over especially well, because the group dutifully tried to operate a production line on a product that was still in the early stages of development.

He also set up a secret project. Those of us who weren't involved couldn't know what it was, although Shockley did let us know that it was potentially as important as the invention of the transistor. In such a small entrepreneurial group, having in-people and out-people created some dissension, the sort of thing that makes it hard to keep everybody working together as a team. As another illustration of his motivating skills, one day Shockley asked a

"William Shockley, the genius scientist and Nobel Prize winner was not an ideal manager."

group of us what we would like to do to make the job more interesting. Would we like to publish some papers? We said, "OK," so as a way of satisfying this demand he went home that night and worked out the theory of an effect in semiconductors. He came back the next day and said, "Here. Flesh this out and put your name on it and publish it." Finally, the beginning of the end, as far as morale was concerned, occurred when we had a minor problem in the company and Shockley decided that the entire staff was going to have to take lie detector tests to find out who was responsible for it.

Then he switched from his original idea of building a cheap silicon transistor to building a rather obscure device known as a four-layer diode. We viewed this with considerable concern, because some of us didn't understand exactly where the four-layer diode fit in. One day, when Arnold Beckman came around to talk to the group, Shockley made some closing remarks, just out of the blue, indicating that he could take his staff and go someplace else if Beckman wasn't enthusiastic about what was happening there. So, given all these problems, we decided that we had to go around Shockley to solve them. A group of us contacted Beckman and sat down with him through a series of dinners to try to work out a position for Shockley, in which he could give us the benefit of his technical insights but not of his management philosophy. We were thinking in terms of a professorship at Stanford. By that time, he had won a Nobel Prize, and Nobel Prize winners can get a professorship almost anywhere.

What we didn't appreciate is that it's awfully hard to push a Nobel Prize winner aside. Beckman decided (as the result of advice he had received elsewhere) that he really couldn't do this to Shockley. We were told essentially that Shockley was in charge, and if we didn't like it we probably ought to look at doing something else. We felt we had burned our bridges so badly by that time that we clearly had to leave, and we started to look at alternatives. (Shockley's company held on for a few years, was acquired by Clevite Corporation, and died eventually.)

The first transistor was demonstrated on Dec. 23, 1947, at Bell Labs by William Shockley. This new invention consisting of P type and N type semiconductive materials (in this case germanium) has completely revolutionized electronics.

(This article has been assorted from http://nobelprize.org/nobel_prizes/physics/articles/moore/index.html)

Origin of Solar Cells

Harpreet Singh

21st century has been dubbed as the Age of Energy. With increasing pace of developments, we need energy to power ourselves to continue working with the same zeal and spirit as we are doing now. We are also aware of the fact that this planet has limited sources of energy. Most of them cannot be replenished but some of them can. It is these renewable sources of energy which will hold the light in the coming dark times of energy-scarcity. Out of these sources, solar energy holds the key for a secure and better energy. Out of the numerous ways to tap solar energy, solar cells have proved to be the best way to tap this invaluable energy.

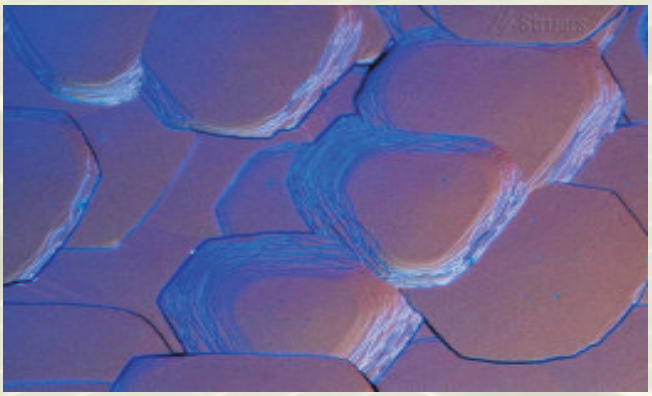
Let's first take a preview into this amazing source of energy. Solar energy, as the name suggests is the energy derived from the sun. Solar cells are just a way to gather this enormous energy. As we all know, a solar cell is a wide area electronic device that converts solar energy into electricity by means of the photovoltaic effect. Sometimes the term solar cell is reserved for devices intended especially to capture energy from sunlight, while the term photovoltaic cell is used with an unspecific source.

History of solar cells

Solar cells date way back to the 1800's when it was first observed that the presence of sunlight is capable of generating electrical energy. It was in the year 1839 that A. E. Becquerel observed the photovoltaic effect, giving rise to the conclusion that sunlight can generate electrical energy and thus the amazing journey of solar cells began. The first solar cell was developed by Charles Fritts in the year 1883. This particular solar cell was made using selenium on a thin layer of gold and gave less than 1% efficiency. Many scientists and researchers, upon seeing the enormous potential of these cells, were involved in developing methods, either to improve the efficiency or to find out new ways and materials of manufacturing solar cells. Thus the age of solar cells had begun.

Generations of solar cells

Talking about age of solar cells, like computers, solar cells are divided into generations, 3 to be precise. These three generations indicate the order of which each became prominent. At present there



Surface of a solar cell

is concurrent research into all three generations while the first generation technologies are most highly represented in commercial production, accounting for 89.6% of 2007 production.

First generation

First generation cells consisted of a large-area, high quality and single junction devices. High energy and labour inputs were the prominent features of first generation solar cells, which prevent any significant progress in reducing production costs. Single junction silicon devices have been observed to reach the theoretical limiting efficiency of 33% and achieve cost parity with fossil fuel energy generation after a payback period of 5-7 years. First generation solar cells are the silicon-based, photovoltaic cells that have, and still do, dominated the solar panel market. These solar cells, using silicon wafers, account for 86% of the solar cell market. They are dominant due to their high efficiency. Though the cost being high, the problem is suppose to be taken care by the second generation of solar cells.

Second generation

Second generation cells, also called thin-film solar cells, are cheaper to produce than the first generation cells but have lower efficiencies. The main advantage of second generation, along with low cost, is their flexibility. Thin-film technology has ushered in an era of lightweight, aesthetically pleasing solar innovations such as solar shingles and solar panels that can be rolled out onto a roof or any other surface for that matter. It is being predicted that second generation cells will be dominating the residential solar market as new,

higher-efficiency cells are researched and produced. Second generation materials were developed to address the energy requirements and production costs of solar cells. It is commonly accepted that as manufacturing techniques evolve, production costs will be dominated by constituent material requirements, whether it be a silicon substrate, or glass cover. Such processes can bring costs down but because of the defects inherent in the lower quality processing methods, have much reduced efficiencies compared to First Generation.

The most successful second generation materials are cadmium telluride (CdTe), copper indium gallium selenide (CuInGaSe), amorphous silicon and micromorphous silicon. These materials are applied in a thin film to a supporting substrate such as glass or ceramics which reduces material mass and therefore costs. These technologies hold promise of higher conversion efficiency and significantly cheaper production costs. There is certainly a trend towards second generation technologies, when it comes to major manufacturing companies, however commercialization of these technologies has proven difficult.

Third generation

Third generation solar cells are the cutting edge and probably the highest level of success of solar technology. Though still in the research phase, third generation cells have moved well beyond silicon-based cells. Generally, third generation cells include solar cells that do not need the p-n junction necessary in traditional semiconductor, silicon-based cells. On the other hand third generation consists of a wide range of potential solar innovations including polymer solar cells, nano-crystalline cells and dye-sensitized solar cells. If and when these technologies are developed and produced, the third generation seems to be divided into separate categories.

The aim of the third generation solar cells is to enhance poor electrical performance of second generation (thin-film technologies) while maintaining very low production costs. Current research is targeted on conversion efficiencies of 30-60% while retaining low cost materials and manufacturing techniques. They were observed to exceed the theoretical solar conversion efficiency limit for a single energy threshold material, which was calculated in 1961 by Shockley and Queisser as 31% under 1 sun illumination and 40.8% under maximal concentration of sunlight.

Implementation

Solar cells are often electrically connected as a module. PV modules frequently have a sheet of glass on the front (sun up) side, allowing light to pass while protecting the semiconductor wafers from outside elements (rain, hail, etc.) which may harm the panel. Solar cells are also usually connected in series in modules, creating an additive voltage. Connecting cells in parallel will yield a higher current. Modules are then interconnected, in series or parallel, or both, to create an array which gives the desired peak DC voltage and current.

The power output of a solar array is measured in watts (W) or kilowatts (kW). In order to calculate the typical energy needs of the application, a measurement in watt-hours, kilowatt-hours or kilowatt-hours per day is usually used. A common rule is that average power is equal to 20% of peak power, so that each peak kilowatt of solar array output power corresponds to energy production of 4.8 kWh per day.

To make practical use of the solar-generated energy, the electricity is most often fed into the electricity grid using inverters (grid-connected PV systems). In stand alone systems like calculators, watches, batteries are used to store the energy that is not needed immediately.

Solar Cells, as we observe, have come a long a way since their development in 1883. They have gone through a lot of changes and a long road to travel. Now, when environment concern is rising, a safe, clean and green technology is the need of hour. A source of energy that satisfies that needs of the energy-drought world, without compromising with the environment is certainly welcome. Solar cells seem to be the certain answer to this quest.

(To be continued)……..

(Harpreet Singh, is a 3rd year B.Tech student of ECE Department, IIT Guwahati.)

Peter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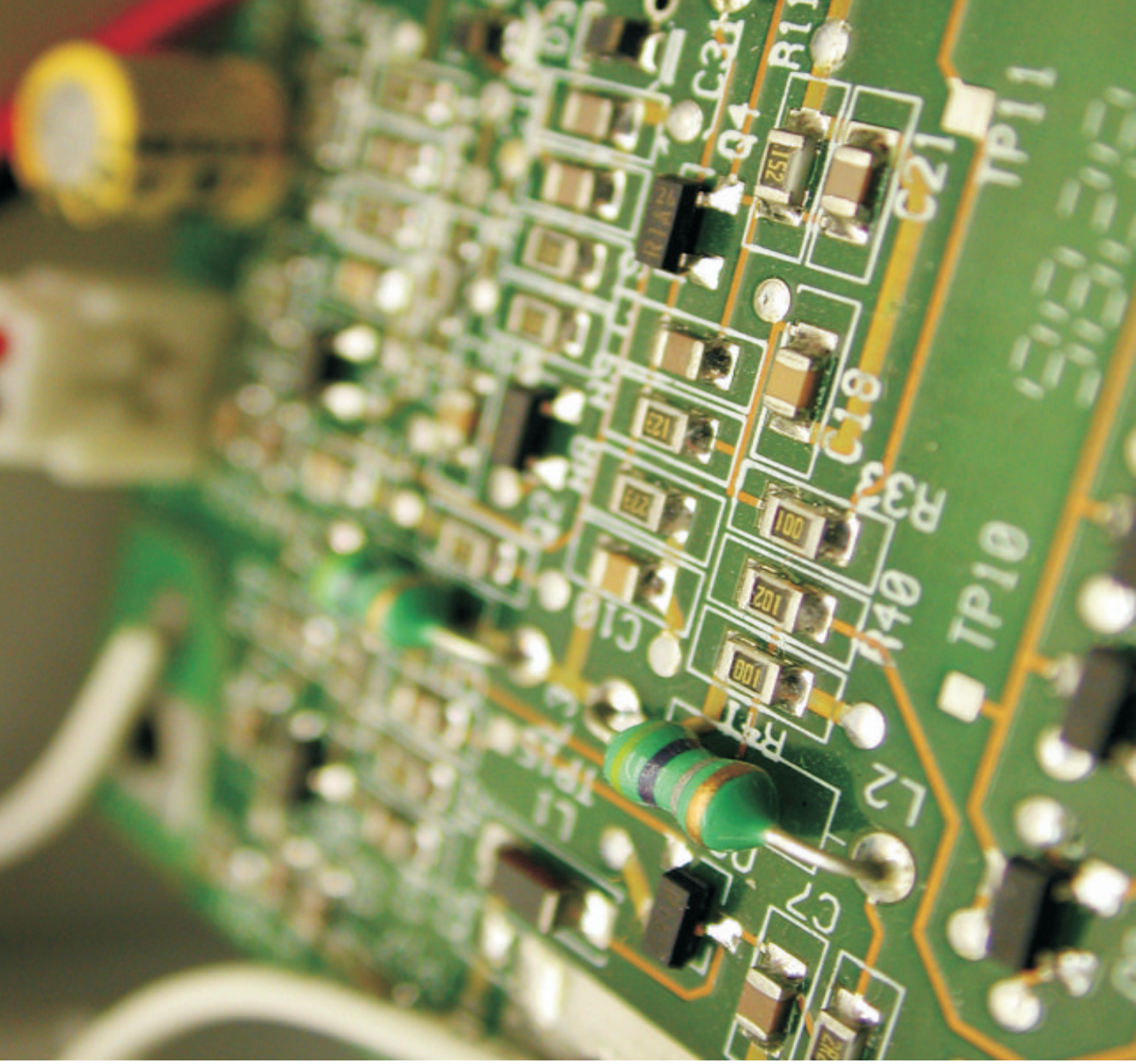

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