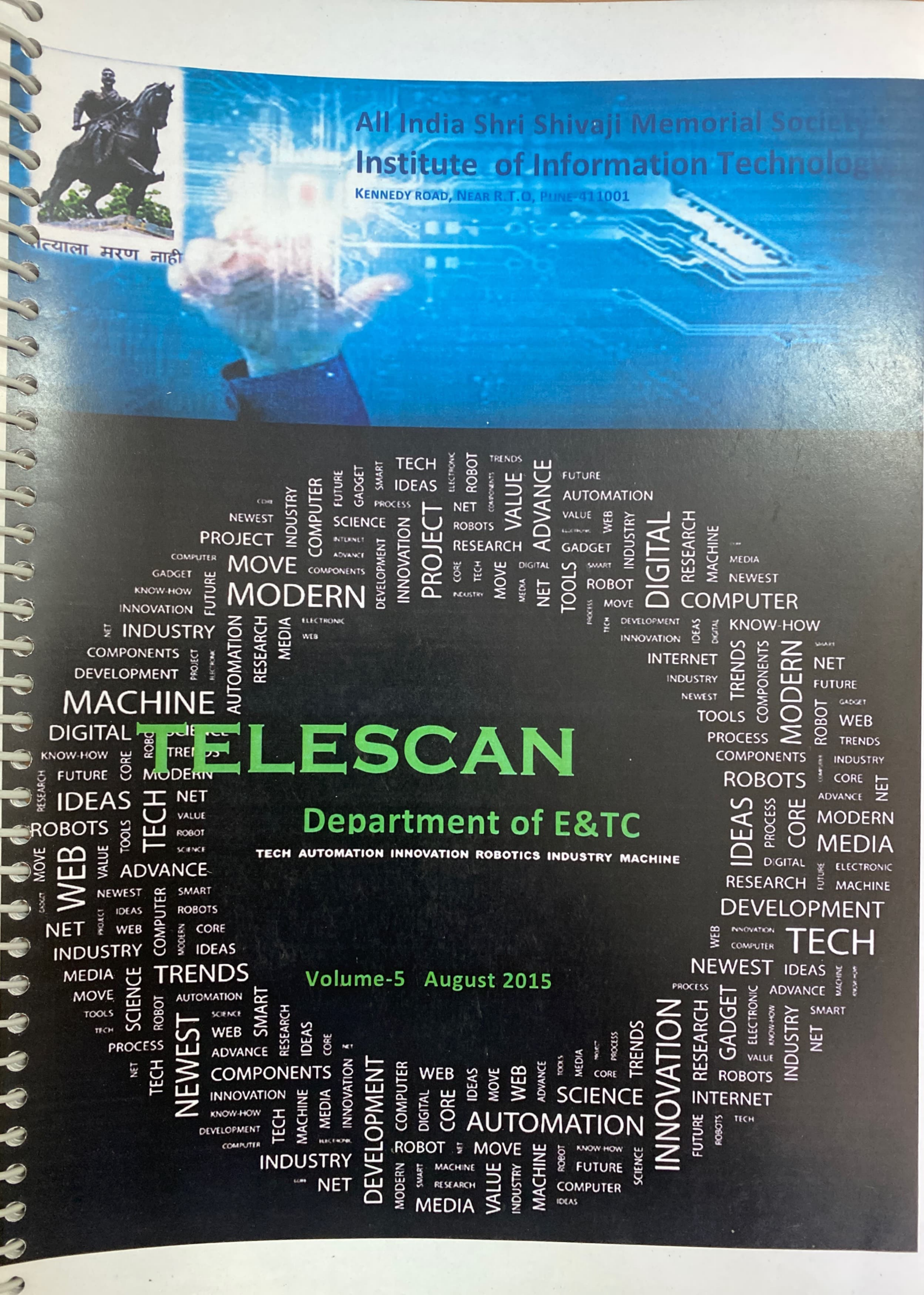

All India Shri Shivaji Memorial Society
Institute of Information Technology
KENNEDY ROAD, NEAR R.T.O, PUNE-411001
TELESCAN
Department of E&TC
TECH AUTOMATION INNOVATION ROBOTICS INDUSTRY MACHINE
Volume-5 August 2015

EXPLORING THE WORLD TECHNICALLY

We are much honored and happy to present you"Telescan 2015"of our departmental magazine.

As Telescan is a technical magazine,it provides a platform to the students to express their advanced technical knowledge.Students get inspired to do study on latest technology before submitting their articles.It is surely beneficial for students.

We would like to thanks Mrs.M.P.Saradey (HOD),Mrs.D.M.Yewale & Mr.S.R.Pawar for their support and encouraging us to represent such a wonder. This year also we have got good response from students and we have made our best to make TELESCAN the gem.

Editorial Team:

Manish Khandelwal (SE A)
Pawan Kumar (SE B)
Tushar Ranwat (SE C)
Ankita Bhosale (TE A)
Alakar Muley (TE B)
Harshal Gothankar (TE C)
Priyanka Degaonkar (BE A)
Nikhil Nimgaonkar (BE B)

Staff Co-ordinator:

Mrs.D.M.Yewale
Mr.S.R.Pawar

INDEX

VISION OF E&TC DEPARTMENT

- To provide quality education in electronics & telecommunication engineering with professional ethics

MISSION OF E&TC DEPARTMENT

- To develop technical competency, ethics for professional growth and a sense of social responsibility among students

"The Leader of Leaders"

SMART LIBRARY

Now a days, as we all are in the modern era of technology. There are many things that we use in our day to day life which has **AUTOMATION.**
Like…

- Coffee machine.

- In various industries.
- Scanner machines for security purpose.
- Automatic doors.

It is possible that such a type of automation can be done in our books library also!!!

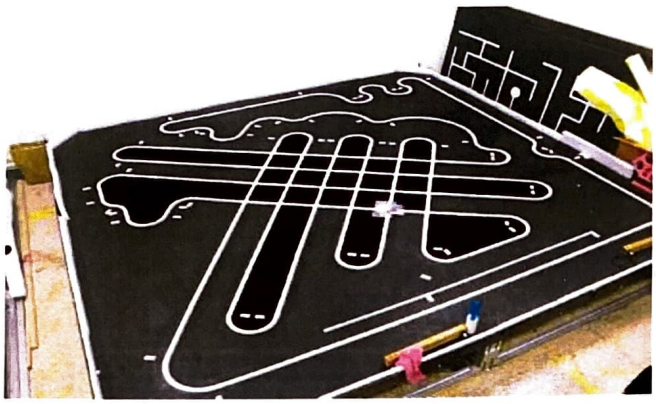
As our library is going to be fully automatic. It is obvious that it will save time of the user, as it will search the required book automatically and will send it to the counter desk. This automation is also going to help the librarian as it will do all the work that the librarian has to do all the day.
The automation will work like…

- It will control and manage all the database of library.
- It will do the entries on issuing or returning or renewing the books hired by the readers.
- It will be quick in service.
- It will provide all the data about availability of the book, the total number of books are there in the library.

To make our application easy to use there should be a user friendly interface in front of the user .That will help the user to hire a specific required book.
To implement this type of mechanism there are some requirements.

The various equipment which we are going to use will work together and make our library a SMART one. The structure of any library looks like..

Many numbers of books will be there in the cupboard, which has different books, titles, no. of authors. Searching for a specific book among those will require much time. So this idea of SMART LIBRARY will reduce this time requirement.



To do so we have to design our library with the modern equipments like robots, robotic arm, some sensors. Instead of using the robot we can also use the roller mechanism. But it will require more space and electricity.

By using robots we can implement our modern library more precisely.

Here we can use the simple fact of the technical games like robo trace which has a task of tracing the given path by the robot. The path is drawn on the floor and the robot has to sense the path and follow it.

we can also use this type of thing in our library. We have to draw lines in the area were a reader used to walk in the search of required book. We will program our robot such that it will trace that line and go near to the shelf where the book is put and will pick up the book and take it to the counter desk. SO WE REQUIRE ROBOTS WITH WHEEL AND ROBOTIC ARM.

Using only robots is not the end. For more precision we will mount some robotic arms on every cupboard in the library with a bar code reader sensor we will generate a bar code for each book which will contain it's details, which will be scan by the sensor. To reduce the number of robotic arm we can use one arm for two parallel racks.

These robotic arms should be like. .

The barcode scanner is...

One more arm with bar code reader should be mounted at the counter desk. So that entries should be done.

Above was the hardware part.

To do all those above mentioned things properly we have to build a software that will send commands to the equipments and should check whether the work is being done in proper manner or not. It will also have the entire database that which book is placed in which cupboard and in which shelf ,which will consist of a user friendly interface. It will have a menu option in which user have to input some data.

Data will be like...

- ✓ Login menu.
- ✓ If the user is new then sign up menu.
- ✓ name of the book
- ✓ name of the author
- ✓ Edition

and more books regarding the given input.

After getting input by the user it will send a signal to the robotic arm at the cupboard in which that book is placed and the arm will check the availability of the book .If the book is available then it will send a signal back to the computer and the computer will assign the path and the location of the book to the robot and robot will carry the book to the counter desk.

At the time of returning the book the arm at the counter desk which has the bar code reader will scan the code and the information of the book will be sent to the computer and again computer will decide at which place the book should be put and will make the entry of the book in the database.

Like this our smart library will work.

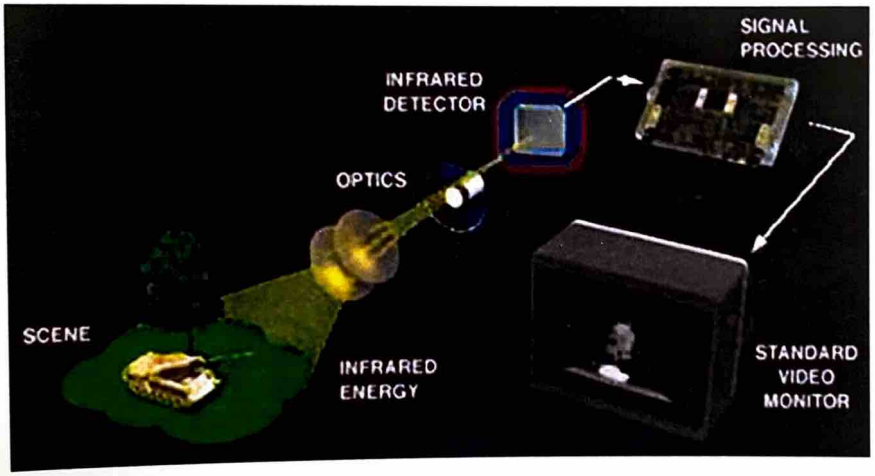
VENKATESH S. MAHINDRAKAR
SE A (E&TC)

NIGHT VISION TECHNOLOGY

And then the troops, unnoticed, surrounded whole of the desert city in that dark night, which certainly was all green for them', we must have come across such lines in some or other war related article. Well, as quite a number of people do know that what does the word 'green' here refers to, very few are able to tell the deep insights about it. This article takes every inch of that green and explains its cause, the Night Vision Technology.

Night Vision Technology, as the name suggests, is the expertise that makes us capable to see in the night without using any external light source such as a torch or a lamp. Highly advanced light sensitive cameras are used in this technology that produce clear visible images at night which the naked eye can't do. Since the human eye is quite sensitive to green colour which falls in the middle of the spectrum, these cameras have green phosphor which gives the green colour to the Night Vision Cameras.

THE WORKING



History

Night Vision technology has been under research since Pre-World War II. However, a defined shape came post World War II, i.e., in early 1950s. This is when Generation-0 for Night Vision was developed. Devices that surfaced during this generation were bulky and expensive. The basic principle followed was using the light of the Infrared region for the purpose of viewing. These early devices had their focus on image covering rather than giving sharp and intensified images. Since the drawbacks were more, the need to have an advanced system was realized quite promptly and within a decade, Generation-1 of night vision technology marked its presence.

1960s was the time, when the Vietnam war had taken a fiercer pace and victory demanded better use of the technology. Following the need, inventions in the night vision came up and were quickly adopted by the war

nations. Generation-1 night vision gadgets didn't have any source of light unlike the previous generation, as they were well advanced to use the little amount of light present in the environment. Even though less bulky and more efficient, these optical sensors needed moonlight to function properly. The images produced were ambiguous at the edges of the lens. But those who were equipped with this technology got a straight edge over the rivals as don't had it found no alternatives than to protect them or use illuminations all night long. The improvements in the image intensifier tube or the ITT were mainly responsible for evolution of new generations in night vision technology.

Generation-2 came up during the 70s when some remarkable achievements in physics and optical phenomena could be actually transformed into other forms. Devices in this generation were loaded with image intensifiers which were basically photo cathodes that came along with micro channel plates or MCPs. These MCPs detect electrons whose frequency doesn't come in the visible region of the light spectrum. This fairly solved the problem of unambiguous images as well as gave a well intensified and resolved image which restricted the life of the tube to be around 1000 hours.

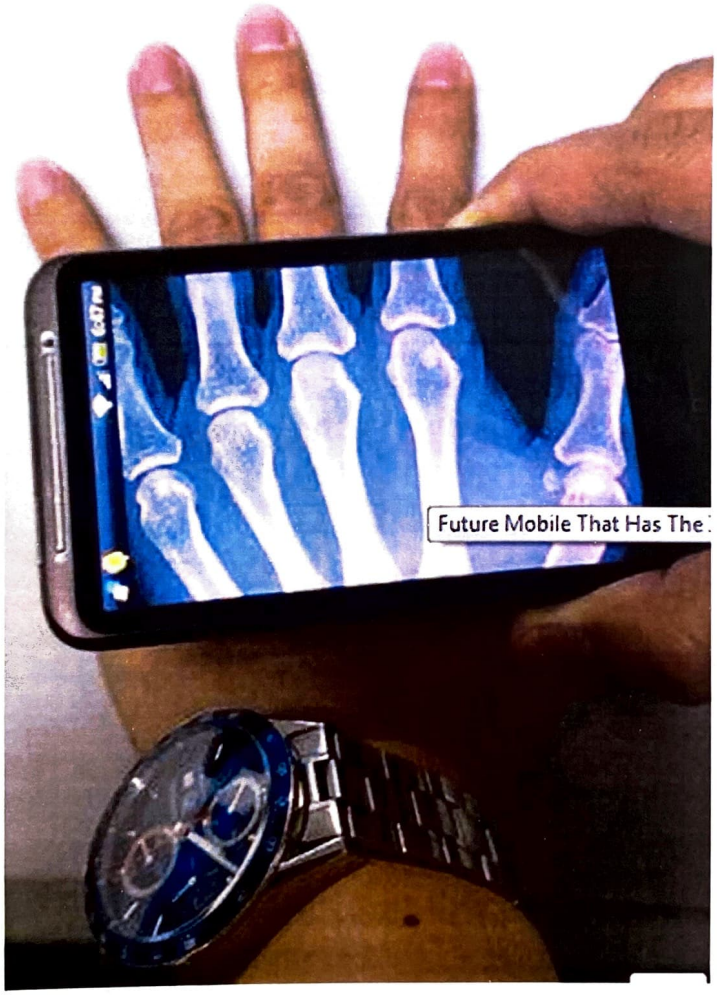
In Generation-3, arrival of Gallium Arsenide as photocathode was seen. This, along with more advanced ion barrier film, increased the amount to which the image could be intensified by MCP and the intensifier tube's life also increased by 1000 hours. Generation-3 devices are widely used and serve as the prime night vision devices for the US Army.

The gating technologies for power input stand as the benchmarks for Generation-4 of night vision technology as they confiscate the ion barriers and give best resolved form of the image. Amazingly efficient in the low light, Generation-4 devices are still considered in Generation-3 by the US Army. Even though Generation-3 is the most used, Generation-2 devices are used for non armed and civilian purposes. At present, night vision devices can last for more than 10,000 hours and can give a fair vision of around 1000 metres in a fully moonlit environment.

PAWAN KUMAR
(S.E E&TC)

New Imaging Technology Would Let Cell phones See Through Walls

Researchers have designed an imaging chip that could turn mobile phones into devices that can see through the wall, wood, plastic, paper and other object. The team of researchers has found a way to make the terahertz band of the electromagnetic spectrum — the spectrum band between microwaves and infrared light — usable for medical or consumer devices. As infrared light can be viewed by some night vision goggles, devices that can image the terahertz band could see through drywall, wood, even human skin. This band has been used before, but the new solution is cheaper and simpler to create.



The research team linked two scientific advancements. One involves tapping into an unused range in the electromagnetic spectrum. The other is a new microchip technology. The electromagnetic spectrum characterizes wavelengths of energy. Radio waves or microwaves are used for cell phones or the infrared

wavelength that makes night vision devices possible. By using the terahertz band of the electromagnetic spectrum, images can be created with signals operating in the terahertz (THz) range without using several lenses inside a device. Chips are manufactured using **Complementary Metal-Oxide Semiconductor** (CMOS) technology.

"CMOS is affordable and can be used to make lots of chips," **Dr. Kenneth O**, professor of electrical engineering at UT Dallas and director of the Texas Analog Center of Excellence (TxACE) said. "The combination of CMOS and terahertz means you could put this chip and receiver on the back of a cell phone, turning it into a device carried in your pocket that can see through objects. We've created approaches that open a previously untapped portion of the electromagnetic spectrum for consumer use and life-saving medical applications. The terahertz range is full of unlimited potential that could benefit us all."

Now, the team is trying to create a fully operational imaging system. However, due to privacy concerns, Dr. O and his team is focused on uses in the distance range of less than four inches. Researchers are hoping that consumers and businesses would use the imaging system to find studs, check money for signs of counterfeiting, or check for health problems like tumors.

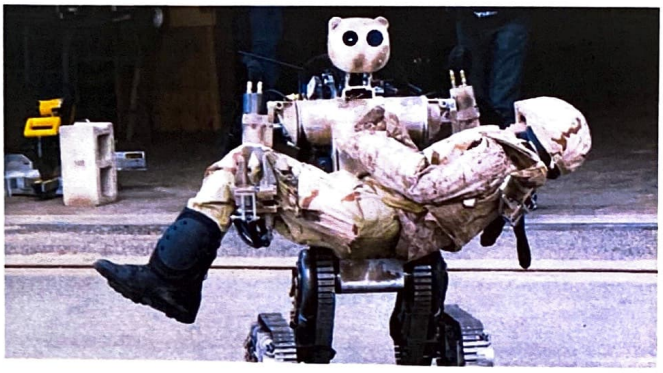
Mrs.Sharvari Patil.
Assistant Professor
Dept. of ENTC
AISSMS IOIT, Pune

Military Robotics: Robots in the Military

The utilization of Robotics in military is well shown by US army. Osama and other terrorists were tracked by these military robots. They are robust, they are obedient, they are daring, they don't have fear of death, and most important they have proved themselves in Iraq and Afghanistan. Now, terrorists are terrified by drone attacks. The utilization of robotics technology in military led to a new field in robotics i.e. Military Robotics.

Military Robotics, Military Robots, Robots in Military

Military robotics isn't about creating an army of humanoids but utilization of robotics technology for fighting terror and defending the nation. Thus, military robots need not be humanoids or they not necessarily need to carry weapons, they are just those robots that can help the armed forces. The opportunities offered by these technologies are boundless. Apart from army research centres there are many private firms also which provide military robots for defence forces like Foster Miller, 21st Century Robotics, EOD Performance, Northrop Grumman and General Atomics etc. They have created many job opportunities and are developing this sector. It is expected that its market will extend up to $9.8 billion by 2016.



History

The vision of robot army isn't a present day concept. The introduction of military robots is dated back from 1898 by the introduction of radio boats by Nicola Tesla. It was visualized by many visionaries in the last century. They were used by Germans and Russians in Second World War. Russians used Teletanks and Goliath were used by Germans. The Teletanks were equipped with DT machine guns, flamethrowers and smoke container to provide a smokescreen. The use of Goliath which is a mobile landmine in World War II by the Third Reich's forces also marked as a turning point in the history of military robots. And today the development in this technology is well demonstrated by military robots in Afghanistan and Iraq. At present the most commonly used military robot is the unmanned aerial vehicle IAI Pioneer and RQ-1 Predator.

One threatening question must be arising, as in every science fiction movie, it is shown that robots have gone crazy and started hunting us, will they go crazy in real world also? Actually, at present it is almost impossible. The developers have very well taken care of this aspect. Most of the military robots are remotely controlled by a human. And if someone has gone crazy then there is a reset button which clear there memory and they again come back to normal state. But with the development in artificial intelligence and military robots, there should be greater attention to implicate their ability to make autonomous decision.

OPERATIONS

Military Operations Today military robots use very sophisticated and advance technology for operations. They use different technologies for reconnaissance, guidance and weaponry. They basically use GPS, Fibre Optic Tethers, LIDARs for guidance. GPS is based on satellite connections and is even used in mobile phones. The fibre optics is a hi-tech and hi-speed communication system especially used by defence. LIDARs are based on laser communication and nowadays used by traffic police to detect over speeding vehicles. For reconnaissance they use other technologies like cameras, electronic RF sensor, RADAR, etc. The robots are mainly used for reconnaissance purposes but they can also carry lethal and non-lethal weapons like AGM-114 Hellfire missiles, M249 saw machine guns, ammo can, bomb diffusal kits, grenades, etc.

VARIETIES

Military robots come in different shapes and sizes as per the task they are designated for. In the development of military robots, we can consider US Mechatronics which has created or developed a working automated sentry gun and is presently developing it further for commercial as well as military use. As far as military robots development is concerned, we cannot forget MIDARS which is a four-wheeled military robot. This robot is outfitted with many cameras, radar, and a firearm that performs arbitrary patrols around a military base automatically. Their size can vary from a small bot TALON and large UAV MQ-1 Predator. Their design is also task specific like, predator is for surveillance and attack from air so it is more like an airplane while TALON is for attack from ground so it is more like an armoured tank. There are three popular classes of military robots i.e. UGVs, UUVs and UAVs.

VEDANT PAITHANKAR
(S.E E&TC)

MEMCOMPUTERS

A new computer prototype called a "memcomputer" works by mimicking the human brain, and could one day perform notoriously complex tasks like breaking codes, scientists say. These new, brain-inspired computing devices also could help neuroscientists better understand the workings of the human brain, researchers say. In a conventional microchip, the processor, which executes computations, and the memory, which stores data, is separate components. This constant relaying of data between the processor and the memory consumes time and energy, thus limiting the performance of standard computers. In contrast, Massimiliano Di Ventra, a theoretical physicist at the University of California, San Diego, and his colleagues are building "memcomputers," made up of "memprocessors," that both process and store data. This setup mimics the neurons that make up the human brain, with each neuron serving as both the processor and the memory.

The building blocks of memcomputers were first theoretically predicted in the 1970s, but they were manufactured for the first time in 2008. [Super-Intelligent Machines: 7 Robotic Futures]Now, Di Ventra and his colleagues have built a prototype memcomputer they say can efficiently solve one type of notoriously difficult computational problem. Moreover, they built their memcomputer from standard microelectronics. “These machines can be built with available technology," Di Ventra told Live Science. The scientists investigated a class of problems known as NP-complete. With this type of problem, a person may be able to quickly confirm whether any given solution may or may not work but can't quickly find the best solution to it. One example of such a conundrum is the "traveling salesman problem," in which someone is given a list of cities and is asked to find the shortest possible route from a city that visits every other city exactly once and returns to the starting city. Although someone may be able to quickly find out whether a route gets to all of the cities and does not go to any city more than once, verifying whether this route is the shortest involves trying every single combination — a brute-force strategy that grows vastly more complex as the number of cities increases.

The memprocessors in a memcomputer can work collectively and simultaneously to find every possible solution to such conundrums. The new memcomputer solves the NP-complete version of what is called the subset sum problem. In this problem, one is given a set of integers — whole numbers such as 1 and negative 1, but not fractions such as 1/2 — and must find if there is a subset of those integers whose sum is zero. “If we work with a different paradigm of computation, those problems that are notoriously difficult to solve with

current computers can be solved more efficiently with memcomputers," Di Ventra said. But solving this type of problem is just one advantage these computers have over traditional computers. "In addition, we would like to understand if what we learn from memcomputing could teach us something about the operation of the brain," Di Ventra said. Quantum computing to solve NP-complete problems, scientists are also pursuing a different strategy involving quantum computers, which use components known as quoits to investigate every possible solution to a problem simultaneously. However, quantum computers have limitations — for instance, they usually operate at extremely low temperatures. In contrast, memcomputers "can be built with standard technology and operate at room temperature," Di Ventra said. In addition, memcomputers could tackle problems that scientists are exploring with quantum computers, such as code breaking. However, the new memcomputer does have a major limitation: It is difficult to scale this proof-of-concept version up to multitude of memprocessors, Di Ventra said. The way the system encodes data makes it vulnerable to random fluctuations that can introduce errors, and a large-scale version would require error-correcting codes that would make this system more complex and potentially too cumbersome to work quickly, he added. Still, Di Ventra said it should be possible to build memcomputers that encode data in a different way. This would make them less susceptible to such problems, and hence scalable to a very large number of memprocessors.

Monish Khandelwal
(SE A E&TC)

VIRTUAL REALITY

Go…Go….Go…Roger FIRE in the hole!.....Fire in the hole!!!….Two down…TWO DOWN…one more one more… YOU LOST!!!

While pressing the keys of your keyboard or keypad to convert the lost games to last moment victories the chances are you have encountered the virtual reality in your life. These games involve you with the characters or objects and with the amplification of the involvement, one feels a part of this virtual world. By using 3D imagery with a head mounted device (HMD) and high quality surrounding sound equipments, these games creates more involvement in the virtual world and consequently shut down the cues of real world. This is what called virtual reality, which has applications far beyond gaming.

What is Virtual Reality?

Virtual reality can be defined as an upcoming technology that makes users feel in a Virtual Environment (VE) by using computer hardware and software. It was originally conceived as a digitally created space which humans could access by donning special computer equipments. It enables people to deal with information more easily. VR provides a different way to see and experience information, one that is dynamic and immediate. For example, in a computer game, user's joystick motions are tracked and the objects in the game are moved according to the joystick movements. In the same way a simulated, three-dimensional world is created around the user in which he/she could interact with objects, people, and environments. Typically three-dimensional life-sized images with support of audio devices are presented around the user and the perspective is modified in accordance with the user input (generally head or eye movements). Many devices along with the computers are used to create a virtual environment.

To enter in a VE, a user dons special gloves, earphones, and goggles, all of which send their output to the computer systems. The virtual environments are intended to replace the real world environment with the digital one and the human senses are immersed in the VE. Immersion is an experience of losing oneself in the VE and shutting out all cues from the physical world. A Virtual Environment can be created on different extents depending on the computer based platform ranging from a cell phone screen to a desktop monitor or a fully Immersive Virtual Environment (IVE).

The tracking and rendering turns the whole process more immersive and interactive than the traditional media like televisions and video games. The user actions result in immediate and observable impact on the content of virtual environment. Following are the main components of a virtual environment:

1. The visual displays that immerse the user in the virtual world and block out contradictory sensory impressions from the real world.
2. The graphics rendering system that generates the ever changing images at 20 to 30 frames per second.
3. A tracking system that continuously informs the position and orientation of the user's movements.

4. The database construction and maintenance system to build and maintain a detailed and realistic model of the virtual world.
5. A sound system that can produce high quality directional sounds and simulated sound fields.
6. Devices like tracked gloves with pushbuttons to enable users to specify their interactions with the virtual objects.

How VR works

A simple example of 'Counter Strike' game can give a thought as to how virtual reality works. The software program for the game is the major element which runs with the help of the computer system and the interfaced input output devices. Every Character and environment within the game behaves closely to reality as per the code written for them. The code facilitates characters and environment to interact with the other characters controlled by the input devices. The code is interpreted by the processor which handles the input – output devices accordingly. This is the simplest example of how VR works. The working of more immersive virtual reality environment is quite similar to working of the game besides the fact that a number of advanced input and output devices along with a high performance processor are added to increase the immersion. The processor executes the processes quickly according to the input given by the user and output is presented to the user in a way that user feels itself a part of the environment and its objects. The video below shows an example of more immersive virtual reality.

The 3D visualization component enables the user to see 3D scenarios by using a display methodology like a head mounted device. Typically the 3D images superimpose the real environment by using one of the display, screen based or projection based. The screen based virtual environment generally uses a high quality display screen in terms of resolution and color, or a head mounted device along with the sound system as output devices. A keyboard, microphone, head tracking sensors, finger trackers, gesture recognition system, a joystick or similar gears are used as input devices. When user moves the gear or joystick, make move of the head, or press any key on the keyboard, the objects of the screen are changes accordingly in a way that user feels if he/she is directly controlling the objects and environments on the screen. A high speed powerful processor processes the inputs. An Application Programming Interface (API) provides the interface to the input devices connected to the system as well as to standard devices like mouse and keyboard. The timings and relationship between input and output devices are so perfect that user feels an immersion with the virtual environment.

The other technique used to create a virtual environment is projection based, which is more immersive than the screen based method. The display images are projected on the multi screen spaces ranging from two to six screens. A six screen's would make a better virtual environment. Both floor and ceiling uses a rear projection while the other four screens yield large surrounding views for both panning actions and looking down. Consequently objects inside the space could be walked around and virtual entreat to be touched.

SOURAB MORE
(S.E E&TC)

The Breakthrough Listen

The big news of month of July is that Astrophysicist Stephen Hawking and Russian entrepreneur Yuri Milner announced a new $100 million initiative to search for extraterrestrial life.

Russian entrepreneur Yuri Milner is committing $100 million to fund the most sophisticated search for extraterrestrials ever attempted, 100 times more powerful than previous attempts, 10-year campaign using radio and optical telescopes, ultra-sensitive detectors and state-of-the-art software to study nearby stars and galaxies for telltale signals of alien civilizations.

Milner announced two programs. The "Breakthrough Listen" initiative will focus on the search for optical and radio signals from other civilizations while a "Breakthrough Message" competition will seek suitable responses to a signal if one is detected.

The "Breakthrough Listen" program will survey the one million closest stars to Earth, across the plane of the Milky Way and toward its center where stars are densely packed and even other nearby galaxies. The program's instruments and detectors will be sensitive enough to separate emissions from Earth-level technologies, like air defense radars, some 2,000 light years away.

The Breakthrough Listen project will buy extensive observing time on the football field-size National Radio Astronomy Observatory dish in Green Bank, West Virginia, and the 210-foot Parks Observatory radio telescope in Australia. The project will cover 10 times more of the sky, with 50 times the sensitivity, of previous searches. Equally important, Breakthrough Listen has arranged to use the 2.4-meter Automated Planet Finder Telescope at Lick Observatory in California to search for optical laser signals.

Automated Planet Finder (APF) Lick Observatory's newest telescope

The Breakthrough Listen project will take spectra of thousands of stars and hundreds of galaxies looking for specific wavelengths, single wavelengths, at which there's a lot of light that would be best interpreted as from lasers from some other civilization.

The best part of project is data collected will be available to the public and Breakthrough Listen will join and support the SETI@home project, the University of California at Berkeley's innovative screen saver program that uses idle personal computers to sift through collected data in search of unusual signals.

Project officials said any signal detection of possible extra-terrestrial origin would be treated like any other scientific discovery, requiring independent verification and peer-reviewed analysis. But they emphasized the program will be conducted "in the open" and that the public would be informed about any potential detections.

In addition to the search, Milner also announced a Breakthrough Message competition, which will award $1 million to the person who creates the best message that could be broadcast to alien life if we knew there was someone out there to hear it

Though Milner is funneling a lot of his own money into the space venture, he said he still doesn't have any high expectations.

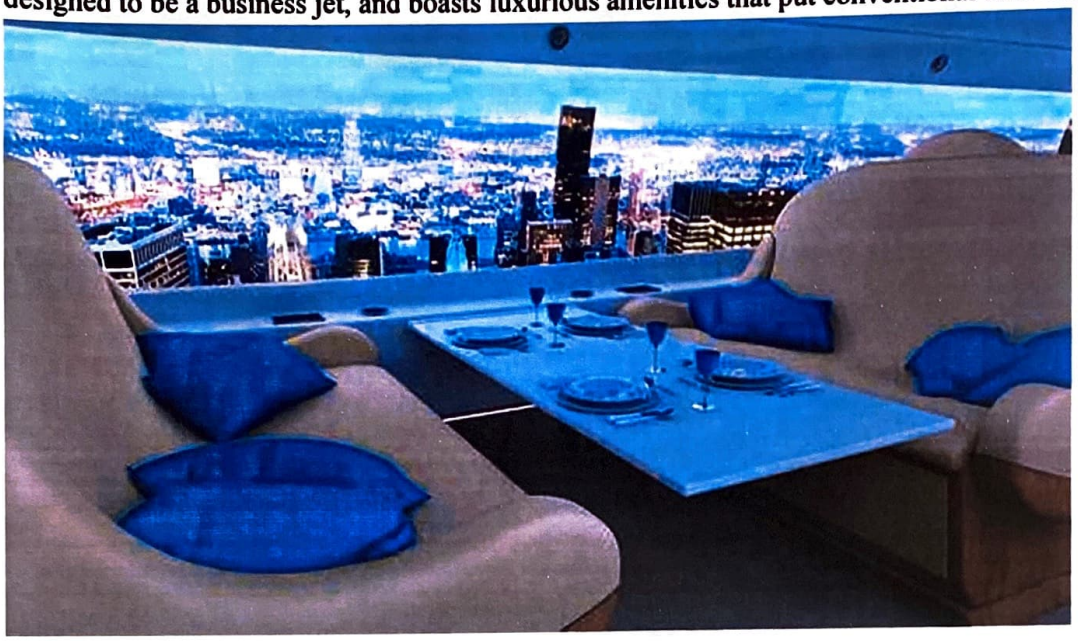
Suprriya Lohar
Assistant Professor
Dept. of ENTC
AISSMS IOIT, Pune

SPIKE: FASTER THAN SOUND

A new supersonic jet designed by Spike Aerospace, a Boston-based company, could fly passengers from New York to London in just 3 hours. The superfast luxury aircraft is designed to reach a maximum speed of Mach 1.8, or nearly two times the speed of sound. Going superfast Spike Aerospace first introduced the S-512Supersonic Jet in 2013, but the company says new upgrades to the plane's design will improve its safety and performance. Supersonic speed .The superfast jet could reach a maximum speed of Mach 1.8, or 1.8 times the speed of sound, according to company officials. Flying time Traveling at 1,370 miles per hour (2,205 km/hr), the S-512 Supersonic Jet could take passengers from New York to London in just 3 hours. Futuristic feel.

The interior of the S-512 Supersonic Jet is dubbed the "Multiplex Cabin," and features leek designs and comfortable seating. Design improvements. Some of the jet's newly upgraded features include "delta" wings that improve aerodynamic efficiency, and a modified tail that will reduce air resistance, or drag, company officials

said. Height of luxury the cabin's huge windows allow for panoramic views. Flying in style The S-512 is designed to be a business jet, and boasts luxurious amenities that put conventional first-class to shame.



Monish Khandelwal
(SE A E&TC)

ELECTRONIC WASTE OR E-WASTE

Have you ever given a thought what happens when you throw or sell your old cell phone or personal computer? Where does it go? And how it affects the atmosphere? Electronic waste or e-waste are those electrical and electronic items that are no longer usable or have been replaced by the new generation version. Computers, cell phones, televisions, refrigerators, air conditioners, DVDs, iPods, copiers, and fax machines are common electronic products, which eventually turn to e-wastes. According to researchers nearly 75 percent of old electronic products are dumped in storage because of the uncertainty of how to manage these materials. Although many of these materials can be reused, refurbished, or recycled but unfortunately they are not, thus making the electronic discards as one of the fastest growing segments of world's waste stream.

With the growth of technology many new companies are stepping in the market with new and/or new versions of the products like laptops, computers, cell phones, televisions, music players etc. Disposal of computers and cell phones is the major segment of electronic waste. As technology improves the lifespan for electronic devices such as computers and cell phones becomes shorter. In developed countries these electronics have an average life span of two years. In the Unites States there are more than 300 million obsolete computers. Although most electronic devices that are thrown away still have parts that are reusable.

Current Scenario

Rapid product innovations and replacement especially in IT sector combined with migration from analogue to digital techniques have together shifted us to the electronic world. The growing economies of the world have given way to lower prices for many electronic goods which has in turn increased global demand for these goods. Increasing production of new electronic goods put the old electronic products into store labelling them 'e-waste'.

People are upgrading their computers, cell phones, televisions, audio players and printers more frequently than ever before. Presently cell phones and computers are causing the biggest problem because they are replaced most often. That is the number of discarded electrical and electronic waste is piling up to millions. Electronics waste now makes up five percent of total municipal solid waste worldwide which is almost equal to the waste of all plastic packaging material. Not only developed countries but the developing countries also have its share in the production of E-Waste. According to the reports, Asia discards an estimated 12 million tons of E-Waste each year. While the electronic waste stream has increased dramatically in the last 10 years; efforts to regulate or recycle them are being developed at a much slower pace.

A recent report by United Nations predicts that by 2020 e-waste from old computers in South Africa and China will have jumped by 200–400 % and by 500 % in India compared to 2007 levels. It also states that by 2020 e-waste from discarded cell phones will be increased to 7 times than 2007 in China and 18 times in India. This report also mentions that in the United States more than 150 million mobiles and pagers were sold in 2008, up from 90 million five years before, and globally more than 1 billion mobile phones were sold in 2007, up from 896 million in 2006. The UN report estimates that countries like Senegal and Uganda can expect e-waste flows from personal computers alone to increase 4 to 8-fold by 2020.

POOJA PAL
(S.E B E&TC)

FUTURE: WILL MACHINE EVENTUALLY TAKE ON EVERY JOB?

It's a booming time to be a truck driver. According to **data NPR compiled** from the US Census Bureau, truck driving is currently the most popular job in 29 states It's not that truck driving is a particularly sought after career path, however. Rather, it is simply one that is available and pays decently. Unlike a plethora of other jobs that have declined in recent years, truck driving has remained immune to the forces that have elbowed out different lines of work. In the past decades, computers, cash machines and self-serve pumps have largely replaced secretaries, bank tellers and gas station attendants, respectively. Door-to-door deliveries, on the other hand, cannot be outsourced to another country, while long haul driving has yet to be automated. Yet truck drivers might be next in line on the endangered jobs list. Google, Uber and Tesla are all working on self-driving vehicles, beginning with **those that make long-haul journeys**. If entrepreneurs succeed at automating cross-country deliveries, this would not only be a boon for companies that ship goods – self-driving trucks don't have to stop for **long mandatory breaks** after spending hours on the road – but also for road safety. In the US alone **up to 4,000 lives each year** are lost in crashes with large trucks (driver error is almost always to blame).

Look, no hands! Will self-driving trucks such as these make humans redundant, or just change our skill set? Self-driving trucks wouldn't be good news for everyone, however. Critics point out that, should this breakthrough be realised, there will be a significant knock-on effect for employment. In the US, up to 3.5 million drivers and 5.2 million additional personnel who work directly within the industry **would be out of a job**. Additionally, countless pit stops along well-worn trucking routes could become ghost towns. Self-driving trucks, in other words, might wreck millions of lives and bring disaster to a significant sector of the economy.

Technological breakthroughs endanger up to 47% of total employment in the US

Dire warnings such as these are frequently issued, not only for the trucking industry, but for the world's workforce at large. As machines, software and robots become more sophisticated, some fear that we stand to lose millions of jobs. According to one unpublished study, the coming wave of technological breakthroughs **endangers up to 47% of total employment** in the US. But is there any truth to such projections, and if so, how concerned should we be? Will the robots take over, rendering us all professional couch potatoes, **as imagined in the film Wall-E**, or will technological innovation give us the freedom to pursue more creative, rewarding endeavors?

The hand that feeds

Examining these questions begins with the realization that technology, innovation and shifting cultural norms have always fuelled a turnover in workforce composition. Machines have been taking our jobs for centuries. "Market economies are never sitting still," says David Autor, a professor of economics at MIT. "Industries rise and fall, products and services change – and that's been going on for a very long time."In the past, as some jobs have disappeared, others have risen in their wake. Artisanal skills – an indispensible commodity in 1750 in England – were replaced by factory work when industrial-scale manufacturing took over in the 19th Century. But by the 1980s, many of the Industrial Revolution-era assembly-line jobs had themselves fallen into the figurative hands of machines. Overall, these changes have brought about more positive than negative results for society. "Generally, our time is made more valuable by the machinery we employ," Author says. "We can accomplish more."

There's a major shift happening in the skill sets people need

Electric washing machines transformed clothes cleaning from an hours-long task into something accomplished with the push of a button; power tools made construction immensely more efficient; and computers eliminated labor-intensive, by-hand calculations and writing. Boosts in quality of life and health and safety also often accompanied such developments. "Overall, people should be happy that a lot of these jobs have actually disappeared," says Carl Frey, co-director of the Oxford Martin Programme on Technology and Employment at the University of Oxford.

Compared to the past, however, what is different about today is the pace at which market transformations are taking place. Aside, perhaps, from the Industrial Revolution, never before have we seen such rapid rates of societal and workforce change. While it's too early to say for sure, data indicate that the employment market isn't necessarily evolving fast enough to keep up with this change: the ratio of employment to the overall population has been falling in developed countries, even independent of the Great Recession. "My reading of the evidence is that the digital economy hasn't created many jobs directly," Frey says. "And the jobs it has created tend to be concentrated in cities like London, San Francisco, New York and Stockholm, which drives up prices, creates inequality and makes it difficult for people to live in or move to places where new jobs are emerging."

Many rail network's - including Dubai's - are already autonomous. Yet the new technology can bring new opportunities

As certain jobs began their march towards extinction, many people who used to hold those middle class positions – travel agents, telephone operators, photo lab technicians, book binders – shifted to lower-paying work – waiting tables, cleaning houses, landscaping – because they lack the training needed to transition into another job in the equivalent economic tier. "There's a major shift happening in the skill sets people need," says Alison Sander, director of the Centre for Sensing and Mining the Future at the Boston Consulting Group. "But that's not a focus of our education

system."Indeed, demand is steeply growing for highly skilled, highly educated workers, but precipitously declining for those with low to moderate education, Autor adds. This means that a large chunk of the population that could have maintained a middle-class lifestyle in past decades can no longer do so. Coming years will likely only see this problem intensify, as jobs that involve any kind of routine or repetitive work – mental or physical – are increasingly at risk of being ousted by automation. The endangered jobs list of the near future includes fast food workers, cashiers, telemarketers, accountants, waiters and even short-form journalists.

Jobs that used to be very interesting start to look more like computer operator jobs

In addition, jobs that were once challenging and required highly skilled expertise could become mundane, thanks to automation. There are hints of this happening today. As X-rays and other medical records are digitised and computer algorithms become better at interpreting them, radiologists, for example, find themselves collaborating with machines, acting more as fact checkers than as medical sleuths. "If radiologists start to respond only to what the computer suggests, then they don't develop their own very sophisticated skills," says Nicholas Carr, author of The Glass Cage: Automation and Us. "Jobs that used to be very complex, idiosyncratic and interesting start to look more like computer operator jobs, just putting in data and interpreting screen readouts."

Old dogs, new tricks

Automation, however, does not necessarily spell doom and boredom for entire sectors of the workforce. So long as jobs are available that require some degree of human involvement, there will be room for people to continue to hold them. When Google's search engine began gaining momentum a decade or so ago, for example, fears abounded that librarians would be rendered obsolete. Instead, openings for librarians actually increased, although new skills were needed to excel at the job. "If it's possible for a machine to completely replace a human, then yes, I'm superfluous," Author says. "But if I'm the person who can now manage that machine, then I become more valuable."Added to that is the fact that – unless the singularity unexpectedly occurs – machines and software will likely never replace certain jobs. So far, humans are vastly superior at any work that relies on creativity, entrepreneurialism, interpersonal skills and emotional intelligence. Jobs that fall into these categories – including clergymen, nurses, motivational speakers, caretakers, trainers, entertainers and more – will probably fare well in a more automated world. Similarly, just because something can be automated, Frey says, doesn't mean it will be. Even if restaurants begin using tablets installed on tables to take orders, and robots to deliver the food and refill beverages, society might not necessarily take to that change. It could turn out that people simply want to be served food – or have their groceries run up, or their taxis driven – by other people, not by machines. This phenomenon is reflected in the recent resurgence of artisans in urban centres around the world, from Brooklyn to London to Berlin to Portland. It turns out that there is a booming market for handcrafted furniture made from salvaged factory beams, hand built headphones, gourmet small-batch foods ranging from marshmallows to mayonnaise – and much more. While these products are valued precisely because automation plays no part in their production,

many artisanal companies rely heavily on technology, like the Etsy peer-to-peer e-commerce website, to find a market for their goods.

Robot surgeons such as the da Vinci system can act as a doctor's hands - though they may lack a good bedside manner

Indeed, for the entire career doors technology shuts, there will also be a wave of new professional paths for people to create and explore. Just as some of today's jobs – social media community manager, app designer, green funeral director – would have been impossible to imagine in 1995, we cannot definitively predict what new types of work will emerge in the future. But we can make educated guesses based on data and social trends. Sander envisions a future in which genetic counselors, software debuggers, bio bankers, augmented reality authors, anti-ageing specialists and urban natural disaster mitigation experts all occupy hot sectors of the economy. As more people move into cities, she also predicts jobs like urban farmers, anxiety counselors; clutter consultants and even pet psychologists will become more favorable.

Automation makes us more prosperous, but it creates income distribution challenges

At the same time, though, we should not automatically assume that the economy will naturally smooth itself out and self-correct. Even if that's happened in the past, there's no guarantee it will play out that way in the future. To make the transition as painless as possible for everyone, we should be proactive about ensuring that the creative destruction of jobs is paired with adequate provisions for those who are displaced. "In the long run, automation makes us more prosperous overall, but it creates income distribution challenges, with the people towards the bottom being crowded out," Author says. "If we manage to create resources without a huge labour demand, the problem will not be, 'Oh no, there's no jobs!' but 'Oh no, we have lots of wealth – now how do we distribute it?'"

Socially responsible options may include bolstered support for the temporarily unemployed and accessible training programmes to help transition them into a new sector. "As the pie gets bigger, we can afford a better safety net for people who end up with bad luck in terms of jobs that get eliminated," says Erik Brynjolfsson, director of the MIT Initiative on the Digital Economy and co-author of **The Second Machine Age**.

Ensuring education keeps pace with societal change is also necessary. "We need to sit down with current curriculums, line them up against new categories of jobs and ask ourselves, 'Are we preparing people in the right way for the future?'" Sander says. Many of the skills being taught today are no longer relevant for current jobs, she says, which has already led to significant mismatches in demand and supply.

We are a far cry from robots who can manage a classroom of children

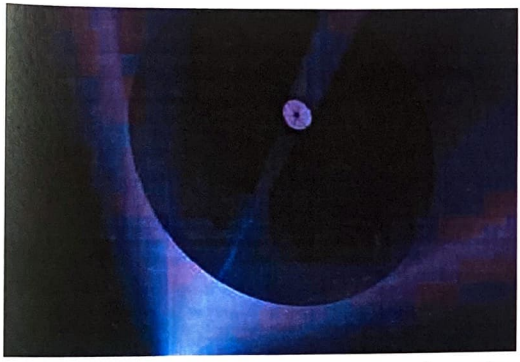
Some countries, industries and companies are responding to these changes better than others. On one

end of the spectrum regulatory regimes can prevent innovation, Sander says, as **France is doing** with the recent ban on Uber . On the other hand, some places are aggressively pursuing innovation. In Germany, 1.5 million people enrol in paid apprenticeships annually, emerging from the programmes as highly skilled technical workers. Likewise, more than 4,000 companies around the world have built training campuses, the largest of which, run by **Infosys** and located in Mysore, India, has churned out more than 100,000 newly minted engineers since 2001. Others are **tuning in to shifting demographics** to try and prevent job loss in the first place. For instance, BMW is modifying to meet the needs of older workers, rather than forcing them to retire. Eventually, though, it very well could be that machines and artificial intelligence do displace the majority of professional tasks that humans currently perform. "I don't think it's imminent and don't know when that will be, but I can certainly imagine a time in the future when machines do most of the jobs we're doing today, and humans don't have to work a whole lot if they don't want to," Brynjolfsson says. Letting the machines take over to some extent isn't necessarily all bad, especially as it is virtually guaranteed to lead to an increase in overall wealth and well being. Thanks to oil, Norway, for example, enjoys one of the highest GDPs in the world, but one of the shortest average workweeks: **just 33 hours**. As Author says: "That doesn't strike me as some terrible dystopia."

I am proud to be a student of engineering and soon as time passes will b one too. So all those who read this article of mine, I would like to pass a message that i personally feel all my mates should know." TECHOLOGY WILL RULE THE WOLRD "sounds silly right?. But it is the universal truth. So study hard and be a engineer (and I really mean that).

Pawan kumar Shodan
(SE E&TC)

INTERSTELLAR FLIGHT



An artist impression of a laser-propelled sail. Philip Lubin's road map to interstellar travel proposes using a similar mechanism to send tiny spacecraft speeding across great distances.

Traveling to other star systems is a big dream, but achieving it may require going ultra-small. Blasting tiny, wafer like sailing spacecraft with powerful lasers could slash interstellar flight times from thousands of years to mere decades, one researcher says. Human excursions to the stars are cursed by math. To get there in any reasonable amount of time, spacecraft must go incredibly fast — but fast travel requires carrying more propellant. That required amount of propellant, whether rocket fuel, a source for nuclear fusion or even antimatter, would make it more and more difficult for the ship to accelerate. Some researchers have found a loophole in this dilemma by imagining a solar, laser or microwave sail. An interstellar craft that surfed on the sun's photons or on a beam shot from Earth orbit wouldn't have to carry a propulsion source with it. But to propel a large probe, humanity would need an extraordinarily large orbiting laser, and possibly a sail the size of Texas.

Philip Lubin, a researcher at the University of California, Santa Barbara's Experimental Cosmology Group, hopes to get around such problems with tiny wafer like spacecraft. His idea is one of 15 that won a Phase 1 grant from NASA's Innovative Advanced Concepts (NIAC) program in May. While manned interstellar flight might not be possible for a long time, Lubin doesn't see why that should stop us from sending robotic emissaries to the stars. "Robotic missions, which have really done the bulk of exploration in our solar system, have become the extension of the human mind into far-distant places," Lubin told Space.com. "We don't have a way to send humans to the nearest star, but we do possibly have a way to send our ingenuity to the nearest stars in the form of a very small robotic probe. NIAC Phase I grants are comparatively small — up to $100,000 — and they encourage researchers to build detailed plans of attack for ambitious, potentially transformative space travel technologies.

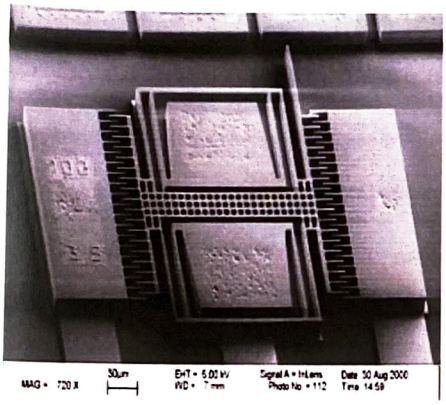
Lubin's concept is a "Roadmap to the Stars" detailing step-by-step development and testing of the tiny, laser-propelled probes. Les Johnson, a NASA technologist and science fiction author, described Lubin's NIAC proposal to Space.com: "Instead of making your propulsion systems gargantuan, and all this energy, why don't you just make what you're sending really, really small? Here's how." The probes, each weighing a single gram, would ride on a laser beam shot from orbit around Earth and would carry tiny sensors to take measurements and transmitters to report back what they found. The system could be built up gradually, because even slightly larger probes or weaker laser beams would be useful for exploring nearer targets within the solar system, Lubin said. Lubin said that there has been dramatic improvement in directed-energy technology, especially by the

United States' Defense Advanced Research Projects Agency (DARPA). Propulsion that would have once required one prohibitively giant laser can now be generated by a much smaller source tied to many amplifiers in orbit around Earth, which could provide enough power to propel a meters-long sail pulling a little probe.

A full-sized laser array would be about 6 miles (10 km) across, but it would be scaled up over time from smaller, usable components. Lubin described the laser setup in earlier research that proposed using the lasers to heat up and knock incoming asteroids off course. Once small versions of this system are established, in ground-based tests and otherwise, they'd begin to scale up. The largest-scale laser system would employ 50 to 70 gig watts of power to propel the craft forward, about as much as is used to launch current spacecraft to Earth orbit. That laser setup, which Lubin described in a proposal paper, could propel a tiny spacecraft with a 3.3-foot (1 meter) sail up to 26 percent the speed of light in 10 minutes. Such a craft could reach Mars in 30 minutes, catch up with Voyager 1 — humanity's farthest spacecraft from Earth — in less than three days and hit the star system Alpha Centauri in 15 years. Larger craft would take longer to accelerate but would still vastly outpace our current options, Lubin said. “What we're proposing is extremely difficult, extraordinarily difficult — but so far we don't see the fundamental showstopper," Lubin said. "What prevents you from executing it except the hard work to do it and the technological evolution to get there? “Marc Millis, a propulsion physicist and the founder and director of the Tau Zero Foundation, a group working to advance interstellar flight research, told Space. Come that to eventually find an approach that's feasible, incremental research like this, on a variety of different interstellar exploration strategies, is essential. “If you want to send out something further, faster, the less mass it has, the easier that will be to do," Millis said. "Within the landscape of different ideas and issues in interstellar flight, it is addressing a small portion of those and using digestible pieces, taking reasonable next steps, but it by no means solves all the problems. Which at this stage, is about all you can really do. "To make the system work, researchers will have to determine how to focus the laser beams precisely enough to direct the tiny spacecraft — as well as how spacecraft that small will be able to transmit back to Earth. It would also require constructing a large orbiting laser, which would become cost-effective after several launches. Johnson also sees Lubin's road map as an incremental step to interstellar travel that makes a lot of sense. "There are ways you can do it with laser sails, antimatter propulsion, a fusion drive, but they're all going to depend on traditional-sized spacecraft and really, really big infrastructures that we just don't have or won't have until the next century," Johnson told Space.com. "This is one that could potentially be done with an infrastructure only a little bit bigger than ours, which means it may not be as far out."

Monish Khandelwal
(SE A E&TC)

MEMS : Micro-Electro-Mechanical Systems



Pressure sensor for high-rel avionics and industrial applications.

The MEMS technology is capable of creating miniaturized electro-mechanical systems comprising of integrated mechanical (levers, springs, vibrating structures, etc.) and electrical (resistors, capacitors, inductors, etc.) components. MEMS devices have dimensions in millimeters and the elements of which are from 1-100 microns in size, i.e. the width of a human hair.

The electrical components in MEMS process the data whereas the mechanical components act in response of the data. For example, MEMS accelerometer used in cars monitors the vehicle's acceleration with the help of a microcontroller.

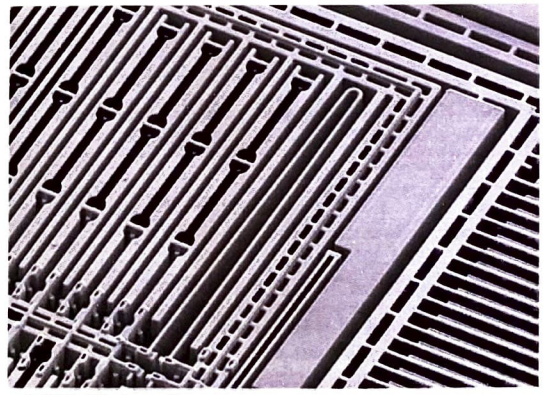
In case of a collision the acceleration reaches an unsafe and unusual level and an airbag is deployed within a fraction of seconds.

- **MEMS vs. IC fabrication:**

MEMS fabrication is developed from IC fabrication. Many techniques and materials used in IC fabrication are reused in MEMS fabrication for the advantages of low cost, high reliability and performance. However, MEMS fabrication is still different from IC fabrication at some aspects.

1.Unconventional Materials - MEMS fabrication involves more variety of materials. Besides the conventional materials used in IC fabrication, MEMS fabrication also use other materials. MEMS can also be made from quartz, ceramics, and polymide etc.

2. Lack of Standard Processes - IC fabrications have converged to certain standard processes, which can be used to implement all kinds of circuit functions, while MEMS fabrication is much more customized and diversified among different applications and different foundries. For example, pressure sensors and inkjet printing nozzles are fabricated by bulk micromachining, and airbag accelerometers and micromirror projection arrays are fabricated by surface micromachining. There is currently no library of design rules available for MEMS



MEMS Accelerometer

3.Mechanical Properties - MEMS fabrication cares about the mechanical properties (such as residue stress, density, young's modulus etc.) much more than IC fabrication. Because the purpose of MEMS fabrication is to make micromachines, we more care about their

mechanical properties, especially for material forming the structures. The properties of interest include Young's modulus, yield strength, density, residual stress and stress gradients.

One could say that ICs are more concerned with electronics engineering applications and MEMS with mechanical engineering applications.

- **MEMS in Industry:**

MEMS researchers and developers have demonstrated an extremely large number of microsensors for almost every possible sensing modality including temperature, pressure, inertial forces, chemical species, magnetic fields, radiation, etc.

Microsensors and microactuators are appropriately categorized as "transducers", which are defined as devices that convert energy from one form to another. In the case of microsensors, the device typically converts a measured mechanical signal into an electrical signal. Hence they are popular in industrial applications.

- **MEMS in Military:**

The potential of MEMS in military applications has been recognized and rightfully exploited for a long time. Aircraft, jets, helicopters, engines, and various harsh environments — everything from air data systems to environment and cabin pressure, to hydraulic systems in airframes, to engines and auxiliary power units, and other applications such as doors, oxygen masks, flight tests and structural monitoring, all of these need a range of sensors. A large jet needs as many as 130 sensors.

As MEMS sensors are extremely tiny they can be easily implemented in military applications and also reduce the overall size and weight of the application.

- **Espionage using MEMS:**

In Dan Brown's Fictional novel *Deception Point* there is a mention of a remote controlled mosquito sized 'flying microbot' that was used to spy on a bunch of scientists.

Instead of attempting to create miniature robots as spies, researchers are now experimenting with developing insect cyborgs or "cybugs" that could work even better. So far scientists can already control the flight of moths using implanted devices.

Even though the story is fictional, Micro-Electro-Mechanical Systems can in fact make the creation of such tiny spy devices possible. It enables a person to literally be a 'Fly on the wall' and eavesdrop on confidential information.

These cyborg bugs, known as 'cybugs' can pose a huge threat to the security of various government and private organizations.

QR code for MEMS information sources:

PRIYANKA R. DEGAONKAR
(B.E. Div:A; E&TC)

INTERNET OF THINGS

The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

But the internet is no longer just a network of computers, servers and mobile devices. There is an entire, enormous Internet of Things (IoT) comprising all sorts of devices connected to the Internet including household appliances, security cameras, transportation systems, infrastructure, medical devices, home entertainment systems, building automation systems and more. Technology think-tank ABI estimates that there will be over 30 billion devices connected to the internet of things by the year 2020. Cisco Systems (CSCO) in a 2011 report predicts that number could be upwards of 50 billion devices by the end of this decade.

Here are some examples of what IoT will make possible: you can use your mobile device to control your thermostat, home security system, lock your doors, turn on and off lights, open the garage or turn off electrical devices accidentally left on – all from anywhere in the world. You can use a smart watch or other wearable to track your fitness, monitor your vital signs and health. Your car can recognize a driver biometrically and automatically adjust user settings for comfort, setting not only the mirrors and seats but also the radio stations, heat & A/C settings and favorite destinations on the GPS. Refrigerators will detect when food is about to spoil or inform food shopping lists of what needs to be restocked. DVR's and home entertainment systems can record shows or suggest media based on preferences and past viewing or listening habits.

The uses of IoT go beyond the household and the home. Factories, remote oil rigs, and infrastructure can be monitored remotely and become more fully automated – sending real-time data and self-diagnosing any issues that may arise. Driverless cars will cruise the streets, allowing occupants to work instead of drive, and at the same time reducing traffic accidents and drunk driving incidents. IoT connected medical devices can ensure better health outcomes for healthcare facilities and ensure that proper treatment is being administered.

Entire 'smart cities' are being planned to better manage traffic, parking, waste collection, water and other utilities and help prevent crime. These cities will be outfitted with thousands of sensors, cameras, and other devices, all of which that are connected to the network.

IoT will also reshape the consumer experience. Retail stores will be able to detect a patron's size and recommend the best-fitting clothing. Systems will also track customer movement and focus within a store, allowing companies to send targeted advertisements and promotions based on those patterns.

The internet of things, or IoT seems like it could be the next big thing in technology. It is already a trillion dollar industry with billions of dollars of capital investment pouring into it. Networked devices at the home, office, and embedded within infrastructure and manufacturing will make the world a more efficient and economic place. Both consumers and producers stand to benefit from increased automation, better information gathering and analysis, and intuitive user interface and design.

Mrs. Deepali M.Yewale
Assistant Professor
AISSMSIOIT,PUNE.

Humans may be able to live on moon in next decade

According to a Nasa-funded study, humans may be able to live on the moon in a little more than a decade from now.

WASHINGTON: According to a Nasa-funded study, humans may be able to live on the moon in a little more than a decade from now. The study outlines a plan to again take human missions to the moon, media reported.

The announcement was made on July 20 - the 46th anniversary of the Apollo 11 crew's first steps on the lunar surface - The Verge (an American news and technology media network) reported.

The, study, undertaken by NexGen Space LLC, lays out a detailed roadmap for when and how to take the next step for a landing.

A robotic return to the moon could happen as soon as 2017, if Nasa were to adopt the plan right away. Rovers would scout the lunar poles for hydrogen in 2018 and prospecting could begin by 2019 or 2020.

Robotic construction of a permanent base would begin in 2021 in anticipation of landing humans on the moon later that year, it said.

The study said the space agency can do it all within the existing budget for human spaceflights. The way for Nasa to do this is to adopt the same method that it is using for re-supplying the International Space Station - a public-private partnership with companies like SpaceX, Orbital ATK or the United Launch Alliance.

SpaceX currently charges NASA about $4,750 for every kilogram of supplies sent to orbit aboard its Falcon 9 rocket, far less than the cost by the Apollo-era Saturn V ($46,000 per kilogram) or even the space shuttle ($60,000 per kilogram).

While the study does use SpaceX's next generation rocket, the Falcon Heavy, as an example in its plans to get to the moon, SpaceX claims the Falcon Heavy will be as cheap or cheaper per kilogram than the Falcon 9.

Nasa is already planning to go back to the moon with its next generation rocket, the Space Launch System (SLS), but there are no plans to land.

By using commercial partners, Nasa could reduce the number of planned SLS launches from 12 to around three, reducing the cost of the programme while still developing the technologies necessary to support it, the study said.

The study was vetted by a 21-person independent review team made up of former members of Nasa's administration, members of the commercial spaceflight community and four former NASA astronauts.

Ankita Bhosale
(TE E&Tc)