VOLUME 5 ISSUE 1

DEPARTMENT OF MECHATRONICS

ASIMOZ

DEPARTMENT TECHNICAL MAGAZINE

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ASIMOZ

DEPARTMENT TECHNICAL MAGAZINE

INSTITUTE VISION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values. We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

DEPARTMENT VISION

To develop professionally ethical and socially responsible mechatronics engineers to serve the humanity through quality professional education

MISSION

1. The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.
2. The department is committed to impart the awareness to meet the current challenges in technology.
3. Establish state of the art laboratories to promote practical knowledge of mechatronics to meet the needs of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

PEO1: Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

PEO2: Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

PEO3: Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

PEO4: Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

Prof.Dr. Ambikadevi Amma.T
Principal,NCERC

Message from Principal

I have great pleasure to know that the students of mechatronics department of our college is bringing out a department magazine "ASIMOZ" for the year 2019-2020. Bringing out a magazine is not a easy task, but it is a venture of the combined efforts of students and faculties.

I wish every success to the venture.

Mr. Niveth L
HoD Incharge , MTR Dept.

I feel privileged in presenting the fifth volume of our department association magazine "ASIMOZ". I would like to place my sincere and heartfelt thanks to all those who have contributed to make this effort a success.

My special thanks to the Management, for their guidance which enabled us to bring out this edition. The magazine has a variety of articles endowed with different subjects contributed by the students of our department and their participation in various activities round the year.

I extend my gratitude to the entire team of the Editorial Board for their constant exertion, revision and support in bringing out the magazine in the present form.

MEMS for Space

By: - Febin Jose
Nehru College of Engineering and Research Centre

Microelectromechanical systems (MEMS) represent a growing technology with critical applications across diverse fields. Much of the industrial effort is directed toward replacing conventional technology with MEMS devices to reduce cost, increase functionality, improve reliability, and decrease size and mass. Micro-electro-mechanical systems or MEMS are micron-scale (human hair < 100 microns) devices and tools that can be fabricated in ways similar to integrated circuits and are used in industrial, automotive, defence, life sciences, and consumer applications. Other examples of real-world MEMS devices are RF components for cell phones, miniature pressure sensors for blood pressure monitoring, DNA detectors on a chip, micro-mirror arrays for portable projectors, as well as inertial sensors for realistic computer gaming joysticks and wireless computer interfaces, etc.

Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors,actuators, and electronics on a common silicon substrate through micro fabrication technology. While the electronics are fabricated using integrated circuit (IC) process sequences and the micromechanical components are fabricated using compatible "micromachining" processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices. MEMS (Micro Electro Mechanical Systems) are the integration of electrical devices and mechanical structures at the micrometre (10-6 m = 0.000001 m) scale. The essence of MEMS is their ability to perform and enhance tasks, in ways and in the micro world, impossible using conventional technologies. MEMS devices find applications in the automotive, medical, aerospace, defence and telecommunications industries. Although, electrical devices and very few mechanical devices at this scale are common, the scaling down of common mechanical devices found in the macro world has created a research area all its own. The behaviour of mechanical structures at the micro scale has yet to reach full understanding.

Although, MEMS are created using many of the fully understood processing techniques used in IC(Integrated Circuit) processing with little variation, there are still many material, fabrication and packaging issues that have yet to be resolved. Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. While the electronics are fabricated using integrated circuit (IC) process sequences (e.g., CMOS, Bipolar, or BICMOS processes), the micromechanical components are fabricated using compatible “micromachining” processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices.

The semiconductor industry already has much of the infrastructure to batch process MEMS devices, however, the expertise to mass produce a wide variety of MEMS devices is still in its infancy, stimulated by research funded by both corporations and government agencies. NASA has a very special interest in MEMS technology. MEMS offer the benefits of significantly reduced mass and power consumption translating directly into direct cost benefits as a result of this. The main obstacle in rapidly integrating new technologies into space systems is determining system reliability. Reliability, the ability of a device/system to maintain performance requirements throughout its lifetime, is a major consideration factor for making device selections for space flight applications. Space missions can be expected to last upwards of 5 years with spacecraft subject to extreme mechanical shock, vibration, temperature, vacuum, and radiation environments. MEMS promises to revolutionize nearly every product category by bringing together silicon-based microelectronics with micromachining technology, making possible the realization of complete systems-on-a-chip. MEMS is an enabling technology allowing the development of smart products, augmenting the computational ability of microelectronics with the perception and control capabilities of microsensors and micro actuators and expanding the space of possible designs and applications

IIOT(INDUSTRIAL INTERNET OF THINGS)

-Aparna S, NCERC

The industrial internet of things (IIoT) is the use of smart sensors and actuators to enhance manufacturing and industrial processes. Also known as the industrial internet or Industry 4.0, IIoT uses the power of smart machines and real-time analytics to take advantage of the data that "dumb machines" have produced in industrial settings for years. The driving philosophy behind IIoT is that smart machines are not only better than humans at capturing and analyzing data in real time, but they're also better at communicating important information that can be used to drive business decisions faster and more accurately.
Connected sensors and actuators enable companies to pick up on inefficiencies and problems sooner and save time and money, while supporting business intelligence efforts. In manufacturing, specifically, IIoT holds great potential for quality control, sustainable and green practices, supply chain traceability, and overall supply chain efficiency. In an industrial setting, IIoT is key to processes such as predictive maintenance (PdM), enhanced field service, energy management and asset tracking. IIoT is a network of intelligent devices connected to form systems that monitor, collect, exchange and analyze data. Each industrial IoT ecosystem consists of:

- connected devices that can sense, communicate and store information about themselves;
- public and/or private data communications infrastructure;
- analytics and applications that generate business information from raw data;
- storage for the data that is generated by the IIoT devices; and
- people.

These edge devices and intelligent assets transmit information directly to the data communications infrastructure, where it's converted into actionable information on how a certain piece of machinery is operating. This information can be used for predictive maintenance, as well as to optimize business processes. There are countless industries that make use of IIoT. One example is the automotive industry, which uses IIoT devices in the manufacturing process. The automotive industry

extensively uses industrial robots, and IIoT can help proactively maintain these systems and spot potential problems before they can disrupt production. The agriculture industry makes extensive use of IIoT devices, too. Industrial sensors collect data about soil nutrients, moisture and more, enabling farmers to produce an optimal crop. The oil and gas industry also uses industrial IoT devices. Some oil companies maintain a fleet of autonomous aircraft that can use visual and thermal imaging to detect potential problems in pipelines. This information is combined with data from other types of sensors to ensure safe operations. One of the top touted benefits of IIoT devices used in the manufacturing industry is that they enable predictive maintenance. Organizations can use real-time data generated from IIoT systems to predict when a machine will need to be serviced. That way, the necessary maintenance can be performed before a failure occurs. This can be especially beneficial on a production line, where the failure of a machine might result in a work stoppage and huge costs. By proactively addressing maintenance issues, an organization can achieve better operational efficiency. Another benefit is more efficient field service. IIoT technologies help field service technicians identify potential issues in customer equipment before they become major issues, enabling techs to fix the problems before they inconvenience customers. These technologies might also provide field service technicians with information about which parts they need to make a repair. That way, the technician has the necessary parts with them when making a service call. Asset tracking is another IIoT perk. Suppliers, manufacturers and customers can use asset management systems to track the location, status and condition of products throughout the supply chain. The system sends instant alerts to stakeholders if thegoods are damaged or at risk of being damaged, giving them the chance to take immediate or preventive action to remedy the situation. IIoT also allows for enhanced customer satisfaction. When products are connected to the internet of things, the manufacturer can capture and analyze data about how customers use their products, enabling manufacturers and product designers to build more customer-centric product roadmaps.

Atomic Battery

By: - Manikandan C
Nehru College of Engineering and Research Centre

A burgeoning need exists today for small, compact, reliable, lightweight and self-contained rugged power supplies to provide electrical power in such applications as electric automobiles, homes, industrial, agricultural, recreational, remote monitoring systems, spacecraft and deep-sea probes. Radar, advanced communication satellites and especially high technology weapon platforms will require much larger power source than today's power systems can deliver. For the very high-power applications, nuclear reactors appear to be the answer. However, for intermediate power range, 10 to 100 kilowatts (kW), the nuclear reactor presents formidable technical problems. Because of the short and unpredictable lifespan of chemical batteries, however, regular replacements would be required to keep these devices humming. Also, enough chemical fuel to provide 100 kW for any significant period of time would be too heavy and bulky for practical use. Fuel cells and solar cells require little maintenance, and the latter need plenty of sun. Thus, the demand to exploit the radioactive energy has become inevitably high. Several methods have been developed for conversion of radioactive energy released during the decay of natural radioactive elements into electrical energy. A grapefruit-sized radioisotope thermo- electric generator that utilized heat produced from alpha particles emitted as plutonium-238 decay was developed during the early 1950's.

Since then, the nuclear has taken a significant consideration in the energy source of future. Also, with the advancement of the technology the requirement for the lasting energy sources has been increased to a great extent. The solution to the long-term energy source is, of course, the nuclear batteries with a life span measured in decades and has the potential to be nearly 200 times more efficient than the currently used ordinary batteries. These incredibly long-lasting batteries are still in the theoretical and developmental stage of existence, but they promise to provide clean, safe, almost endless energy. Betavoltaics is an alternative energy technology that promises vastly extended battery life and power density over current technologies. Betavoltaics are generators of electrical current, in effect a form of a battery, which use energy from a radioactive source emitting beta particle (electrons). The functioning of a betavoltaics device is somewhat similar to a solar panel, which converts photons (light) into electric current.

Betavoltaics technique uses a silicon wafer to capture electrons emitted by a radioactive gas, such as tritium. It is similar to the mechanics of converting sunlight into electricity in a solar panel. The flat silicon wafer is coated with a diode material to create a potential barrier. The radiation absorbed in the vicinity of and potential barrier like a p-n junction or a metal-semiconductor contact would generate separate electron-hole pairs which in turn flow in an electric circuit due to the voltaic effect. Of course, this occurs to a varying degree in different materials and geometries. An optoelectric nuclear battery has been proposed by researchers of the Kurchatov institute in Moscow. A beta emitter such as technetium-99 are strontium-90 is suspended in a gas or liquid containing luminescent gas molecules of the exciter type, constituting "dust plasma". This permits a nearly lossless emission of beta electrons from the emitting dust particles for excitation of the gases whose exciter line is selected for the conversion of the radioactivity into a surrounding photovoltaic layer such that a comparably light weight low pressure, high efficiency battery can be realized. These nuclides are low cost radioactive of nuclear power reactors. The diameter of the dust particles is so small (few micrometres) that the electrons from the beta decay leave the dust particles nearly without loss. The surrounding weakly ionized plasma consists of gases or gas mixtures (e.g. krypton, argon, xenon) with exciter lines, such that a considerable amount of the energy of the beta electrons is converted into this light the surrounding walls contain photovoltaic layers with wide forbidden zones as egg. Diamond which converts the optical energy generated from the radiation into electric energy.

The battery would consist of an exciter of argon, xenon, or krypton (or a mixture of two or three of them) in a pressure vessel with an internal mirrored surface, finely-ground radioisotope and an intermittent ultrasonic stirrer, illuminating photocell with a band gap tuned for the exciter. When the electrons of the beta active nuclides (e.g. krypton-85 or argon-39) are excited, in the narrow exciter band at a minimum thermal losses, the radiations so obtained is converted into electricity in a high band gap photovoltaic layer (e.g. in a p-n diode) very efficiently the electric power per weight compared with existing radionuclide batteries can then be increased by a factor 10 to 50 and more. If the pressure-vessel is carbon fibre / epoxy the weight to power ratio is said to be comparable to an air breathing engine with fuel tanks. The advantage of this design is that precision electrode assemblies are not needed and most beta particles escape the finely-divided bulk material to contribute to the batteries net power. The disadvantage consists in the high price of the radionuclide and in the high pressure of up to 10MPa (100bar) and more for the gas that requires an expensive and heavy container.

How will the 6G era benefit us?
-Rajith Krishnan, NCERC

Literally, every single improvement in network connectivity that 5G will bring to the end-user will get further perfected with 6G. Whether it's smart cities, farms or factories, and robotics, 6G will take it to the next level. Much of that will be facilitated by 5G-Advanced, the next standard enhancements for 5G. It comes with improved efficiency and extended capabilities and improved user experience. Looking at the past, it's clear that each generation optimizes the use cases of the previous generation and introduces new ones. This will continue to be the case. 6G will build on top of 5G in terms of many of the technological and use case aspects, driving their adoption at scale through optimization and cost-reduction. At the same time, 6G will enable new use cases.We will connect the physical world to our own human world, thanks to the massive scale deployment of sensors and artificial intelligence and machine learning (AI/ML) with digital twin models and real-time synchronous updates. These digital twin models are crucial because they allow us to analyze what's happening in the physical world, simulate possible outcomes, anticipate needs and then take productive actions back into the physical world. Digital twin models are already being used with 5G. With 6G, we can expect these technologies to operate at a much larger scale. Digital twins will be found not only in factories but also in wide area networks of cities and even digital twins of humans which will have a major impact on the network architecture. While the smartphone will remain a key device in the 6G era, new man-machine interfaces will make it more convenient to consume and control information. Touchscreen typing will gradually get replaced by gesture and voice control. Devices will come embedded into clothing and even transform into skin patches. Healthcare will be an important benefactor as wearables facilitate 24/7 monitoring of vital parameters. The maturing of AI and machine vision and their capacity to recognize people and objects will turn wireless cameras into universal sensors. Radio and other sensing modalities like acoustics will gather information on the environment. Digital cash and keys may become the norm. We may even start relying on brain sensors to actuate machines. 6G will also promote sustainability in a variety of ways. By enabling faster and lower cost per bit connectivity, it would be able to support data collection and closed-loop control of numerous appliances. The data can be analyzed using sophisticated tools to improve energy efficiency in industries. The advanced multi-sensory telepresence that is created with very high data rates will reduce the need for travel through the introduction of multi-modal mixed reality telepresence and remote collaboration. 6G will be significantly more energy-efficient, turning off components and scaling down capacity when the demand is lower. Energy efficiency will be a major design criterion in 6G along with the other metrics such as capacity, peak data rate, latency, and reliability.

MICROBIAL FUEL CELLS
- Jithin Anand N
NCERC PAMBADY

In an era of climate change, alternate energy sources are desired to replace oil and carbon resources. Subsequently, climate change effects in some areas and the increasing production of biofuels are also putting pressure on available water resources. Microbial Fuel Cells have the potential to simultaneously treat wastewater for reuse and to generate electricity; thereby producing two increasingly scarce resources. While the Microbial Fuel Cell has generated interest in the wastewater treatment field, knowledge is still limited and many fundamental and technical problems remain to be solved Microbial fuel cell technology represents a new form of renewable energy by generating electricity from what would otherwise be considered waste, such as industrial wastes or waste water etc. A microbial fuel cell [Microbial Fuel Cell] is a biological reactor that turns chemical energy present in the bonds of organic compounds into electric energy, through the reactions of microorganism in aerobic conditions. Microbial fuel cell consists of anode and cathode, connected by an external circuit and separated by Proton Exchange Membrane. Anodic material must be conductive, bio compatible, and chemically stable with substrate. Metal anodes consisting of noncorrosive stainless steel mesh can be utilized, but copper is not useful due to the toxicity of even trace copper ions to bacteria. The simplest materials for anode electrodes are graphite plates or rods as they are relatively inexpensive, easy to handle, and have a defined surface area. Much larger surface areas are achieved with graphite felt electrodes. The most versatile electrode material is carbon, available as compact graphite plates, rods, or granules, as fibrous material (felt, cloth, paper, fibers, foam), and as glassy carbon. Proton Exchange Membrane is usually made up of NAFION or ULTREX. Microbial Fuel Cells utilise microbial communities to degrade organics found within wastewater and theoretically in any organic waste product; converting stored chemical energy to electrical energy in a single step. Oxygen is most suitable electron acceptor for an microbial fuel cell due to its high oxidation potential, availability, sustainability and lack of chemical waste product, as the only end product is water. To assess bacterial electricity generation, metabolic pathways governing microbial electron and proton flows must be determined. In addition to the influence of the substrate the potential of the anode will also determine the bacterial metabolism. Increasing MFC current will decrease the potential of the anode, forcing the bacteria to deliver the electrons through more- reduced complexes. The potential of the anode will therefore determine the redox potential of the final bacterial electron shuttle, and therefore, the metabolism. Several different metabolism routes can be distinguished based on the anode potential: high redox oxidative metabolism; medium to low redox oxidative metabolism; and fermentation.

Students Corner

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Vishnu Sukumaran ,2nd Year MTR

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