ANAND INSTITUTE OF HIGHER TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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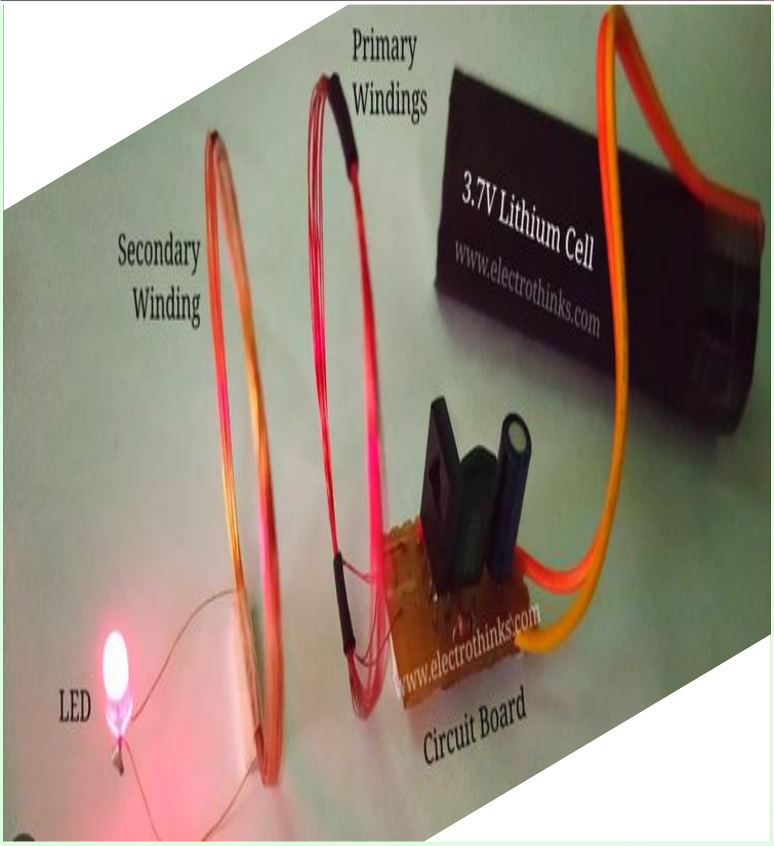
Tech-EEE

Empower students to achieve academic Excellence and Innovation.



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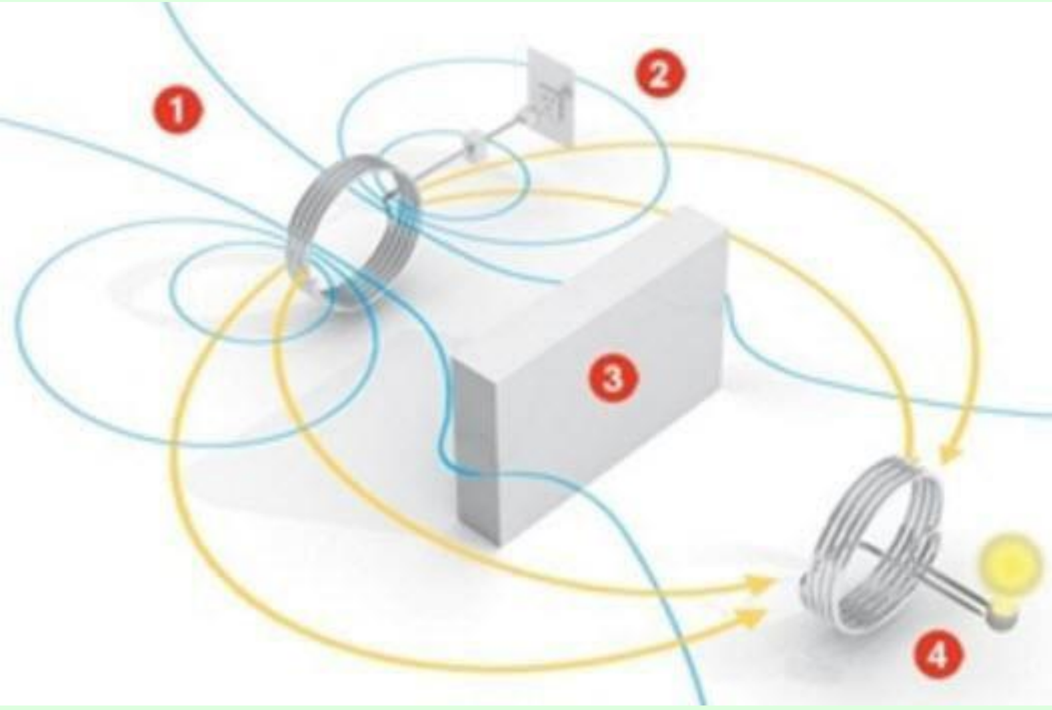
WPT (Wireless Power Transmission) Technology

WPT technology is an old technology, and it was demonstrated by "Nikola Telsa" in the year 1980. Wireless power transmission mainly uses three main systems such as microwaves, solar cells and resonance. Microwaves are used in an electrical device to transmit electromagnetic radiation from a source to a receiver. Accurately the name WPT states that, the electrical power can be transferred from a source to a device without using wires. Basically, it includes two coils they are a transmitter coil & a receiver coil. Where the transmitter coil is powered by AC current to create a magnetic field, which in turn induces a voltage in the receiver coil.



The basics of wireless power transmission include the inductive energy that can be transmitted from a transmitter coil to a receiver coil through an oscillating magnetic field. The DC current supplied by a power source is changed into high frequency AC current by particularly designed electronics built into the transmitter.

In the TX (transmitter) section, the AC current increases a copper wire, that creates a magnetic field. Once an RX (Receiver) coil is located near to the magnetic field, then the magnetic field can induce an AC current in the receiving coil. Electrons in the receiving device, converts the AC current back into DC current that becomes working power.

The technology for wireless power transmission or wireless power transfer **(**WPT**)** is in the forefront of electronic development. Applications involving microwaves, solar cells, lasers, and resonance of electromagnetic waves have had the most recent success with WPT. The main function of wireless power transfer is to allow electrical devices to be continuously charged and lose the constraint of a power cord. Although the idea is only a theory and not widely implemented yet, extensive research dating back to the 1850's has led to the conclusion that WPT is possible. The three main systems used for WPT are microwaves, resonance, and solar cells. Microwaves would be used to send electromagnetic radiation from a power source to a receiver in an electrical device.

Today, portable technology is a part of everyday life. Most commonly used devices no longer need to draw power from the supply continuously. But from portability emerges another challenge: energy. Almost all portable devices are battery powered, meaning that eventually, they all must be recharged using the wired chargers currently being used. Now instead of plugging in a cell phone, PDA, digital camera, voice recorder, mp3 player or laptop to recharge it, it could receive its power wirelessly–quite literally, "out of thin air".

Future is in our hands - IOT

Smart toasters connected rectal thermometers and fitness collars for dogs are just some of the everday "dumb items" being connected to the web as part of the socalled Internet of Things (IoT).

Connected machines and objects in factories offer the potential for a 'fourth industrial revolution', and experts predict more than half of new businesses will run on the IoT by 2020.

Here's everything you need to know about the increasingly connected world.

What is the Internet of Things?

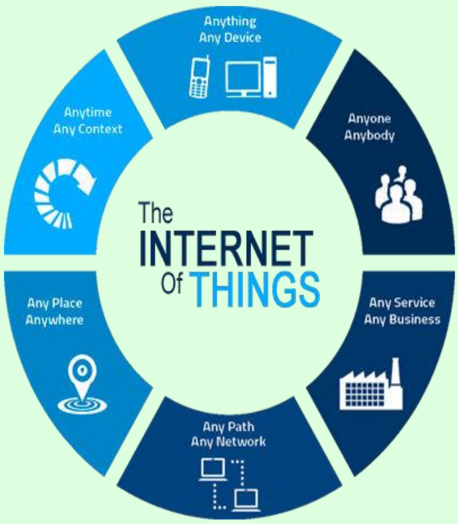
In the broadest sense, the term IoT encompasses everything connected to the internet, but it is increasingly being used to define objects that "talk" to each other. "Simply, the Internet of Things is made up of devices – from simple sensors to smartphones and wearables – connected together," Matthew Evans, the IoTprogram head at techUK, told WIRED.

By combining these connected devices with automated systems, it is possible to "gather information, analyze it and create an action" to help someone with a particular task, or learn from a process. In reality, this ranges from smart mirrors to beacons in shops and beyond.

"It's about networks, it's about devices, and it's about data," Caroline Gorski, the head of IoT at Digital Catapulttold WIRED. IoT allows devices on closed private internet connections to communicate with others and "the Internet of Things brings those networks together. It gives the opportunity for devices to communicate not only within close silos but across different networking types and creates a much more connected world."

Why do connected devices need to share data?

An argument has been raised that only because something can be connected to the internet doesn't mean it should be, but each device collects data for a specific purpose that may be useful to a buyer and impact the wider economy.



Within industrial applications, sensors on product lines can increase efficiency and cut down on waste. One study estimates 35 per cent of US manufacturers are using data from smart sensors within their set-ups. US firm Concrete Sensors has created a device that can be inserted into concrete to provide data on the material's condition.

"IoT offers us opportunity to be more efficient in how we do things, saving us time, money and often emissions in the process," Evans said. It allows companies, governments and public authorities to re-think how they deliver services and produce goods.

"The quality and scope of the data across the Internet of Things generates an opportunity for much more contextualized and responsive interactions with devices to create a potential for change," continued Gorski. IoT "doesn't stop at a screen".

Where does the IoT go next?

Even those who have purchased one of the myriad smart home products – from light bulbs, switches, to motion sensors – will attest to the fact IoT is in its infancy.

"Additional needs are emerging for standardization," the Internet Society says. If standardization happens it will let more devices and applications be connected.

Gorski described IoT, even among those with the most experience of the concept, as a "relatively immature market" but said 2016 may have been a turning point. The Hyper cat standard is now supported by ARM, Intel, Amey, Bae Systems and Accenture and the firms are currently agreeing on a format for "exposing collections" of URLs, for example.

"In the short term, we know [IoT] will impact on anything where there is a high cost of not intervening," Evans said. "And it’ll be for simpler day-to-day issues – like finding a car parking space in busy areas, linking up your home entertainment system and using your fridge webcam to check if you need more milk on the way home.

What makes you an electrical engineer?

A career as an Electrical Engineer is best suited for someone who is investigative. To a lesser extent, this career is well suited for someone who is realistic and conventional.

Realistic

A realistic person is someone who is very body-oriented. This individual enjoys using their hands and eyes to solve practical problems. They like doing outdoor, mechanical, and physical activities. It's very natural for a realistic person to relate to the physical world—this type of person usually does not deal with problems concerning ideas, data, or people, but rather, they like to concentrate on problems they can solve with their hands.

Investigative

The role of a electrical engineer requires someone who enjoys visualizing and solving problems with their mind. To solve problems, they prefer reading and studying, books and text, rather than their using their hands. They tend to analyze situations before making decisions. Investigative people are independent thinkers that are both curious and insightful.

Conventional

A good electrical engineer is typically careful, quiet, and pays close attention to detail. Following a set of rules appeals to electrical engineers as they like to feel secure and certain. They prefer to carry out tasks assigned by others rather than take on a leadership role. They are typically neat, tidy, and enjoy working with data in structured settings.

An electrical engineer must be careful about detail and thorough in completing work tasks. Electrical engineers must be good at analyzing information and using logic to address work-related issues and problems. The role of an electrical engineer often involves dealing with difficult obstacles. It is important for a electrical engineer to be able to continue to try even though something is difficult.

Facts about Electricity

- Electricity travels at the speed of light - more than 186,000 miles per second!
- A spark of static electricity can measure up to three thousand (3,000) volts.

- A bolt of lightning can measure up to three million (3,000,000) volts, and it lasts less than one second!

- Electricity always tries to find the easiest path to the ground.
- Electricity can be made from wind, water, the sun and even animal poop.
- A 600 megawatt natural gas plant can power 220,000 homes.
- The first power plant - owned by Thomas Edison - opened in New York City in 1882.
- Thomas Edison invented more than 2,000 new products, including almost everything needed for us to use electricity in our homes: switches, fuses, sockets and meters.
- Benjamin Franklin didn't discover electricity, but he did prove that lightning is a form of electrical energy.
- Electricity plays an important role in the way your heart functions. Muscle cells in the heart are contracted by electricity that runs through your body.

- Electrocardiogram (ECG) machines are used in hospitals to measure the electricity flowing through a patient’s heart, displaying a line that spikes with every heartbeat.
- The first successful electric car was built in 1891 by American inventor William Morrison.
- Reports of people receiving shocks from electric fish date back to ancient Egyptian texts of 2750BC.
- Around 600BC, Greek philosopher Thales of Miletus became the first person to experiment on electricity obtained by rubbing pieces of amber

- First use of the word ‘electric’ in print was in 1646, from the Greek ‘elektron’ meaning ‘amber’.
- Edison invented the electric chair not as a means of execution but to demonstrate the dangers of alternating current.
- Iceland is the only country whose electricity supply comes entirely from renewable sources
- The first street in the world to be lit by electric light bulbs was Mosley Street, Newcastle upon Tyne, in 1879.
- The first four common domestic items to be powered by electricity were the sewing machine, fan, kettle and toaster.
- Google searches account for about 0.013% of the worlds’ energy usage.
  This equals enough electricity to power 200,000 homes continuously. The energy it takes to conduct 100 searches on Google is the equivalent of a light bulb burning for 28 minutes.
- The Brooklyn Bridge was the first bridge to be lit using electricity.
- A typical microwave oven consumes more electricity powering its digital clock than it does heating food.
- Water doesn’t actually conduct electricity. Impurities in water is what makes it conduct electricity.

Accelerated Pavement Testing Efforts Using the Heavy Vehicle Simulator

The need for accelerated testing of pavements arose from the uncertainty of design models and analysis techniques that could previously only be verified with performance observed under normal traffic in real time. Accelerated Pavement testing (APT) was developed to fill the important gap between mechanistic-empirical design models using laboratory materials testing characterization and real, long-term pavement performance monitoring and analysis data.

APT is a technique used to evaluate the performance of full-scale constructed pavements in an accelerated manner as opposed to long-term pavement performance monitoring. To study the negative impacts of the environment and traffic on the condition and performance of pavement structures can take years under true field conditions.

Fixed-facility APT devices, and in some cases loop facilities, have the disadvantage that specially designed experimental pavement sections built at these facilities may not be typical of in-service pavements. In order to address the shortcomings of all the available APT technologies at that time, the former National Institute of Road Research (NIRR) of the Council for Scientific and Industrial Research (CSIR) (now CSIR-Built Environment Unit) developed a fully mobile APT device, the Heavy Vehicle Simulator (HVS). As stated above, the motivation for the development of the HVS was mainly because it could be used for evaluations on as-built mainline pavements throughout South Africa.

The desire was expressed by some road authorities to verify new pavement designs in the field before the beginning of any major construction, by constructing trial sections in the same area so that environmental and subgrade conditions would be similar. The objective would be to determine the mechanism of distress and remaining life (in terms of the number of load repetitions) to “failure” of the proposed pavement. To improve the South African new Pavement and Rehabilitation design procedures. The specific aims were:

- To determine wheel load equivalencies;
- To establish the effect of bi-directional trafficking;
- To verify new designs proposed in the pavement design method;
- To extend the data from above to four climatic regions in South Africa;
- To verify the theoretical predictions of distress in cemented base pavements;
- To evaluate the prediction of fatigue cracking in bituminous pavements, and
- To evaluate stress-dependent response and deformation of existing pavement for overlay design purposes.

The HVS-Airfield Mk V at WES is typically used for high wheel load short duration APT studies.

For instance, the first test at WES was planned to

involve 100,000 coverages of a B727

aircraft gear. Work has **Fig. 1. The South African HVS Mk II and III** been performed on evaluating pavement structures for the new C-17 cargo aircraft including rapid repair strategies. Short term research has focused on wheel load interaction for new aircraft gear configurations. WES is unique in its evaluation of expedient airfield pavements for military use over very short periods, with durations of 4 weeks, 6 months or 2 years. The long-term efforts focus on pavement performance relationships

The South African HVS programme had a significant impact on the development of pavement engineering in South Africa over the past 40 years. The use of this

technology has resulted in significant

savings in road building and rehabilitation costs to the country. The successful use of the HVS in South Africa led to increasing international interest in the technology, and two

HVS MK III's were acquired by Caltrans in 1994 for use in the Cal/APT research program. This extremely successful APT effort has evolved into the current PRC program, now using a MK VI HVS. The California success spurred further interest and the HVS technology was continually improved to the current MK VI version. Seventeen machines are in use worldwide for APT efforts on a wide variety of pavement types and concerns by the organizations listed in the paper. This makes the HVS the most successful and widely used APT device in the world, largely due to its reliability, durability and productivity. Further HVS improvements are under consideration by CSIR and Dynatest, and are likely to be implemented if the current high level of interest in APT continues into the future. Given the international acceptance of HVS technology, the next 40 years are likely to be equally successful.

PIEZOELECTRICITY

What is the Piezoelectric Effect?

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The word Piezoelectric is derived from the Greek piezein, which means to squeeze or press, and piezo, which is Greek for “push”.

One of the unique characteristics of the piezoelectric effect is that it is reversible, meaning that materials exhibiting the direct piezoelectric effect (the generation of electricity when stress is applied) also exhibit the converse piezoelectric effect (the generation of stress when an electric field is applied).

When piezoelectric material is placed under mechanical stress, a shifting of the positive and negative charge centers in the material takes place, which then results in an external electrical field. When reversed, an outer electrical field either stretches or compresses the piezoelectric material.

The piezoelectric effect is very useful within many applications that involve the production and detection of sound, generation of high voltages, electronic frequency generation, microbalances, and ultra fine focusing of optical assemblies. It is also the basis of a number of scientific instrumental techniques with atomic resolution, such as scanning probe microscopes (STM, AFM, etc). The piezoelectric effect also has its use in more mundane applications as well, such as acting as the ignition source for cigarette lighters.

The History of the Piezoelectric Effect

The direct piezoelectric effect was first seen in 1880, and was initiated by the brothers Pierre and Jacques Curie. By combining their knowledge of pyroelectricity with their understanding of crystal structures and behavior, the

Curie brothers demonstrated the first piezoelectric effect by using crystals of tourmaline, quartz, topaz, cane sugar, and Rochelle salt. Their initial demonstration showed that quartz and Rochelle salt exhibited the most piezoelectricity ability at the time.

Over the next few decades, piezoelectricity remained in the laboratory, something to be experimented on as more work was undertaken to explore the great potential of the piezoelectric effect. The breakout of World War I marked the introduction of the first practical application for piezoelectric devices, which was the sonar device. This initial use of piezoelectricity in sonar created intense international developmental interest in piezoelectric devices. Over the next few decades, new piezoelectric materials and new applications for those materials were explored and developed.

Piezoelectric Materials

There are many materials, both natural and man-made, that exhibit a range of piezoelectric effects. Some naturally piezoelectric occurring materials include Berlinite (structurally identical to quartz), cane sugar, quartz, Rochelle salt, topaz, tourmaline, and bone (dry bone exhibits some piezoelectric properties due to the apatite crystals, and the piezoelectric effect is generally thought to act as a biological force sensor). An example of man-made piezoelectric materials includes barium titanate and lead zirconatetitanate.

In recent years, due to the growing environmental concern regarding toxicity in lead- containing devices and the RoHS directive followed within the European Union, there has been a push to develop lead free piezoelectric materials. To date, this initiative to develop new lead-free piezoelectric materials has resulted in a variety of new piezoelectric materials which are more environmentally safe.

Applications Best Suited for the Piezoelectric Effect

Due to the intrinsic characteristics of piezoelectric materials, there are numerous applications that benefit from their use:

1. *High Voltage and Power Sources*

An example of applications in this area is the electric cigarette lighter, where pressing a button causes a spring-loaded hammer to hit a piezoelectric crystal, thereby producing a sufficiently high voltage that electric current flows across a small spark gap, heating and igniting the gas. Most types of gas burners and ranges have a built-in piezo based injection systems.

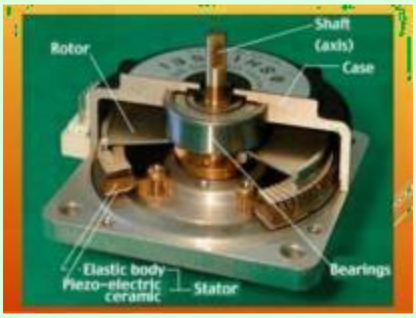
2. *Sensors*

The principle of operation of a piezoelectric sensor is that a physical dimension, transformed into a force, acts on two opposing faces of the sensing element. The detection of pressure variations in the form of sound is the most common sensor

application, which is seen in piezoelectric microphones and piezoelectric pickups for electrically amplified guitars. Piezoelectric sensors in particular are used with high frequency sound in ultrasonic transducers for medical imaging and industrial nondestructive testing.

3. *Piezoelectric Motors*

Because very high voltages correspond to only tiny changes in the width of the crystal, this crystal width can be manipulated with better than micrometer precision, making piezo crystals an important tool for positioning objects with extreme accuracy, making them perfect for use in motors, such as the various motor series offered by Nanomotion.



Regarding piezoelectric motors, the piezoelectric element receives an electrical pulse, and then applies directional force to an opposing ceramic plate, causing it to move in the desired direction. Motion is generated when the piezoelectric element moves against a static platform

(such as ceramic strips).

The characteristics of piezoelectric materials provided the perfect technology upon which Nanomotion developed our various lines of unique piezoelectric motors. Using patented piezoelectric technology, Nanomotion has designed various series of motors ranging in size from a single element (providing 0.4Kg of force) to an eight element motor (providing 3.2Kg of force). Nanomotion motors are capable of driving both linear and rotary stages, and have a wide dynamic range of speed, from several microns per second to 250mm/sec and can easily mount to traditional low friction stages or other devices.

The operating characteristics of Nanomotion's motors provide inherent braking and the ability to eliminate servo dither when in a static position.