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Letter from the Chairmen

Dear readers,

We are incredibly proud to finally release the first issue of the youth science journal! We also hope you enjoy reading it. We greatly appreciate that you take the time to read through the articles and share your feedback with us.

For us, it has been inarguably a remarkable experience to research these scientific topics and write about them in the articles. Writing this issue has allowed us to delve deeper into our favorite fields of study and deepen our knowledge about it. We let ourselves research topics that we love in various fields of science in the beginning and gradually chose to write about certain topics we wanted to delve into more. During the process of writing, we faced a lot of setbacks in the sense that the sources we were using were too complicated or incomprehensive to us, high school students. However, by the end, we were extremely satisfied with the result and how it turned out. To deliver this product, we utilized a relatively simple yet professional rubric for the articles that let us keep the articles easily comprehensible for high school students but, at the same time, scientific and formal. In addition, the subjects of each article were initially pre-determined, but we found that method limited us significantly as it didn't let us to fully explore our favorite fields of study. Therefore, we kept the subjects of each article up to the writers. We also found that when we wrote about our favorite field of study allowed us to output a higher caliber of work.

This issue goes from various subjects from neuroscience to computer science and psychology. Highlights include an in-depth review of a neurological condition, how could AI be used in future pandemics and a history of IQ tests. Even though we are highly proud of this issue, we still hope to improve the next issues significantly by partnering with undergraduate students and doctorates to peer-review our articles and make sure that all our articles are scientifically correct. We'd also like to review other more deeper topics in the fields of science.

If you have any questions or would like to contact us, please do from our official website www.ys-journal.com or email us at ysciencejournal@gmail.com!

Best Regards,
Gasser Mamdouh (Chairman)
Moemen Wael (Vice-Chairman)
Saif Taher (Vice-Chairman)

Life with No Pain: Congenital Insensitivity to Pain

Gasser M. Alwasify

Abstract

Pain is mostly associated with unpleasant feelings and is largely despised and feared due to the emotional distress of sensations. However, without pain, humans wouldn't be able to separate harmful actions from non-harmful ones and wouldn't let their body heal. The sensation of pain is very crucial to the human body as it acts as a defense mechanism by alerting the body of on-going damage to the tissue or potential damage. The importance of pain is even more obvious when diagnosing patients with congenital insensitivity to pain, as their life is filled with terror of being hurt but being unable to detect it, which could ultimately lead to their death. This article dives into this disorder and how it can affect the normal daily lives of human beings, further revealing the vital importance of pain

Background

According to the International Association for the Study of Pain, "Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." It is very vital that scientists started considering it as 'the sixth sense' [1]. Pain serves a critical survival purpose: it protects our body from risky or damaging situations by prompting it to withdraw and escape these situations. For instance, if a person touches a hot object, a potentially endangering situation, they would displace their hand immediately as an attempt to reduce the damage caused by it. Furthermore, pain helps protect that part of the body after the incident. It informs the brain that this part of the body is damaged and requires time to recover. Therefore, the sensation of pain would alert that person to avoid utilizing it for a while, thus speeding up healing. The final function of pain is pretty straightforward: it helps humans learn to prevent similar damaging situations in the future [1].

When people understand that this sensation is just a neat way for the human body to indicate dangers, it can help to remove some of the worries that often accompany the pain. However, humans should never ignore pain. Unlike an alarm that can be turned off, pain should not be overlooked as it can lead to hazardous consequences such as permanent tissue damage and potential permanent loss of function.

Before trying to comprehend the mechanism of pain, it is essential to understand the difference between pain and nociception. Pain is the state of agony usually followed by an injury; however, nociception is the subconscious detection of actual or likely tissue damage. Although they might seem very closely related at first, they can occur independently from each other. For example, some people with severe tissue damage might report having no pain or vice versa. Those are believed to be experiencing nociception, but no actual distresses of pain [2].

Mechanism

Pain occurs when special fibers called nociceptors respond to stimuli that can potentially cause tissue damage. Nociceptors are different from the usual neurons as they have a cell-like body with a peripheral axon and an ending that responds to diverse stimuli and is additionally the transmitter of the pain-related information to the central nervous system as shown in figure 1 [3]. Various discrete nociceptors respond to different stimuli like thermal, mechanical, and polymodal nociceptors. Thermal nociceptors mostly respond to heat or cold stimuli and notify the body about it, while the mechanical nociceptors are activated by sharp pinprick-type stimuli. Polymodal nociceptors are responsible for responding to any stimuli that are already causing tissue damage, leading to a slow-burning type of pain [5]. These

nociceptors are the same receptors that also respond to chemicals released in chilly or spicy food like hot pepper, which induces a burning sensation [6].

C-fibers, characterized by unmyelinated axons, are the most abundant subclass of nociceptors, conducting slowly and responding to noxious thermal, mechanical, or chemical stimulation arising from neural crest cells. After the C-fibers, the second most abundant subclass of nociceptors are the thinly myelinated nociceptors that are characterized by their fast conduction and are more likely to convey more sudden pain [3].

When tissue damage occurs, it triggers the release of different chemicals at the site of damage, causing inflammation. Some of these chemicals are Prostaglandins, which enhance the sensitivity of receptors to tissue damage, making humans feel pain more intensely. When those receptors are activated, they transmit an impulse to the brain. The signals travel up the spinal cord and reach the brain, which then processes the information and assesses how dangerous it is. Modern brain imaging has indicated that there is no specific area in the brain that processes pain. Instead, it is a complex array of reactions that take place in several parts of the brain which correspond with emotions, thought processes, etc. [6].

In this process, experience plays an essential role as it indicates if the stimulus was dangerous in the past or not. If the brain thinks that the event is dangerous or potentially damaging, it will evoke the sensation of pain and send impulses out to the peripheral cells that might compel that person to pull away or yell out in distress. Since pain is such a significant signal to the human being, it does not get subjected to the same kinds of filtering that occurs with the other senses. For instance, most senses will adapt to a stimulus that exists for a long time, and it starts to ignore it more and more over time, but in the case of pain, it is never neglected by the nervous system.

Life with No Pain?

Children and even young adults have always wished to have superpowers like not feeling pain ever and similar abilities. This is a very common thought for people as they think that feeling no pain would relieve them from the emotional distress that follows it. Nonetheless, this
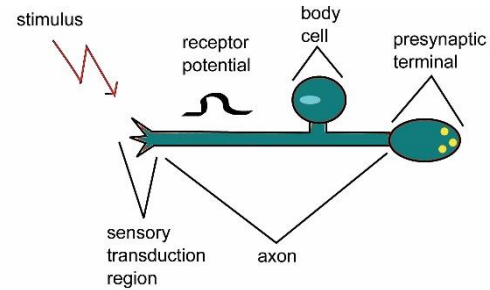

Figure 1: Schematic drawing of a nociceptor showing the four regions of the cell [4]

'super-ability' is not fictional. This rare 'super-ability' has occurred in almost 20 cases, all over the world [7]. However, this isn't something that people should wish for, as the inability to feel pain is extremely fatal and should never be considered as a 'superpower' but rather an exceedingly dangerous disorder.

Congenital Insensitivity to Pain (CIP), is a hereditary disorder where a person is not able to perceive any physical pain from birth. However, they can still feel touch and differentiate between sharp and dull objects, and hot and cold. On the other hand, they can't sense if a hot object is burning their body. As described before, one of the most essential functions of pain is teaching the human brain that doing this action again might injure the body. Hence, patients with CIP cannot comprehend if certain actions are dangerous or not, it leads to the accumulation of wounds and broken bones due to a lack of awareness of the danger and not expressing any discomfort. This ultimately decreases these patients' life expectancy. Most people born with this condition die during their childhood as they often do not realize their fatal injuries, such as broken bones until it is too late {1}.

Recent research indicated that the prime cause behind this disorder is a gene mutation in different genes such as the PRDM12 gene, SCN9A, or the NTRK1 gene. Mutations more frequently occur in the NTRK1, the neurotrophic tyrosine receptor kinase 1 gene on chromosome 1, which is the receptor gene responsible for the nerve growth factor. In consequence, failure of differentiation and migration of neural crest cells occurs which induces the complete disappearance of small myelinated and unmyelinated nerve fibers causing the loss of pain sensation [8].

According to a study performed on a 1-year old with CIP, the most common symptoms accompanied by the

insensitivity to pain are frequent episodes of fever, mental retardation, and self-mutilating behavior. This specific child had the gene mutation in the PRDM12 gene, causing frequent tongue and perioral lesions, loss of teeth, and a habit of self-mutilation [8]. Moreover, self-mutilation such as frequent biting of the tongue, fingers, wrists, and feet is considered to be the most dangerous side-effect as it causes severe bleeding. This was evidently shown in a case documented of a 9-month-old boy, who suffered the aforementioned issue as he was reported with 3 months of prior self-mutilation. These further advances the idea that the dire effects of CIP only begin with the fruition of teeth in children as it permits them to hurt themselves through biting without awareness, resulting in scarring and deformation [9].

Unfortunately, there is no definite treatment for this disorder up until now due to the still largely unknown mechanism of pain perception and how such a disorder could cause the dysfunction of pain. However, alternative measures can be taken to help prevent self-mutilation and damage such as a new proposed mouthguard-like appliance that can prevent the biting. This appliance was applied extensively in a 16-month-old girl patient.

Through several trials using different materials, the research found that the usage of methyl methacrylate for the mouthguard-like appliance proved to be successful as the 16-month-old girl accepted it and allowed her lesions to heal. It allowed her to enjoy a rather lesion-free life until she learned how to remove the appliance which gave rise to severe lesions and teeth loss. At that point, nothing could protect her from herself except her understanding of the situation and learning that removal of the appliance could injure her fatally [10]. One of the proposed solutions was full mouth extraction: the process of removing all the teeth in one's mouth. The procedure was not agreed upon by the parents due to the psychological and functional implications.

These cases are nothing more than proof to demonstrate that congenital insensitivity to pain isn't a blissful condition, but rather more of a curse to those who have it. A patient named Betz said, "People assume that feeling no pain is this incredible thing and it almost makes you superhuman. For people with CIP, it's the exact opposite. We would love to know what pain means and what it feels like to be in pain. Without it, your life is full of challenges" [11]

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Is intelligence inherited: A brief history of IQ test and what makes us smart.

Mohamed A. Salem

Abstract

Intelligence and how it is perceived was always a matter of debate throughout history. Several hypotheses gave the genes the lion's share of one's intelligence, others accounted the high intelligence of someone to its education, environment, and even his mother's womb. On the other hand, other opinions see that someone's intelligence isn't even measurable and that IQ tests are absurd and mostly biased, with the presence of threshold that is uncrossable to them regarding testing one's ability and skill. However, research have showed all the previous points of view can be right and wrong at the same time.

Case #1

In 1995-1997, Robert Plomin, an American psychologist, and geneticist gathered a group of children to perform an experiment. He gathered a group of gifted students chosen from all over America, ages 12 to 14, who excel in their grades, in the top 1 percentile in their respective classes, and have an IQ of about 160. The children were brought together every summer in Iowa to perform the experiments. Plomin and his team believed that those children are the closest they have to a genius and that they must have the best version of each gene that may have an effect and influence one's intelligence. They took a blood sample from each of the children to begin their hunt using little of DNA from human chromosome 6; the reason for choosing human chromosome 6 is based on a previous research of Plomin's. Later on, in the experiment, Plomin and his team found on the long arm of chromosome 6, a sequence that was different from other people. This led them to conclude that, if there is a gene for intelligence, it is present in the human chromosome 6 [1].

The First IQ Test.

Alfred Binet, a French psychologist, was asked by the French government in the early twentieth century, to help them decide which students will encounter difficulties in their education; as the French government back then, began making tuition mandatory. Binet, and a colleague of his, Théodore Simon, began the development of a set of problems that may serve the purpose of determining someone's limits regarding academic prowess as instructed by the French government. Later on, they developed what is known as the Binet-Simon Scale, which is the base of every IQ test now, the first IQ test [2].

The test was used then by H.H Goddard on Americans and immigrants, which was considered absurd, as the test was very subjective and biased towards the middle and upper class. But that wasn't the end of it, the test caused unnecessary discrimination between immigrants upon intelligence [3]. The test was also by Robert Yerkes, as he applied it on millions of world war 1 recruits [4]. Despite the results of those tests being ignored, it later affected the use of IQ tests. Later Robert Stemberg, an American psychologist and psychometrician, suggested that there are three types of intelligence: analytical, creative, and practical [5]. This proclamation emphasized the

ignorance of both Yerkes and Goddard, and their false use of IQ tests.

Case #2: Beth and Amy

Twin sisters, Beth, and Amy were put for adoption, they were separated by a Freudian psychologist to do an experiment. The experiment's goal was to measure the effect of the family and inside the house environment on one's intelligence and personality.

Amy was adopted by an overweight, insecure, poor family that struggled in society, and on top of that, with an uncaring mother. Amy turned out to be neurotic and introverted. Beth, on the other hand, was put in a rich, relaxed, loving, and cheerful family, like the ones on TV. It was expected that Beth will turn out as an extroverted, easy-going, cheerful girl. However, the results were nowhere near that; she turned up just like her sister [5]

Case #2: intensified

In 1997, Thomas Bouchard, an American psychologist, and geneticist researched pairs of separated twins from all over the world; to compare their intelligence and personality, just like with Beth and Amy.

The highest correlation in his studies was between twins reared together, twins that weren't separated. They shared the same genes, womb, and family. However, the most surprising correlation was between adopted children from different families who were reared together. They only shared the family, and there was no correlation, this led to the conclusion that family had no effect at all on one's intelligence and personality.

Conclusion

Francis Galton, an English Victorian era statistician, wrote an analogy once that said "Many a person has amused himself with throwing bits of stick into a tiny brook and watching their progress; how they are arrested, first by one chance obstacle, then by another; and again, how their onward course is facilitated by a combination of circumstances. He might ascribe much importance to each of these events, and think how largely the destiny of the stick had been governed by a series of trifling accidents. Nevertheless, all the sticks succeed in passing down the current, and in the long run, they travel at nearly the same rate" He was implying that if children were exposed to better education in a great amount it affects their IQ dramatically but only for temporary period which was somewhat true. You could excel in fifth grade and your friend would fail, but that doesn't mean it can't be the way around in ninth grade. And as in the experiment of Beth and Amy, and in Bouchard's experiment, the family was somehow proved to have no effect at all. A lot of other studies had the cause of uncovering what affects our intelligence the most. It's believed that half of your IQ was inherited, one fifth formed upon your surrounding environment, and the rest was formed in the womb and others.

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Usage of Artificial Intelligence in Future Pandemics

Saif Taher

Abstract

In [1], researchers found that radiologists have relatively mediocre sensitivity rates compared with specificity rates when diagnosing COVID-19 cases via CT scans. AI has potential to make the diagnosis process more efficient, effective, and economical. In [3], a group of researches examine the possibility of using deep learning to analyze CT scans, and [5] presents a brilliant cloud-deep-learning framework that combines data gathered from embedded smartphone sensors to give a COVID-19 diagnosis. However, [4] warns that the lack of training data will prevent any practical application of these solutions during this pandemic.

Background

Many people still regard AI merely as an element of science-fiction, exclusively existing in writers' imagination. Unbeknownst to those people, AI has already slipped under our noses into much of our daily lives. From life-saving machines to more subtle gadgets, AI continues to transform numerous industries, and healthcare definitely won't be an exception.

The medical industry has seen some amazing innovations recently fueled by the pandemic. These developments have shed some light on AI's great potential to aid with detecting, preventing, responding to, and recovering from future disease outbreaks.

The Problem

In epidemiologists' talk, sensitivity refers to the portion of positive cases who were correctly identified as such, or the TPR (True-Positive-Rate). On the other hand, specificity refers to the portion of negative cases who were correctly identified as such, or the TNR. (True-Negative-Ratio). Both terms are shown in figure #1.

During a study conducted in [1], seven radiologists were asked to differentiate between 219 COVID-19 pneumonia chest CT scans and 205 non-COVID-19 pneumonia scans. Overall, the group displayed fairly good specificity rates, but on the other hand, sensitivity rates were rather mediocre; in some cases, there could be only minuscule differences between COVID-19 pneumonia and some other types of pneumonia, which occasionally leads medical experts to erroneously rule out positive cases as negatives, hence the lackluster sensitivity. Imperfect sensitivity rates threaten to overwhelm healthcare facilities, causing cross-infections, putting vulnerable patients' lives in danger, and inflicting even more economic damage. Besides, CT testing can be time-consuming, and COVID-19 test kits are at short supply, which further hinders the diagnosis of patients.

Clearly, this is an urgent problem with far-reaching consequences. However, it also happens to be a very good opportunity for AI systems to prove their worth.

The Solution

Deep learning is a form of machine learning inspired by the human brain, where artificial neural networks use gigantic amounts of data to learn how to do a specific task by repeating it countless times, slightly optimizing itself every time until it masters that task [2]. Deep-learning algorithms have become advanced to the point where they could be used reliably to diagnose COVID-19 patients, which is exactly what many researchers have already done. A group of researchers developed a ResNet-50 Convolutional Neural Network (CNN) model which is able to distinguish COVID-19 pneumonia cases from other pneumonia cases. The model, namely "COVNet", has an AUC-ROC rating of 0.96, which is outstanding for a binary classification system. There have been several other neural networks developed in addition to COVNet, with AUC-ROC ratings as high as 0.99 and accuracies up to 98% [3]. Moreover, it's important to predict which patients are likely to need Intensive Care Units (ICU), because their capacity is limited to very high-priority patients. Fortunately, researchers have developed a prognostic prediction algorithm which is able to calculate the mortality risk of COVID-19 patient. Other researchers have developed an AI which is capable of predicting whether a patient would develop Acute Respiratory Distress Syndrome (ARDS) with 80% accuracy [4].

These results clearly show that ML algorithms have become immensely useful against disease outbreaks.
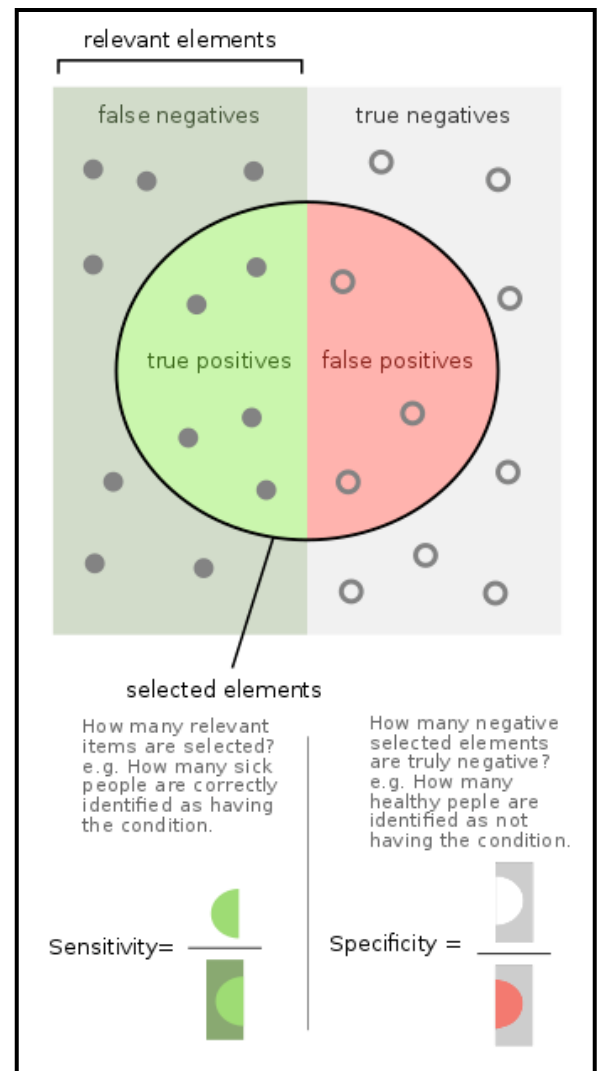

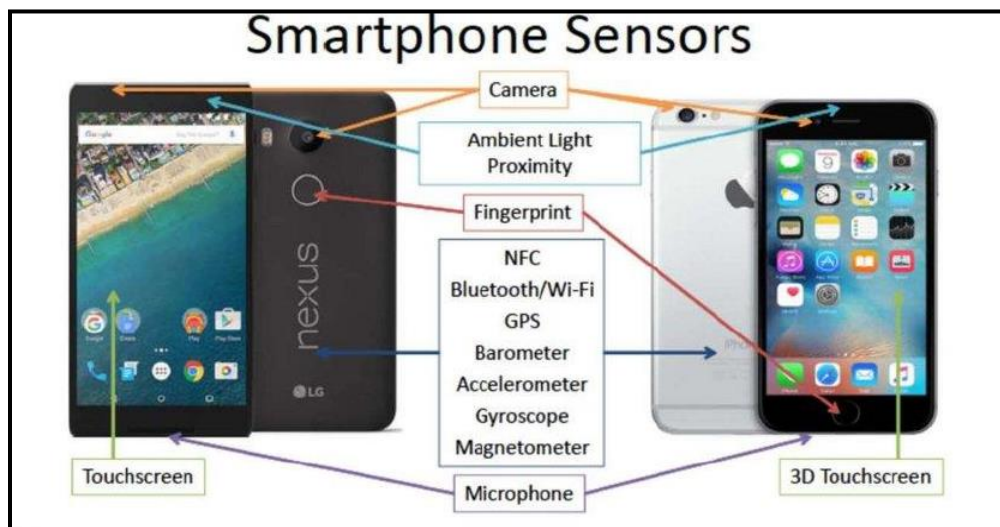Figure #1: An illustration of sensitivity vs. specificity

Figure #2: A diagram showing where many of the modern smartphone sensors are embedded – Source: ResearchGate [6]

However, X-ray generators and CT scans won't be available everywhere, every time: Consider developing countries with poor healthcare systems and hospitals, where there are often "peak" times when said facilities are completely overloaded with no capacity to receive more patients. Those situations require novel approaches that enable rapid and effective testing using whatever equipment is at hand.

Luckily, smartphones have a lot of embedded sensors, **as shown in figure #2**, which can be exploited and turned into a means of diagnosis. In [5], a brilliant framework incorporating these sensors is presented, which would allow for quick, cheap, and effective testing. The framework works by aggregating input from different sensors, and uploading that data to a cloud deep learning model that analyzes it to predict what symptoms the patient might have and the severity of each of them; and based on the result of said analysis, the model will yield the probability of the patient having COVID-19. Each sensor collects information about certain behavior, according to the sensor's functionality: The temperature-fingerprint sensor is used to predict the level of fever; the camera and the accelerometer are used to detect fatigue, nausea, posture, and headache; and finally the microphone chipset is used to analyze audio data and indicate the type of cough the patient has. This mobile-based framework is considerably accurate, as data is collected from many different sources, and is also far cheaper and less time-consuming than CT scans and X-rays.

Challenges & Conclusion

Although both of the frameworks discussed above are very promising, they are currently undermined by many challenges, the biggest of which is lack of data; Thus, AI systems need billions upon billions of bytes for training, and in this context, data must be acquired through expanded testing and CT scans, most of which as of yet have come from Chinese hospitals which implies the possibility of selection bias **Error! Reference source not found.**. It would take years to collect enough volumes of random, unbiased data for properly training AI, which means we probably won't be seeing AI-powered COVID-19; instead, we'll probably be seeing AI deployed in areas with the most short-term potentials, such as social control via surveillance (e.g, checking citizens' temperature with IR cameras, using facial recognition to check if they're wearing masks, etc.). To conclude, maybe AI won't be a huge player this pandemic, but we have surely learned invaluable lessons and gained crucial insight as to how it may be used against future pandemics and disease outbreak.

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Solar Energy: In-depth review of solar cells

Mohammed A. Ali

Abstract

The Earth receives an incredible supply of solar energy. The sun, an average star, is a fusion reactor that has been burning over 4 billion years. It provides enough energy in one minute to supply the world's energy needs for one year. In one day, it provides more energy than our current population would consume in 27 years. In fact, "The amount of solar radiation striking the earth over a three-day period is equivalent to the energy stored in all fossil energy sources." Solar energy is a free, inexhaustible resource, yet harnessing it is a relatively new idea. Considering that the first practical solar cells were made less than 30 years ago, we have come a long way. A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. In this article, types of solar cells will be studied and their various applications.

Amorphous silicon (a-Si) solar cells.

Amorphous silicon (a-Si) is the non-crystalline form of silicon. It is the most improved type of thin film technologies that has been released last 15 years. The manufacture of amorphous silicon photovoltaic cells is based on plasma-enhanced chemical vapor deposition (PECVD), which can be used to produce silicon thin film. Substrate can be made of the flexible and inexpensive material. It can also be at low temperature that allows the deposition on plastic as well.

"In its simplest form, the cell structure has a single sequence of p-i-n layers." Single layers could suffer from significant degradation in their power output. The mechanism of the degradation is called Staeble Wroski Effect that refers to the light induced metastable changes in the properties of the hydrogenated amorphous silicon. As the defect in density of hydrogenated amorphous silicon increases with high exposure causing an increase in recombination current and reducing the efficiency of the conversion of sunlight into electricity. In addition, to solve this problem, it is better to use multiple thin layers instead of one in order to increase the electric filed strength across the material.

One of the pioneers of developing solar cells using amorphous silicon is Uni-Solar [1].

They use a triple layer system that is optimized to capture light from the full solar spectrum. The thickness of the solar cell is just 1 micron, or about 1/300th the size of mono-crystalline silicon solar cell because amorphous silicon features a high absorption capacity, the i-layer usually features a thickness of 0.2–0.5 μm. Its absorption frequency ranges between 1.1 and 1.7 eV, which is different from that of the silicon wafer, which has an absorption frequency of 1.1 eV. Unlike the crystal, the structural homogeneity of amorphous material is comparatively low.

Electrons and holes are conducted inside the material; therefore, within the case of long-distance conduction, there could also be a high composite probability of electricity. To avoid this phenomenon, the i-layer should not be too thick or too thin, because the latter problem can easily cause inadequate absorption. To overcome this predicament, a multilayer structured stack is usually utilized in the planning of amorphous silicon solar cells to realize a balance between the optical absorption and photoelectric efficiency. While crystalline silicon

achieves a yield of about 18 percent, amorphous solar cells' yield remains at around 7% [2].

The low efficiency rate is partly due to the Staebler-Wronski effect, which manifests itself in the first hours when the panels are exposed to sunlight, and results in a decrease in the energy yield of an amorphous silicon panel from 10 percent to around 7 percent. The principal advantage of amorphous silicon solar cells is their lower manufacturing costs, which makes these cells very cost competitive [1].

Concentrated PV Cell (CVP and HCVP) following the sun.

A Concentrating electrical phenomenon (CPV) system converts light-weight energy into current within the same approach that typical electrical phenomenon technology well but uses a sophisticated optical system to focus an outsized space of sunlight onto every cell for optimum potency as shown in figure #1. Different CPV styles exist, generally differentiated by the concentration issue, like low-concentration (LCPV) and high concentration (HCPV). Concentrator photovoltaics' (CPV) could be electrical phenomenon technology that generates electricity from daylight [3].

Contrary to standard electrical phenomenon systems, it uses lenses and mirrors to focus daylight, but extremely economical, multi-junction (MJ) star cells as shown in figure 1. In addition, CPV systems typically use star trackers and sometimes a cooling system to any increase their efficiency [4].

Current analysis and development are rapidly rising their fight within the utility-scale segment and in areas of high solar insulation. CPV technology has been around since the 70s. Recent technological advancements have enabled CPV to succeed in viability with ancient fuel plants, such as coal, gas, and oil, once put in in regions of the world with sunny and dry climates. Concentrating photovoltaic systems work by changing sun light into electricity past upside solar modules think about constant basic conception to come up with electricity [4].

Figure 1: representation of the structure of concentrated CPV.

CPV systems have utilized optical elements that concentrates important amounts of sunlight onto "multi junction" solar cells. Particularly High concentrating electrical phenomenon (HCPV) systems have the potential to become competitive within the close to future. They possess the very best potency of all existing PV technologies, and a smaller electrical phenomenon array additionally reduces the balance of system prices. Currently, CPV is not utilized in the PV roof high segment and much less common than typical PV systems.

Concentrating electrical phenomenon (CPV) modules add abundant the same approach as past PV modules, except that they use optics to concentrate the sun light onto solar cells that do not cover the whole module space. This concentration issue – in Semprius' case over one,100 times – dramatically reduces the amount of semiconductor required (<0.1 percent) and opens up the potential to cost-effectively use terribly high performance multi-junction cells efficiently levels greater than forty one to figure properly, however, CPV modules should accurately face the sun.

Therefore, CPV modules area unit utilized in conjunction with high-performance trackers that showing intelligence and mechanically follow the sun throughout the day. Aside from this, CPV systems area unit designed and operate very like ancient PV systems [4].

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