EDUCATIONAL APPROACH TO THE INTERNET OF THINGS (IOT) CONCEPTS AND APPLICATIONS

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ABSTRACT

The term "Internet of Things (IoT)" and its ecosystem is expanding very rapidly, and therefore, it has become complicated to capture the actual definition of 'IoT.' This has created numerous challenges and complications for the students looking forward to achieving accurate perception. This paper is presented with an insight to educate the audiences who do not have sufficient knowledge of the Internet of Things (IoT). The scope of this paper expands from the concepts of Information Technology, Digitalization, Wireless Networking, and sensor technologies to the broad arena of IoT. A simple and easily understandable explanation of IoT including applications and impacts to the society has been proposed. This paper exhibits present state-of-the-art experimental research outcomes as extended examples for the reader to develop a comprehensive conceptualization of IoT. Finally, after going through this paper, a layman who does not have any specific knowledge in this field, do build the concepts and understands the advancements behind the buzzword, "IoT."

KEYWORDS

Internet of Things; Things-to-Things Connectivity; IoT Applications

1. INTRODUCTION

The dynamicity of the world is vividly increasing with the increment in the smart devices (explained later) and connectivity with them and within them. Reliable and strong connectivity has been possible with sophisticated communication techniques and systems. The peculiarity of recently developed devices stands on their capability of communication within two smart devices and further decision making depending upon the conclusion derived from the communication processes. The introduction of devices capable of communicating within themselves has laid the foundation for the gigantic and phenomenal era of IoT.

In recent years, the buzzword "Internet of Things (IoT)" has gained a lot of popularity within the community of science and engineering. To develop a clear understanding of the field, we studied several pieces of research literature from IEEE, Springer Journals, Elsevier archived databases. The articles hence obtained solely gave a complete understanding of "what is Internet of Things?", "How it works?" [1], "What will be a simple network architecture of IoT?" [2], "How future world is changing with the application of IoT?" [3], "What could be the possible effects or impacts on human beings in future?" and "How entire world is rapidly adopting the development towards things-to-things connectivity?" [4]. However, we could not get a simple answer to those

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above questions within an article, and hence, in this paper, we have presented a better insight towards IoT and solutions to the above problems in a systematic way.
We came across many people around the globe, who try to understand the basic concepts behind the ‘IoT’, which is a trendy term since the year 2015. If taken into account managers in an academic institutions, or the mid-level officers in an industry, or the persons associated with governmental organizations, or the people related to UN missions, or the workers in a factory,

or the undergraduate and graduate students (whose area of study is not IT or the Computer Science), most of them are unaware of IoT concepts, the phenomena of things-to-things connectivity and its future impacts. This article focuses on this group of audience and attempts has been made to build a vision and develop an insight about IoT, its architecture, it's working, and its future impacts. We also hope that this article will go into a big audience, and it is probable to a considerable number of feedbacks from the readers.

IoT has emerged from the trend of connections and communications between human-to-human, human-to-objects, and objects-to-objects. Practically, this can be taken as a real network of people, things, and devices (intelligent entities that have some processing capabilities). Combining the concept of connectivity along with the practical network through which this connectivity is developed, it can conclude that, this network of communication hence developed is commonly called as “Internet of Things” or IoT.

Taking the definition, a step further, IoT is an extensive range network of multiple devices. IoT devices are generally termed as “smart devices”, e.g., smart TVs, smartphones, Smart Refrigerators, etc.. “Smart Devices” can be defined as electronic devices with multiple Sensors and Actuators, possessing the quality of communicating over internet and intranet. These devices also possess the decision-making ability, which takes place by the continuous feedback mechanism and administrator connection. This approach of decision making is termed as “Controlled Decision Making”. [5] [6]

An IoT device is a combination of multiple segments, where each segment is considered as a node. The foundation of IoT systems lies in the connections and communications between device-to-device as well as within the device, hence, several entities of different natures, working capabilities, functions, etc. are always communicating with each other. This communication generally takes place by high pace data exchange, and some analysis or interpretation of data being done at every node. Further, this communication and processing of data result in the integration of multiple IoT devices and completion of a more significant task efficiently.

Connected devices are designed for the gathering (by Sensors), transmission (by the established communication network), and processing of information over the network of devices connected to each other. The fusion of different smart devices and processing units into one single device is the fundamental idea behind IoT systems. IoT devices have the power to gather real-time data, process it according to the need, and further transmit the output is a first working loop of an IoT device. The completion of these three essential tasks with speed, accuracy, and reliability makes this technology exceptionally revolutionary for the present era.

The underlying architecture of IoT devices is depicted in Figure 1. This architecture is built depending on the composition and function of an IoT. The different layers of architecture are the Perception layer, Data Management Layer, Network Layer, Business Logic Layer and Application Layer [5]. These layers will be defined in detail with the help of examples in further sections.

2. RELATED WORKS

We have explored and reviewed several articles in order to find a proper definition and concept on the IoT technology, but unfortunately, even after studying many of conference proceedings and journal articles we could only see the architecture, sensing technology, communicating systems, processing units, security and handling of data being focused upon mainly.

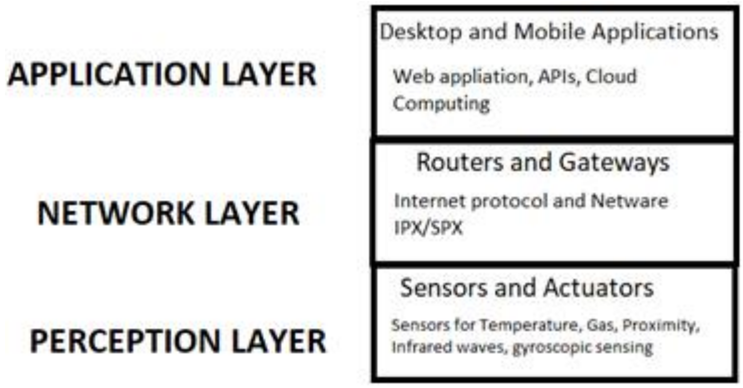

Figure 1. Basic Architecture of IoT devices

The IoT technology is based on the performance of sensors as these equipment are responsible for the human-machine interaction. A complete picture of sensors and their role can be studied in the paper. Though the paper focusses on implementation and importance of sensors in the IoT devices. An application of IoT system is in healthcare for the process of Electrocardiography where sensors play an essential role in collecting the pulses of heart and producing a useful graph. [7]

The data acquisition and transmission after the data collection from the environment becomes the next goal. This is achieved by the combining of the transmission system which is responsible for the transfer of data. Wireless data transmission is the current technology and is widely used which is achieved by various methods of wireless communications [8].

The logic according to which the acquired data will be processed further and an output will be generated is to be tackled. This step is where the integration of computer science with the already existing hardware comes into the picture. The processing of raw data depends on the desired output. The home security system based on the concept of IoT is the state of art technology. The system is programmed such that any unusual behavior sensed by the sensors will be used to trigger the output system where an alert is sent to the owner and an alarm buzzer rings. [9]

The M2M, i.e. machine to machine connectivity, is vital in an IoT system. To achieve reliable connectivity, various radio technologies have emerged, such as Low-Power WiFi, Low-Power Wide Area (LPWA) networks, and various improvements for cellular M2M systems. Intelligent parking systems are an example of an IoT system where a high level of M2M connectivity is implied. In such a system, an IoT device is installed at all the parking locations, and the processing of the image data is done, and an output is generated related to the availability of the parking space in an area. The data needs to be immediately transferred on the cloud so that people looking for parking areas get aware of the availability of parking space. Here, the internet connection over devices was built by an Ethernet connection or a cellular 3G modem. [10]

A large amount of data is gathered by the sensors on a day to day basis. The collection, processing, storing and integration of data from different sensors is required. The data can be

Multisource High Heterogeneity Data, Huge Scale Dynamic Data, Low-Level with Weak Semantics Data, and Inaccuracy Data. For the handling of varied types of data, modules such as Data Acquisition and Integration Module, Data Management Module, Data Processing Module,

Data Mining Module, and Application Optimization Module is developed. The management of this massive amount of data from the sensors is done by Data Management Based on Metadata, Semantic Annotations, and Data Indexing Strategy [11].

The complete architecture of the IoT systems for ambient assisted living has been implemented for the study of indoor Air Quality has been conducted. The paper can be concluded with a piece of detailed information about the architecture of an IoT system in general. Here, an IoT system can be seen as a combination of a sensor network, a coordination network, connections with internet, and the output receivers. [12]

We came across scientific pieces of literature that define various parts of IoT with suitable examples, but the deficiency for a paper which explains the concept of IoT, its fundamental working and the flow with which an IoT device is designed in a language that even layman can understand is felt.

3. REFRIGERATOR AND CAR AS IOT DEVICES

After the basic introduction to the IoT and looking at the scope to which IoT can be extended, let us now understand the integrity of IoT in detail and develop an insight about the architectural layers provided in figure 1, in more detail. Let us consider a simple Refrigerator [13], and understand how a refrigerator, which was supposed to be a device for cooling things, can be integrated with the IoT systems, and a “Smart Refrigerator” is developed.

What a refrigerator does, what is its primary function? A traditional refrigerator keeps things (grocery, medicines, water, milk, etc.) cold. A traditional refrigerator is designed just to keep things cold if the door is properly closed. For regular refrigerators, even if the door is opened, it does not give you any signal or beep. This is because the conventional refrigerators do not have the capability of processing the faulty input of the door being opened and the cooling gases escaping out of the door. This can be identified as the very beginning of limitations of conventional devices.

These limitations of conventional devices obstruct it to perform its basic function properly. The introduction to the connectivity of different segments of a device and making the data processing possible at each node has made the functioning very efficient and error-free. In the process of conversion of a conventional Refrigerator to Smart refrigerator, computational intelligence is added to it, so that it can send information when the door is ajar. The intelligence added can also process data regarding, the butter tray being at a low level. By the local resources (not using networked resources, just use local processor capability and database), the refrigerator can send information about whether the food stored in the refrigerator has high-fat content. Moving a step further, by locally programming the electronic integrations, fridge can send information regarding the presence of milk and butter to make a pancake. An analysis of the grocery (by reading the bar code) present inside the fridge can be done and results regarding the possible dish to be prepared can be suggested. So far, the refrigerator is using its own resources and is still not networked with other internet or intranet environments. [14]

Taking the study, a step further, if the refrigerator with computational intelligence is integrated with a WLAN chip and internet environment is created, then the conventional refrigerator can be considered as an IoT device. This IoT device is now capable of conveying information regarding the possible recipe of the dish, which can be prepared from the available grocery, search news and analyze global trends[15]. If it is networked with the internet, it automatically recognizes the butter tray is low and orders a new packet of butter, and the next day you can

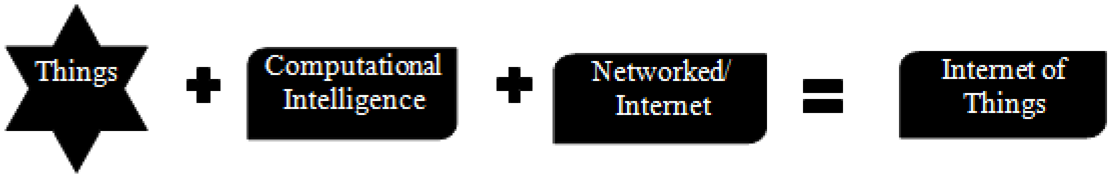

Figure 2. Significant contextual elements of the Internet of Things

collect it to your doorstep. By the above-done integrations, the traditional refrigerator has become smart enough to intelligently read the global trends based on the weather forecast and convey the information regarding the increasing trend in the prices of food items due to approaching winter and further, send a suggestion of buying the grocery beforehand. If not, the refrigerator has got the capability of ordering grocery by itself after performing proper analysis of prices, quality, and food interests of the owner. All these activities of the refrigerator can be controlled in real-time by the administrator by a simple GUI based mobile application. In the other way around, the fridge is capable of providing information about the user's food interest, which will be suitable for the stores, so that the stock of most demanded and less demanded things can be balanced properly.

Evaluating the previous example, we can say that an IoT device must have some intelligence in it and be networked as well. Let us consider a "car." In twenty-first-century a car has a lot of add-ons than just a vehicle for movement. The modern automobile is a sophisticated combination of sensors, processors, output devices like screens, audio systems, etc. embedded in it. These integrations in the contemporary car have led to features like anti-lock braking system, efficient fuel injection system, better fuel to energy ratio, much more comforting driving experience, and, most importantly, a reliable system for airbag functioning. Apart from the driving experience, the integration of the car with IoT leads to additional amenities like vehicle location, Wi-Fi on board, accident detection GPS based navigation system, etc.. With the current research in Artificial Intelligence domains, the car may be capable of making a memory of driving behaviors and identifying unusual driving behavior and send an SOS notification to the emergency helpline.

The fundamental function of a car to take people from one place to another remains the same, but with the integration of IoT, the transformation is massive. The connectivity to internet has changed and boosted the utilization perspective of consumers. Due to the automation, networked connections and administrator-controlled decision making, the security reliance on the devices has increased up to a vast extent when compared to conventional methods. The internet environment builds within cars provides an opportunity to contact the emergency helpline numbers (for example, 112 in Finland) before or after the crash.

After the examples above, Figure 2 combines the contextual information to a picture and depicts an overview of IoT.

Figure 1 depicted the different layers in an IoT device. These layers are the architectural framework with which any IoT device is modeled and practically realized. Among these, there are three very major layers, namely, Perception Layer, Network Layer, and Application Layet, and these layers can be explained as follows: [16]

- Perception Layer: This layer is also known as the Recognition layer. This layer is the lowest layer and its fundamental function is to collect information from the surrounding environment. This layer consists of sensors for the detection of the stimuli being generated in the external environment. These sensors include heterogeneous devices, humidity sensor, temperature sensor, RFID tags, GPS, etc. [17]

- Network Layer: It is the brain of an IoT system. The network layer collects the information from the perception layer and facilitates secured data transmission to the application layer for further processing. The entire data processing is taken place at the Network layer and hence, this is called “Core Layer”. Data transmission by encryption processes with unique addresses ensures uninterrupted integration between object-to-object over a single network which is established with the collaboration of numerous devices and hence maintains the universality of the IoT notion. The network layer is achieved by wired, wireless and satellite technologies which include Bluetooth, WiFi, NFCs, etc.[16] [18]

- Application Layer: This is the top layer of IoT systems. This layer provides personalized based services according to the user needs. In this layer, the final depth of integration of IT with industry takes place. This layer fills a major gap between user and application and its main function is to share information and maintain the privacy of the data. [16] [19]

Table 1. The different architectural layers in Smart Refrigerator and Smart Cars.

Architectural Layer	***Smart Refrigerator***	***Smart Car***
Perception Layer	Bar code reader, door sensors, moisture, and humidity sensor	IR sensors, Actuators, gyroscopic sensors, GPS sensors.
Network Layer	WLAN chip	WLAN chip, Bluetooth connectivity
Application Layer	Mobile application, LCD screen	Buzzer indication, LCD,

4. UNDERSTANDING IOT USING SOME APPLICATIONS

4.1. Smart Learning Environment

Education is the most essential foundation for the human resource of any country. To flourish the economy of any country, the youth needs to be educated and hence, the education sector still persists to be the most focused for any government. Proper education is one of the major foundations of our society and needs to be accessible to everyone. The conventional education system where the teacher interacts with the student and vice versa has brought up a lot of challenges, among which the prominent ones are classroom environment, lack of visualization, absence of practice tests, etc.. The considerable decrement in the understanding levels of the students has been a significant challenge to the research community.

IoT systems have helped in tackling the challenges being faced by the conventional teaching methodology and has proven to make learning more comfortable, more individual, and more effective. Figure 4, depicts the IoT based learning system. The diagram shows the modern approach to a teaching-learning process where an IoT based environment is created. The central part of this environment is the server upon which the entire concept lies. This server connects to the devices of students and teachers via an interactive computer-based application, and this server is connected to other devices via internet. This set-up can be termed as Smart Learning Environment (SLE). Smart Learning Environments (SLEs) shall help to establish a seamless connection between a virtual and a physical environment. SLEs adjust content and studying techniques according to the need of the student and provide a platform to communicate with others. The interaction with teachers can be done easily over the server and moreover, by the close monitoring of the learning patterns of students, teachers can take care of every student in a unique way. The lack of visualization among students can be improved by the use of 3D- printers, visualization tools, etc.. In this way, the teaching will be depictive and demonstrative rather than the conventional lecture method. Moreover, it is seen that the physical environment of the classroom affects the teaching and learning process. The temperature, ventilation, mic, presentation board, etc. affect the leaning process [20]. These factors can also be controlled by the server by building intranet-based connectivity. The server can be connected with the temperature sensor and air conditioner both, the motors in the windows can be connected with the server, the mic and the amplifiers can be connected together with the server, etc. In a similar way, all the other internal devices (i.e. devices inside the lecture hall) can be connected to the server via intranet connectivity, and an administrator-based control can be gained over the external factors of the hall. With the development of digital classrooms, the standard of education being imparted can be made efficient as the units in a digital classroom works on the coordination of IoT devices which are interconnected and works on the sensors, sensor data and is further, processed by using Artificial Intelligence algorithms. [21][22]

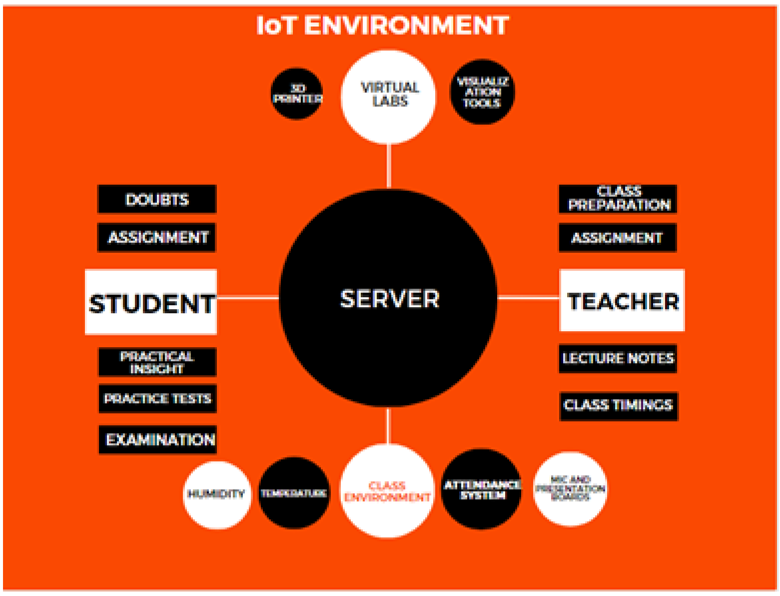

Figure 4. The IoT based modern classrooms.

4.2. Disaster Control

The occurrence of a disaster in a state is an emergency where there is a lot of effort and promptness needed from the rescue team to tackle the challenge posed. The main goal during the time of disaster is to save the lives of citizens by robust planning and execution within least time and minimal failure risks. According to Quaeantelli (1988), the major problem faced by the rescue team during disaster management is in coordinating among the team in the rescue process [23]. In such critical scenarios where the life of citizens are at stake, the integration of IoT with safety equipment has proved to be reliable. IoT technologies help to recognize life- threatening dangers, warn citizens and evacuate them as soon as possible. They can also support the rescue workers by providing them with information and hence, help to tackle the problem of poor coordination faced at different steps among the rescue workers. A wireless sensor network can be created which transits the information regarding temperature, humidity, etc. along with the development of a communication path over radio waves [24]. Figure 5 shows the block diagram of the wireless sensor network which is a novel method of talking about the problem of poor communication and coordination.

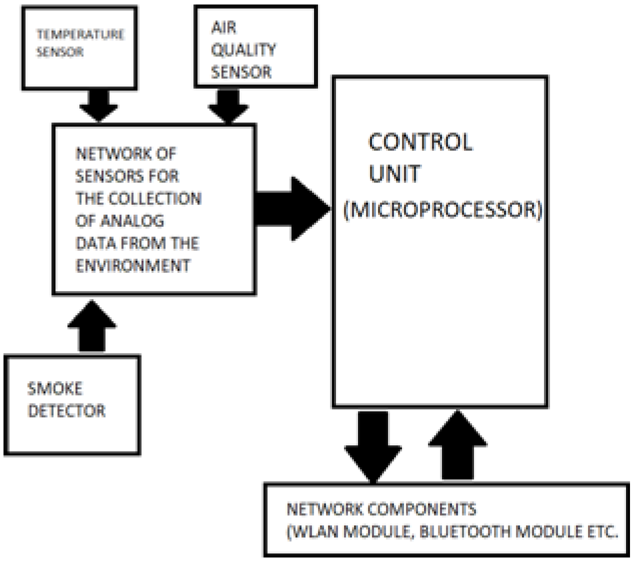

Figure 5. Block diagram showing the connections between microcontroller and other sensors as a part of the architecture of the device.

In the case of jungle fire, prior installment of sensors on trees, monitor different parameters to warn as fast as possible of wildfire and alarm the local fire department and the team for fire extinguishing can act robustly. Moreover, by a simple mobile application, the citizens of the place can be warned of the fire and further, safety measures can be taken. IoT can be a life savior in the case of building and factory fires as well. In cases of a building fire, the wireless sensor network is being utilized to automatically stop lifts, open emergency exit gates, glow all the emergency signals and fire alarms to warn all the people stuck inside the building, whereas robots and machines in factories are stopped immediately and fire extinguishers are activated. The promising accuracy and precision which IoT devices provide are being utilized for the management of disaster widely and get control over it. These tactics are also used to save the citizens from terror attacks, earthquakes, electric breakdowns, etc.. IoT innovation is still developing in this arena with utmost pace to take make the system fully automatic and reliable [25].

Floods have been known for creating a huge number of casualties and infections due to the waterlogging and intake of impure water [26][27]. The maintenance of fresh drinking water and disintegrating the water logging during the flood is the biggest challenge for the government and as a failure to achieve it, diseases like diarrheal infections, acute respiratory infections, malaria, leptospirosis, measles, dengue fever, viral hepatitis, typhoid fever, meningitis, as well as tetanus and cutaneous mucormycosis has been known to spread during flood. [28] These diseases occur because of the increase in the disease vector which takes place due to complex sources at the sight of flood.

Prevention over the water prone diseases spreading in the areas of waterlogging, eventually leading to increment in the disease vector during a flood can be easily done by IoT technology.

In such scenarios, a system of sensors detecting the type of microorganisms growing in the water is installed and the data received from these sensors is transmitted to government bodies so that proper treatment and precautions can be taken at the place [29]. Moreover, the citizens are informed regarding the current situation and the water quality and water levels can be monitored by the government agencies. The healthcare facilities and supply of antidote of the pathogens attacking the population at the site of calamity is done, leading to a reduced number of causalities. Similarly, in the tropical regions of the world, heavy snowfall can lead to huge casualties and is considered to be a great disaster. To tackle this, an IoT based drone system has been constructed, which measures the depth of the snow coagulated. The information gathered by the RADAR of the drone is processed and published on the cloud platform so that residents of such places can be protected [30].

4.3. Smart Homes

The advancement in IoT technology has led to the ease in the maintenance of smart gadgets inside the house. Home automation has become very popular as it becomes difficult to manage household gadgets in busy routines. The quality of life has been increased up to a huge extent due to the automation provided by IoT devices. The connectivity of devices-to-devices has led to the ease in the operation of gadgets. E.g., the lighting systems of the different rooms can be controlled by the mobile application [31]. This kind of system is considered to be partial automation as the intervention human being is required whereas cases where there is no human intervention required leads to a fully automated system. E.g., by advanced algorithm, the air-conditioner calculates the time taken to drive the room's temperature to the user's comfortable temperature and gets started automatically before the user arrives home from the office with the perfect setting of temperature. It should be noted that in both the conditions, the control exists with the user and the system can be stopped/modified according to the desires of the user.

4.4. Smart Parking Management System

Intelligent parking management was a huge challenge for the road authorities, and it was posing great difficulties to the drivers. In big cities, finding an empty parking spot was a massive task as the management was hazy and unclear. IoT technologies gave a solution to this problem with the integration of internet and RFID tags and readers. In this technological advancement, all the parking spots are connected to the internet via RFID tags and the information of the place being filled or empty is transmitted over the internet based on the output of these RFID tags. Moreover, when a car arrives at the parking spot, the car's RFID tag is read by sensors, and the time for which the car was parked is billed and the bill is sent to the owner [32].

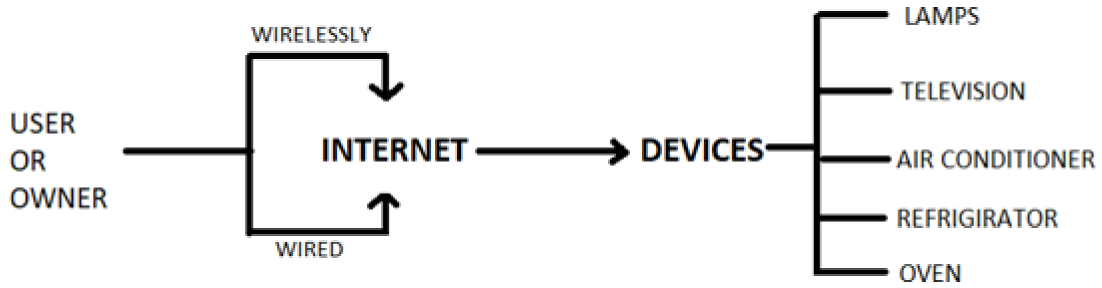

Figure 6. The simple flow chart for the working of the home automation devices.

4.5. Titanic vs Amorella

The advancement in IoT can be felt by comparing two cases from the past. The first case is of the Titanic ship, which sank in the water after hitting the iceberg in 1912. After thorough studies

by different scientists, it was found that one reason behind a considerable number of casualties in the accident was the lack of connectivity and communication among ships in the same area. It is also believed that a lot of people could have been saved if the information about the accident of Titanic was shared among the other ships and the control unit instantly [33]. A similar incident took place with a passenger ship, Amorella, which ran aground while it was on a voyage from Finland to Sweden in the Baltic Sea in December 2013. Since Amorella ship was equipped with the latest emerging technologies of connectivity and a well-established GPS network, lives of all the passengers, including crew members were rescued by sending a rescue team on time.

5. A DETAILED EXAMPLE: IOT SMART BIN

Technology is evolving rapidly, which makes the price and size of batteries and microchips smaller while computing power and battery capacity is increasing. This evolution has made it possible to develop a new kind of information technology network capable of exchanging data and communicating with each other in real-time, using programmable microchips and sensors connected to the internet, radio networks or telecommunications network. These technologies enable people to interact remotely with the real world. Cloud computing makes it possible to process a massive amount of data generated by these networks to analyze it almost instantly.
In this regard, we have designed and developed an IoT based smart bin that is capable of transmitting data to the cloud in real-time based on load sensor readings. This experiment was carried out in the Electronics Laboratory of Savonia Institute of Applied Sciences, Finland as a part of orientation project. A prototype for the IoT bin was built that measures the weight of the container and the surrounding temperature and sends the data to the required authorities. Four load cell sensors were used that handle 50 kg each, so maximum weight allowed is 200 kgs. Load cells were connected, using Wheatstone bridge, to an analog to digital converter (HX711) that converts pressure on the sensors to voltage calculated in the microchip. The microchip used was ESP8266 WLAN module-based chip (ESP8266 NodeMCU). It analyses the information coming from the converter and also sends it to a website by connecting to the internet and cloud services. All these tasks are programmed into a microchip using Arduino IDE software. As a

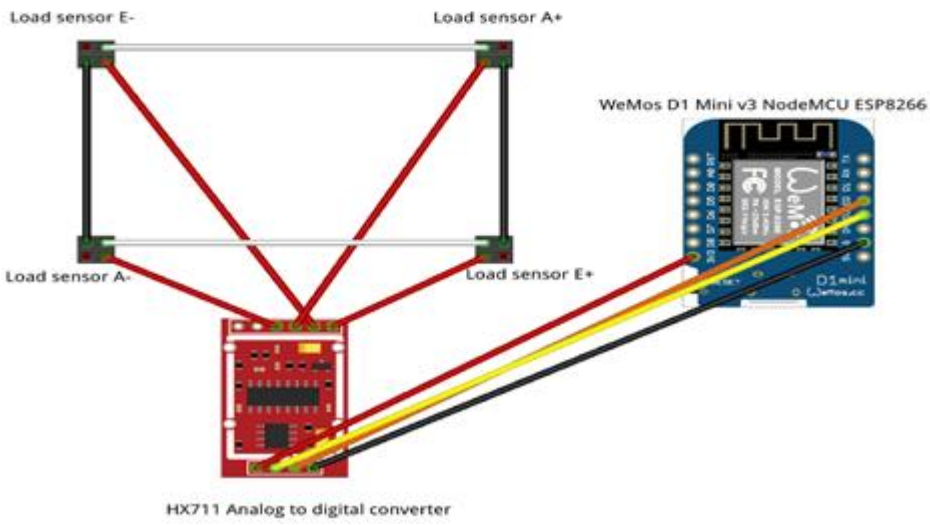

Figure 7. Wiring and Setup of the Components

cloud platform, Google Firebase is used. Firebase provides NoSQL real-time database with website hosting, so data is updated almost instantly to the webpage where it is visualized and plotted into a graph. Data can be accessed with a computer or a mobile phone using an internet

connection. ESP8266 board is powered with the rechargeable battery through a micro USB port. It is also possible to power them with necessary mobile phone charger using AC, as some of the waste bin shelters have electricity for lights and hence, these AC ports can be used for power the ESP8266 board.

Firebase cloud services provide hosting only, so the website still has to be built from scratch. A functional website for the prototype, as shown in Figure 8, was created using basic HTML, CSS, and JavaScript. Firebase is free to apply for a smaller volume of data to be displayed. If it is necessary to store and view more than 1 GB of data per month, it should be updated using a paid version.

The prototype as shown in Figure 8. acted as a proof of concept that it would be possible to monitor waste weight remotely and possibly send a bill based on the load of the bin to the client. However, there are still some revisions to be made before it would be possible to implement into a waste management process. For proper functioning, wireless internet is required by the developed system. It would be cost-effective to provide region-wise wireless internet for the developed system, or it could be used only in the areas where there is a condominium owned internet service. During the wintertime, battery-powered scales would not be an option if bins were kept below negative temperatures. The implementation of this technology can help the person who is responsible for the monitoring of the garbage levels and clean it regularly, especially to the driver of garbage container vehicles. As a future prospect, the data obtained from the sensors can be further analyzed to achieve the real-time graphs related to the filling rate, micro-organisms being developed in the bins. A ratio of biodegradable to non- biodegradable wastes can also be calculated. These data will be helpful in further studies on waste disposal by the government authorities.

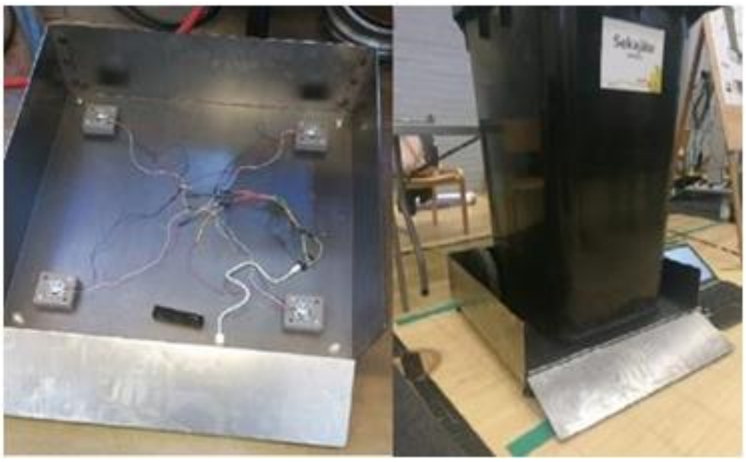

Figure 8. Final Working Prototype

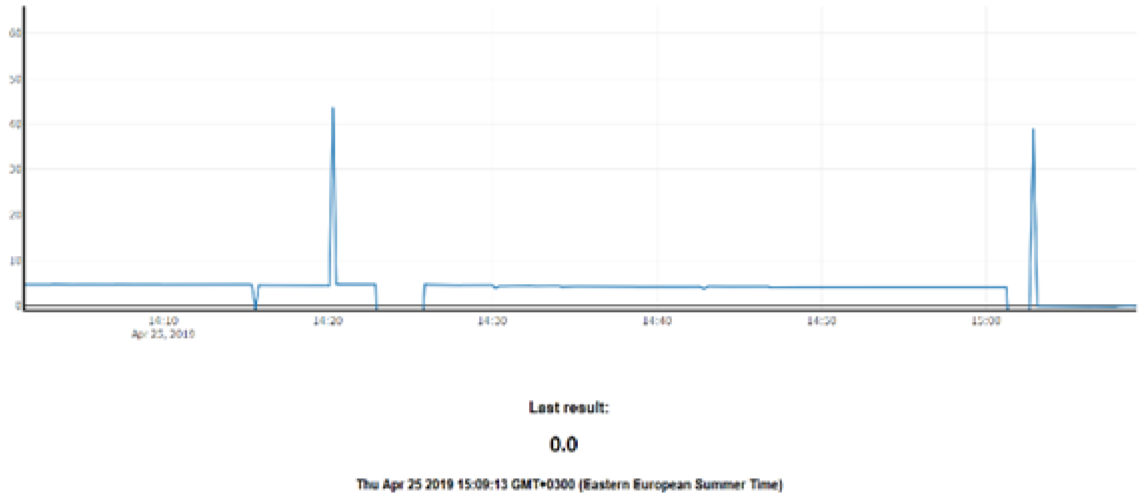

Figure 9. Screen capture of data visualized and updating instantly to the webpage

6. How the World is Channing with Things Connectivity and Future Impacts

IoT is the technology of the future. Scientists across the globe are working for the integration of different devices. The GSMA intelligence [34] report reveals that mobile connections, including licensed cellular IoT, has exceeded beyond 9.32 billion subscriptions. The earlier days' station to station phone connectivity has been changed to the station to people and then people to people and now an era of a device to device connectivity is at our doorsteps. This significant change in the connectivity entirely shifts the principles, technologies, systems, and applications of our daily used gadgets like mobile phones, television, refrigerator, etc. and hence, the most popular term “SMART DEVICES” has evolved. The acceleration in the integration of IoT technology with different areas of Science has been taking place at a very high rate.

There exists a vast range of scientific research scopes possible in this field. Proximately, IoT is expected to lead to the development of an earthquake detecting device with the integration of principles of IoT and earth sciences. This device will be capable of sensing the activities of the inner earth before the earthquake and give signals to the control unit outside. Further, the replacement of medical practitioners with highly efficient robots is expected to be seen very soon, and the security system can be completely automatized by the integration of multiple sensors, memory units, and advanced processing power, etc..

7. Conclusion

This paper was targeted to the people who aren't associated with the field of computer science and Electronics and has no knowledge of IoT. The objective of the paper was to present the idea of the topic ‘Internet of Things’ in a straightforward way so that even a layman can understand it after reading this article. The topic was explained by proper examples and real-life implementation of IoT. To give the reader a picture of the state of art development in the field, the experimental work on the monitoring system of garbage bins was presented in the later stage of the paper in greater detail and proper discussion. This experiment shows how a simple sensing technology can be combined with cloud computing and innovative technology can be developed.

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