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Applications of Internet of Things: A Review

[1]Annupriya, [2]Damandeep, [3]Isha Jhakar
[1,2,3]Computer Science Department
Chandigarh University
Gharuan (Mohali)
[1]Annupriya.cse@cumail.in, [2]Damandeep.cse@cumail.in, [3]Ishajhakar.cse@cumail.in.

Abstract: *The term Internet of Things (IoT) refers to scenarios where network connectivity and computing capability extends to sensors, objects and everyday items that are not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention. Different applications of IoT have been developed and we are going to discuss about applications of IoT.*

Keywords: Introduction, Applications, Challenges, security, privacy.

I. INTRODUCTION

Internet of things is a revolution of the internet. It makes objects recognizable, obtain intelligence, communicate information about themselves by themselves and they can access information that has been aggregated by other things. The iot allows people and things to be connected anyplace, anytime, with anything and anyone, ideally using any path/network and any service. The vision of iot is to use smart technologies to connect things any-time, any-place for anything. The IoT was started in the year 1998 and the term internet of things was first coined by kevin ashton in 1999.

The internet of things provides interaction among the real/physical and the digital/virtual worlds. The physical entities have digital counterparts and virtual representation and things become context aware and they can sense, communicate, interact, exchange data, information and knowledge. [1]through the use of intelligent decision making algorithms in software applications, appropriate rapid responses can be given to physical entity based on the very latest information collected about physical entities and consideration of patterns in the historical data, either for the same entity or for similar entities. These paves new dimension of iot concept in the domains such as supply chain management, transportation and logistics, aerospace, and automotive, smart environments (homes, buildings, infrastructure), energy, defence, agriculture, retail and more.

II. APPLICATIONS OF IOT

Domain	Description	Applications
Society	Activities related to the betterment and development of society, cities and people	Smart Cities, Smart Animal Farming, Smart Agriculture, Healthcare, Domestic and Home automation, Independent Living, Telecommunications, Energy, Defense, Medical technology, Ticketing, Smart Buildings
Environment	Activities related to the protection, monitoring and development of all natural resources	Smart Environment, Smart Metering, Smart Water Recycling, Disaster Alerting
Industry	Activities related to financial, commercial transactions between companies, organizations and other entities	Retail, Logistics, Supply Chain Management Automotive, Industrial Control, Aerospace and Aviation

Smart Homes: Smart Home clearly stands out, ranking as highest Internet of Things application on all

measured channels. More than 60,000 people currently search for the term "Smart Home" each month. This is not a surprise. The IoT Analytics company database for Smart Home includes 256 companies and startups. More companies are active in smart home than any other application in the field of IoT. The total amount of funding for Smart Home startups currently exceeds $2.5bn. This list includes prominent startup names such as Nest or AlertMe as well as a number of multinational corporations like Philips, Haier, or Belkin. Several stellar smart home IoT devices have already hit the market and made their way into thousands of houses around the world. First we have the Amazon Echo, arguably the first and most recognizable name in this space. The device functions as a central hub for your other smart home gadgets, and its voice-activated assistant, Alexa, provides convenience that few other products can match. Amazon also offers two sister products, the Tap and the Dot. Nest, one of the more famous smart home device manufacturers, has created a Learning Thermostat that can automatically adjust temperature based on your location and uses a far-field sensor to determine the time and temperature from a distance. And thanks to a recent update, it now works with Alexa, too. The August Smart Lock provides enhanced security for the home, is easy to install, and works with Siri through the Apple HomeKit. And for smart bulbs, there's the Lifx Color 1000, which can change color as necessary, and the Philips Hue Wireless Dimming Kit for your white-light needs.[2]

Smart Agriculture and Smart water: The IoT can help to improve and strengthen the agriculture work by monitoring soil moisture and trunk diameter in vineyards to control and maintain the amount of vitamins in agricultural products, control micro climate conditions to maximize the production of fruits and vegetables and its quality, study of weather conditions in fields to forecast ice information, rail, drought, snow or wind changes, control of humidity and temperature level to prevent fungus and other microbial contaminants. The role of IoT in water management includes study of water suitability in rivers and the sea for agriculture and drinkable use, detection of liquid presence outside tanks and pressure variations along pipes and monitoring of water level variations in rivers, dams and reservoirs. This kind of IoT applications use Wireless sensor network and single sensors as IoT elements and the bandwidth range as medium. The already reported IoT applications in this kind are SiSviA[3], GBROOS[4] and SEMAT[5].

S**ecurity & Emergencies:-** The IoT technologies in the field of security and emergencies are tremendously increased in which few are listed; perimeter access control, liquid presence, radiation levels and explosive and hazardous gases, etc. The perimeter access control is used to detect and control the unauthorized people entry to restricted areas. The liquid presence is used for liquid detection in data centers, warehouses and sensitive building grounds to prevent break downs and corrosion. The radiation levels application used to measure the radiation levels in nuclear power stations surroundings to generate leakage alerts and the final IoT application is used to detect the gas levels and leakages in industrial environments, surroundings of chemical factories and inside mines.

Wearables: Wearables remains a hot topic too. As consumers await the release of Apple's new smart watch in April 2015, there are plenty of other wearable innovations to be excited about: like the Sony Smart B Trainer, the Myo gesture control, or LookSee bracelet. Of all the IoT startups, wearables maker Jawbone is probably the one with the biggest funding to date. It stands at more than half a billion dollars! Health- and fitness-oriented wearable devices that offer biometric measurements such as heart rate, perspiration levels, and even complex measurements like oxygen levels in the bloodstream are also becoming available. Technology advancements may even allow alcohol levels or other similar measurements to be made via a wearable device. The ability to sense, store, and track biometric measurements over time and then analyze the results, is just one interesting possibility. Tracking body temperature, for example, might provide an early indication of whether a cold or the flu is on the way. Some additional capabilities of wearable devices are more mundane, but might also provide information that could be useful in adjusting environmental controls. Wearable devices could tell if you have your jacket on in the car or if it's just in the back seat (perhaps by placing a few stress measurement device threads within the fabric of the jacket). [8]This could be helpful in keeping the car temperature at a comfortable level. If your wristband can measure perspiration levels that could also be used as a data point for adjusting both temperature and humidity. The above examples could all use a smart phone as the central control for delivering these capabilities, but is that really the most efficient approach? Would it be better if Internet of Things (IoT) devices could communicate directly? You certainly don't want to be required to use your smart phone to okay every transaction your wearable devices wish to make. Perhaps a better model is that the smart phone can help set up the modes of operation you want to support, as well as the privacy level you wish to enforce. Once the communication "strategy" is in place, all the devices can communicate in the ways you

have allowed.[3]

Smart City: Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fueled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days IoT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer. Smart city projects require expertise that spans many different fields including finance, planning , transport, energy safety telecommunications and more. They also require public–private partnerships (PPPs) that embrace all of these different dimensions. The IoT smart city concept is a holistic and layered framework that addresses the needs of mulitple aspects of smart city projects and allows cities to use urban data to boost economic competitiveness, and build more effective, workable solutions to many city challenges. Working with an ecosystem of partners, we offer products, tools and services for public service providers, city network operators, application providers, and enterprises. We use our technologies and expertise to create an effective common network infrastructure, a secure IoT architecture, and layers of control and management that serve the needs of CIOs, city agencies and city councils. [7]

Smart Grid: A smart grid is a special one. A future smart grid promises to use information about the behaviors of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity. 41,000 monthly Google searches highlight the concept's popularity. However, the lack of tweets (Just 100 per month) shows that people don't have much to say about it.[8]

Smart farming: It is an often overlooked business-case for the internet of Things because it does not really fit into the well known categories such as health, mobility, or industrial. However, due to the remoteness of farming operations and the large number of livestock that could be monitored the Internet of Things could revolutionize the way farmers work. But this idea has not yet reached large-scale attention. Nevertheless, one of the Internet of Things applications that should not be underestimated. Smart farming will become the important application field in the predominantly agricultural-product exporting countries. Of the many advantages IoT brings to the table, its ability to innovate the landscape of current farming methods is absolutely groundbreaking. IoT sensors capable of providing farmers with information about crop yields, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time.[8] New hardware, like the corn-tending Rowbot, is making strides by pairing data-collecting software with robotics to fertilize the corn, apply seed cover-crops, and collect information in order to both maximize yields and minimize waste. Another direction in which smart farming is headed involves intensively controlled indoor growing methods. The OpenAG Initiative at MIT Media Lab uses "personal food computers" (small indoor farming environments that monitor/administrate specific growing environments) and an open source platform to collect and share data. The collected data is termed a "climate recipe" which can be downloaded to other personal food computers and used to reproduce climate variables such as carbon dioxide, air temperature, humidity, dissolved oxygen, potential hydrogen, electrical conductivity, and root-zone temperature. This allows users very precise control to document, share, or recreate a specific environment for growing and removes the element of poor weather conditions and human error. It could also potentially allow farmers to induce drought or other abnormal conditions producing desirable traits in specific crops that wouldn't typically occur in nature.[9]

Smart Transportation and Mobility: The development in transportation is one of the factors to indicate the wellbeing of the country. A road condition monitoring and alert application is one of the most important of IoT transformation application [6] . The main idea of the concept of smart transportation and mobility is to apply the principles of crowd sourcing and participatory sensing. The process began with user identified the route wishes and marked some points as pothole in the smart phone's applicatio . IoT can also be used in transportation is an electric vehicles, which is an important means to reduce both the fuel cost and the impact of global warming have also gained considerable attention from drivers. Government in many countries has supported researches on systems to monitor performance of Lithium-ion (Li-on) battery for electric vehicle as explored. The system presented was designed to detect the functions of Li-on power battery by deriving the driving situation from the realistic working conditions for driver so that the driver was able to get the idea of the route status. This solution was embedded with many essential functions such as dynamic performance test of the Li-on battery, remote monitoring with on-line debugging and error correction that could significantly reduce the maintenance cost .

Smart Health: A close attention that required to hospitalized patients whose physiological status should

be monitored continuously can be constantly done by using IoT monitoring technologies. For smart health sensors are used to collect comprehensive physiological World Scientific News 67(2) (2017) 126-148 -133- information and uses gateways and the cloud to analyze and store the information and then send the analyzed data wirelessly to caregivers for further analysis and review as shown in Figure 6 below [9]. It replaces the process of having a health professional come by at regular intervals to check the patient's vital signs, instead providing a continuous automated flow of information. In this way, it simultaneously improves the quality of care through constant attention and lowers the cost of care by reduces the cost of traditional ways of care in addition to data collection and analysis [10].

III. INTERNET OF THINGS CHALLENGES

Technology

This part is covering all technologies needed to make IoT systems function smoothly as a standalone solution or part of existing systems and that's not an easy mission, there are many technological challenges, including Security, Connectivity, Compatibility & Longevity, Standards and Intelligent Analysis & Actions [11].

Figure 1: Technological Challenges

Security is a crucial issue on the Internet, and it is probably the most significant challenge for the IoT. When you increase the number of connected devices, the number of opportunities to exploit vulnerabilities through poorly designed devices can expose user's data to theft, especially when the data streams are left with inadequate protection. In certain cases, it may even harm the safety and health of people. The Zika virus is not the only threat out there!There are a number of IoT deployments that also have collections of near identical or identical devices. This magnifies the impact of any one security vulnerability by the number of devices that all have similar characteristics.

Connectivity: Connecting so many devices will be one of the biggest challenges of the future of IoT, and it will defy the very structure of current communication models and the underlying technologies [12]. At present we rely on the centralized, server/client paradigm to authenticate, authorize and connect different nodes in a network.This model is sufficient for current IoT ecosystems, where tens, hundreds or even thousands of devices are involved. But when networks grow to join billions and hundreds of billions of devices, centralized systems will turn into a bottleneck. Such systems will require huge investments and spending in maintaining cloud servers that can handle such large amounts of information exchange, and entire systems can go down if the server becomes unavailable.

Compatibility and Longevity: IoT is growing in many different directions, with many different technologies competing to become the standard. This will cause difficulties and require the deployment of extra hardware and software when connecting devices.Other compatibility issues stem from non-unified cloud services, lack of standardized M2M protocols and diversities in firmware and operating systems among IoT devices.Some of these technologies will eventually become obsolete in the next few years, effectively rendering the devices implementing them useless. This is especially important, since in contrast to generic computing devices which have a lifespan of a few years, IoT appliances (such as smart fridges or TVs) tend to remain in service for much longer, and should be able to function even if their manufacturer goes out of service.

Standards: A lack of documented or standard best practices has had a much larger impact on Internet of Things devices that goes well beyond simply limiting their development and potential. An absence of standards may well enable inappropriate behavior by IoT devices. Without the right standards to guide and regulate manufacturers, developers may design products that operate in any number of disruptive ways online without regard for their impact. [11]If they are configured or designed poorly, these devices may have negative consequences for networking resources they connect to and, in the broader picture, the Internet itself.A lot of this is caused by cost constraints as well as the need to develop products and get them to market before their competitors.

Privacy: The IoT creates unique challenges to privacy, many that go beyond the data privacy issues that currently exist. Much of this stems from integrating devices into our environments without us consciously using them.[12]This is becoming more prevalent in consumer devices, such as tracking devices for phones

and cars as well as smart televisions. In terms of the latter, voice recognition or vision features are being integrated that can continuously listen to conversations or watch for activity and selectively transmit that data to a cloud service for processing, which sometimes includes a third party. The collection of this information exposes legal and regulatory challenges facing data protection and privacy law.

In addition, many IoT scenarios involve device deployments and data collection activities with multinational or global scope that cross social and cultural boundaries. What will that mean for the development of a broadly applicable privacy protection model for the IoT?

In order to realize the opportunities of the IoT, the ISOC whitepaper suggests that strategies will need to be developed to respect individual privacy choices across a broad spectrum of expectations, while still fostering innovation in new technologies and services.

IV. CONCLUSION

The IoT has the capacity to be a transformative force, positively impacting the lives of millions worldwide,. Not only this is the view of Chinese Government, all countries have been started and allotted more funding to carry out researches in the field of IoT in all these about said issues and challenges. Many research teams have been initiated from all over the world to carry out IoT related researches. All their aims to add a new dimension to this process by enabling communications with and among smart objects, thus leading to the vision of ‘‘anytime, anywhere, any media, anything” communications. To keep this objective in mind, we carefully surveyed the most important aspects of IoT, the various applications of IoT, and the communication enabled technologies or IoT elements which are used in IoT applications. The last part of this paper also highlighted the issues and challenges related to IoT and guide the researchers on future research directions which are penetrated in IoT field.

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