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A Review on Internet of Things and its Applications

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Abstract

We are entering a new age of technology in computing, i.e. From the Internet of Things (IoT). In the cloud, the IoT is a kind of universal global neural network that links different things. In order to address this new challenge, the IoT is an intelligently connected device and system consisting of smart machines that interact and communicate with other machines, environments, objects and infrastructures, and Radio Frequency Identification (RFID) and sensor network technologies. As a result, a large amount of data is generated, stored and processed into useful actions that can "command and control" stuff to make our lives much simpler and safer and reduce our environmental effects. The Internet of Things (IoT) is known to be an ecosystem comprising smart objects equipped with sensors, networking and processing technologies that integrate and work together to provide an environment in which end-users receive smart services. The IoT brings various advantages from the world into human life through which smart services are given to use any operation anywhere and at any time. All these services and facilities are transmitted via the various applications carried out in the IoT area. Monitoring and thus immediate decision-making for energy efficient management are the most significant utilities gained by the IoT applications. High business as well as social values are considered the huge data collected by the Internet of Things (IoT) and secret information is derived from raw data, different data mining algorithms can be applied to IoT data. In this paper, we survey systematic application analysis in the field of the Internet of Things (IoT) along with its merits and demerits.

Keywords: *Internet of Things, Smart City, smart grid, smart farming, network security, privacy, energy consumption*

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INTRODUCTION

The Internet of Things (IoT) refers to the type of the network which connect anything i.e. physical objects devices, buildings, vehicles and other items embedded with software, sensors and network connectivity based on stipulated protocols that enables these objects to collect and exchange data. Due to Seamless integration of classical networks with IoT, it enables a great vision that all things can be easily monitored and controlled which results into voluminous data. So, in order to make IoT more smarter, lots of data analysis is needed for which one of the most solution is data mining. Much research in recent years has focused on data mining in Internet of Things (IoT) which connects physical objects, person to person, person to machine or machine to machine via internet and manages information [1–8].

In recent years, the Internet of Things (IoT) has penetrated pervasively into the most aspects of human life everywhere such as cities, homes, universities, industrial factories, organizations, agriculture environments, hospitals and health-care centers. Numerous capabilities such as produce/consume data and online services, improve daily life and activities around the world through the IoT context [10]. The facilities and smart services are carried through the various applications which are performed in the IoT environment. As users' desires grow, innovative applications are being provided for

monitoring, managing and automating human activities. Also, IoT applications apply cloud service computing for achieving proper composite services via composition of existing atomic services for service-based applications in the IoT context. IoT scenarios are applied to applications with smart devices which users apply them in their daily activities in various fields [11]. Also, IoT applications have some benefits for users to choose the best opportunity in any case, decision making, managing, and monitoring environmental cloud resources.

Despite the different application domains' motivations, all of them have a shared and common goal: provisioning smart services to increase the quality of human life. The main concern of IoT applications is satisfying Quality of Service (QoS) metrics. User's requirements should be supported by smart services in IoT applications that cover the QoS metrics such as security, cost, service time, energy consumption, reliability and availability. The world of information and communication technology is advancing with the addition of new sensing and communication technologies, to connect anything from anyplace, anytime. This type of connectivity is known as the Internet of Things (IoT). Security, connectivity, privacy, and standard procedures for communication in IoT-based networks are the biggest concerns nowadays.

The essential idea of the Internet of Things (IoT) has been around for nearly two decades and has attracted many researchers and industries because of its great estimated impact in improving our daily lives and society [6]. When things like household appliances are connected to a network, they can work together in cooperation to provide the ideal service as a whole, not as a collection of independently working devices. This is useful for many of the real-world applications and services, The idea of IoT is especially valuable or persons with disabilities, as IoT technologies can support human activities at larger scale like building or society, as the devices can mutually cooperate to act as a total system.

APPLICATIONS

Most of the daily life applications that we normally see are already smart, but they are unable to communicate with each other and enabling them to communicate with each other and share useful information with each other will create a wide range of innovative applications [7]. These emerging applications with some autonomous capabilities would certainly improve the quality of our lives. A few of such applications are already in the market, let's take the example of the Google Car which is an initiative to provide a self-driving car experience with real-time traffic, road conditions, weather and other information exchanges, all due to the concept of IoT [11]. There are a number of possible future applications that can be of great advantage.

Smart Transportation

Traditional transportation systems or facilities such as the railway network, road transport, airline transport, and water transport have existed for a long time. In traditional transport each of these operates independently even in a specific type of transport system, making global usage difficult. Smart transportation also known as the Intelligent Transport Systems (ITS) includes various types of communication and navigation systems in vehicles, between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure). ITS also covers the rail, water, and air transport systems, and even their interactions. The smart transportation system has made it possible to construct global airway hubs, intercity railway networks, intelligent road networks, protected cycle routes, protected pedestrian paths, and integrated public transport for safe, rapid, cost effective, and reliable transportation. The use of ICT and real-time data processing has made the smart transportation system possible. The smart transportation system maximizes the utilization of the vehicles used in the system, for example, the number of aircraft that an airline has or the number of trains a railway network has. The smart transportation system allows passengers to easily select different transportation options for low-cost, shortest distance, or fastest routes.

Specific examples of smart transportation technology including sensors in vehicles for

collision avoidance and anti-skidding to increase the safety of the system. A radio frequency identification (RFID) based toll collection is an example of smart transport technology. In the RFID toll collection drivers need not stop at a physical toll booth which typically takes time, blocks the traffic flow, as well as requires manpower for toll collection. Automatic passport control at airports is an emerging technology deployed in smart transportation. In automatic passport control, the passengers can use RFID based passports or electronic passports for fast and reliable entry without the need for manual passport check. Another example of smart transportation is the use of smart apps in mobile phones to hire taxis and even tracking the exact location of the taxi and driver information in the same smart app.

Another subcategory application for IoT in a smart city is where the automotive industry offers smart cars. From headlights to engine all systems in between request a range of innovative technologies in modern cars. IoT will provide web-connected vehicles to implement telemetry, predictive maintenance, car-to-car and car-to-user connections [3]. It is mostly desired to replace wire with wireless communications in a smart car while maintaining a safe and comfortable driving.

Smart Energy

Energy is the property of an object or system which defines its ability to produce work. Energy can be in various forms such as potential energy, kinetic energy, chemical energy, and thermal energy. Energy sources are also quite diverse including solar, fossil fuels, gas, electricity, and battery. Energy can be neither created nor destroyed but can be transformed from one form to another. In the last several years, in addition to traditional energy forms, many other terms are associated with it including clean energy, green energy, sustainable energy, renewable energy, and smart energy. Solar energy or wind energy are forms of green energy sources. Sustainable energy and renewable energy are energy sources which cannot be consumed within a few generations and can be regenerated faster than they can be consumed. However, there can be some differences between sustainable energy and renewable energy: sustainable energy sources are ones not created by human beings, whereas renewable sources are created by human beings. One example of renewable energy is biogas which requires the growth, consumption and disposal of organic materials to generate it.

Smart energy is a much broader concept that any of the above such as traditional energy or clean energy, etc. Smart is a concept which can be viewed as an "Internet of Energy" model. This model is based on one or more principles of smart power generation, smart power grids, smart storage, and smart consumption. In essence any traditional energy, clean energy, green energy, sustainable energy, and renewable energy along with the information and communication technology (ICT) makes smart energy. Low-carbon generation, also known as a green energy, photo-voltaic, solar thermal, biogas, and wind energy can be an important part of a smart energy system. Efficient distribution in the smart energy system is made possible by the use of smart infrastructure, smart grid, smart meters as well as an appropriate level of utilization of the information and communication technology (ICT). The core of a smart energy system is the information infrastructure which is responsible for collecting the energy consumption information as well as sharing the provider rate information [1].

IoT for Smart Farming

IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity, rain prediction and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems. The benefits of smart farming are it increases the business efficiency through process automation, enhances product quality and volumes, increases control over the production, Monitoring of climate conditions, Crop management. It also provides better control over the internal processes and lower production risks.

IoT for Smart Health

A constant attention is 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 complete physiological information and uses gateways and the cloud to analyze and store the information and then send the analysed data wirelessly to care givers for further analysis and review.

IoT for Smart Energy and the Smart Grid
A smart grid that combine the information and communications technologies (ICTs) to the electricity network will enable a real time, two-way communication between suppliers and consumers. It creates more dynamic interaction on energy flow and that will help to deliver electricity more efficiently and sustainably. The significant elements of information and communications technologies will consist of sensing and monitoring technologies for power flows; digital communications infrastructure to transmit data across the grid; smart meters within home display to inform energy usage; coordination, control and automation systems to aggregate and process various information, and to create a highly interactive, responsive electricity. Many applications can be possible due to the internet of things for smart grids, such as industrial, solar power, nuclear power, vehicles, hospitals and cities power control.

Smart Traffic System
Traffic is an important part of a society therefore all the related problems must be properly addressed. There is a need for a system that can improve the traffic situation based on the traffic information obtained from objects using IoT technologies. For such an intelligent traffic monitoring system, realization of a proper system for automatic identification of vehicles and other traffic factors is very important for which we need IoT technologies instead of using common image processing methods. The intelligent traffic monitoring system will provide a good transportation experience by easing the congestion. It will provide features like theft-detection, reporting of traffic accidents, less environmental pollution.

Smart Environment
Prediction of natural disasters such as flood, fire, earthquakes etc. will be possible due to innovative technologies of IoT. There will be a proper monitoring of air pollution in the environment.

IoT in Mining Industry
IoT technology can be used to ensure safety for miners and can provide Mining Companies with important information regarding mining process which can help them in enhancing the current practices. RFIDs, Wi-Fi and sensors can be deployed to improve communication between miners and their employers. Furthermore, diagnosis of different diseases in miners can be done by collecting symptoms using these sensors.

IoT in Transportation
IoT is revolutionary in the Transportation and Logistics industry. We can track vehicles and products using RFIDs and sensors from source to destination in real-time. A DNS architecture is developed for IoT where large scale operations enhances the capabilities of IoT in supply chain management.

IoT in Garments
A new type of E-Thread envisions the idea of collecting data from clothes. This can help in collecting real-time data to track the activities of a patient without using any extra device.

Food Supply Chains (FSC)
IoT can have a huge impact on business industry. Using IoT technologies, vendors can track the production of their products from the farm to the end users.

Smart Cities
One of the most scintillating and emerging applications for IoT is Smart Cities which has gained popularity in the last few years. A smart city is a combination of different smart domains like Smart Transportation, Smart Energy Saving Mechanism, Smart Security and many more which provide the users with latest technological facilities all under one umbrella.

Smart Home
IoT will also provide DIY solutions for Home Automation with which we will be able to remotely control our appliances as per our needs. Proper monitoring of utility meters, energy and water supply will help saving

resources and detecting unexpected overloading, water leaks etc. There will be proper encroachment detection system which will prevent burglaries. Gardening sensors will be able to measure the light, humidity, temperature, moisture and other gardening vitals, as well as it will water the plants according to their needs. Intelligent energy control in buildings is an important aspect in this.

Smart Hospitals

There are many medical emergencies such as cardiac arrest but ambulances take some time to reach patient, Drone Ambulances are already in the market which can fly to the scene with the emergency kit so due to proper monitoring, doctors will be able to track the patients and can send in the drone to provide quick medical care until the ambulance arrive.

ARCHITECTURE OF IoT

The layered architecture in context of IoT has five layers named business, application, middle, network, and perception layers.

- *Business layer:* It receives the information from the application layer. This layer for analyzing the information may build the business model, use flow graphs, graphs etc. It also decides the success rate and future plans of the business. This manages all kinds of such tasks.
- *Application layer:* This does the overall object model on the basis of information received from the middle ware. The applications can be smart health, city, intelligent transport, and military and social sites' operations.
- *Middleware layer:* It transports data from sensor to control rooms for processing the information safely. It serves the requests taken from the network layer.
- *Network layer:* This layer sends data from sensor to information processing systems through a wired and wireless medium.
- *Perception layer:* This keeps the physical objects and sensors and deals in the object identification. This collects information from the sensor to the network layer.

SECURITY FOR INTERNET OF THINGS

If one thing can prevent the Internet of things from transforming the way we live and work, it will be a breakdown in security. While security considerations are not new in the context of information technology, the attributes of many IoT implementations present new and unique security challenges [2]. Addressing these challenges and ensuring security in IoT products and services must be a fundamental priority. Users need to trust that IoT devices and related data services are secure from vulnerabilities, especially as this technology become more pervasive and integrated into our daily lives. Important challenge is the integration of security mechanisms and the user acceptance. User must feel that they control any information that is related to them rather than they feel they are being controlled by the system [12]. This integration generates new requirements, not been previously considered. IoT infrastructure itself to potential harm. Accordingly, a collaborative approach to security will be needed to develop effective and appropriate solutions to IoT security challenges that are well suited to the scale and complexity of the issues.

Privacy

Privacy is considered to be one of main challenges in IoT due to the involvement of humans and increasingly ubiquitous data collection. Privacy of data includes confidential data transmission in a way that it shouldn't expose undesired properties, e.g. identity of a person. This requirement is considered as big challenge as almost every other sensing device collect personal information and large amount of such data becomes Personally Identifiable Information (PII) when combined together; enough to identify a person.

Network Security

Network security requirements are divided into confidentiality, authenticity, integrity, and availability. Factors like heterogeneity and constrained resources must be considered while applying these to IoT architectures. Interconnecting the devices require to have

better confidentiality so technologies such as IPSec and Transport Layer Security (TLS) are employed to meet this requirement. There's another dedicated secure network stacks of IoT available in case overhead exceeds the resource constraints of things.

ENERGY CONSUMPTION OF IoT DEVICES

The multiplication of smart devices and smart applications pushes the limits of Internet: IoT is now used everywhere for home automation, smart agriculture, e-health, smart cities, logistics, smart grids, smart buildings, etc. [4, 5]. IoT devices are typically used to optimize processes and the envisioned application domains include the energy distribution and management. It can for instance help the energy management of product life cycle.

Several works aim at reducing the energy consumption of the device transmission or improving the energy efficiency of the access network technologies. Based on real measurements, previous studies have proposed energy models for IoT devices [9]. Yet, these models are specific to a given kind of IoT device or a given transmission technology. These models can be used to evaluate the energy efficiency of communication protocols or computation offloading techniques.

ADVANTAGES OF IOT APPLICATIONS

- Security: You can monitor your home using your mobile phones, with the ability to control it. It can provide personal safety.
- *Stay connected:* You and your family members can always be in the network. You can virtually stay connected.
- *Efficient use of electricity and energy:* If your home appliances are communicating with you about the work done, their maintenance and repair will be easy. If appliances can operate by themselves then electricity utilization will be possible by an efficient way.
- *Best health care and management:* The patient monitoring is possible on a real time basis without doctor's visit and also enables them to make decisions as well as offer treatment when emergency is there.
- *Cost-effective business operations:* A large number of business operations like shipping and location, security, asset tracking and inventory control, individual order tracking, customer management, personalized marketing and sales operations, etc. can be done efficiently with a proper tracking system using IoT.

DISADVANTAGES OF IOT APPLICATIONS

- *Privacy issues:* Hackers can break into the system and possibility of stealing the data.
- *Becoming indolent:* People are more habituated to have a click-based work making them lazy to any sort of physical activity, applied science in their daily routine.
- *Unemployment:* Lower level people like unskilled labour may have high risks of losing their jobs.

CONCLUSION

IoT applications, IoT architecture and the main security and privacy challenges were reviewed in this paper. Due to the heterogeneous design of sensors, low resources and the system architecture of IoT applications, traditional security primitives cannot be used. Strong network protection infrastructures are necessary to prevent unauthorized use of user data, protect their privacy and to mitigate security and privacy threats. Any unauthorized use of data can limit the use of IoT-based applications by users. An IoT system, which explains the critical need for a flexible layered architecture, should be able to link many heterogeneous devices through the internet.

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