**Future Applications of Internet of Things**

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**Introduction**

The Internet of Things (IoT) is a phenomenon that enables electronic devices and sensors to communicate over the internet to help our lives. The IoT uses smart devices and the Internet to provide new solutions to various challenges and problems related to various businesses, governments and public sectors around the globe. IoT is slowly becoming an essential part of our lives and is omnipresent [1].



Figure 1.1: Components of IoT application

IoT is widely used in fields like environmental monitoring, energy management, healthcare, engineering and transportation etc.,. Given the limited resources of IoT devices, the calculations are performed in powerful cloud for accurate results. Still the input and output operations of the following calculations can interfere with the privacy of IoT users and are not affected by the collision of cloud servers and malicious IoT users [2-3]. The components of an IoT based applications is shown in Figure 1.1.

In addition, IoT researchers are involved in improving the lives of people with disabilities and the elderly. The IoT stands out in this regard by giving a new direction to people’s normal lives. Since these materials and tools are very advantageous in terms of construction costs and are easily available at normal prices, they are used by most people [4]. The state of the art IoT research held annually in Newark during 2022, produced some enormous results as represented in Figure 1.2. Various firms are getting involved in the development of IoT devices since they see an opportunity to improve the business and create a business culture but are not able to do it alone.

Figure 1.2: IoT Applications based on Sectors

 From smart cities to smart agriculture, transportation to smart living environment, IoT is expected to penetrate almost every aspect of day to day life. Although present IoT technology has made great progress in recent years, still there are many issues left that need attention. As IoT concepts are derived from various technologies, numerous research challenges will arise. The scope of IoT is so wide that it affects almost every area of our lives, making it an important research topic in many related fields namely Information Technology and Computer related fields [5].

**Prospective IoT Applications**

IoT helps us save a lot of time by deploying various services and plays an important role in making better decisions by leveraging resources. The main purpose of IoT is to improve the quality of life by providing better services to users and how the concept of connecting IoT with other new technologies such as Artificial Intelligence (AI), Blockchain and Cloud Computing can make more powerful, smarter and efficient machines. The use of IoT is already having a huge impact in many areas. The following sections discuss about the applications of IoT in various fields such as Agriculture, Robotics, Healthcare and Business Sectors [6].

**Application of IoT in Agriculture**

The global livestock population and human beings depend on agriculture as an important source of food. Apart from generating food, the role of agriculture has now stretched out towards the acceptance of green energy based technical novelties like bio inspired diesel fuels. The organic matter required for the production of chemicals, textile materials and various medicines are also the product of agriculture [7]. Figure 1.3 represents various applications of IoT in agriculture domain.

**Smart Farming:**

Information and communication technology can be a tool for smart farming in agriculture. Agricultural areas are monitored with the help of IoT-enabled devices. The machine uses sensors to monitor humidity and temperature. It also enables efficient use of water by using automated irrigation models. Precision farming allows farmers to track their crops and increase productivity.



Figure 1.3: Agriculture IoT Applications

**Drones in Farming:**

One of the best IoT applications is agriculture and farming drones. They developed very good farming techniques. With the help of drones, the health of crops can be more easily measured. All this can be done with good IoT based equipment for the production of agricultural drones.

**Green House Farming:**

Farmers use greenhouses to increase the yield of their crops. Growing crops in greenhouses uses AI to monitor environmental factors that affect crop growth. In contrast, this method of manually adjusting crop growth has low efficiency. The IoT and technical advancements have led to IoT enabled Green houses equipped with climate control sensors and other related devices.

**Application of IoT in Healthcare**

In a secure network, medical devices will provide doctors with information about a patient’s health. This allows doctors to analyse patients remotely [8-9]. Some prospective applications in Healthcare IoT are mentioned below in Figure 1.4:



Figure 1.4: Healthcare IoT Applications

**Minimizing the Treatment Error’s:**

 With the help of IoT devices, manual errors in identifying the patients are reduced. In this way, patients can receive timely care. Additionally, 24/7 on-board diagnostics can provide a clearer picture of a patient’s health than manual diagnostics.

**Remote Assessment and Medication by Experts:**

The IoT solves a huge problem in the healthcare industry: the shortage of doctor, especially specialists, in rural areas. Thanks to the IoT, it is now possible to care from patients without a doctor. All patients need is to put on the device. The computer then sends all the information about the patient’s health to the appropriate doctors for analysis. In this ways, the impact of IoT can play an adequate role for those in need.

**IoT enabled Smart City**

The smart city is one of the hot demand areas for IoT, which includes smart buildings. A smart home includes IoT-enabled home appliances, air conditioning or heating, TVs and security devices that communicate among each other to reduce comfort, security and power consumption. All these communications takes place via Internet through an IoT based control system. The concept of smart cities has gained popularity in the previous decade and has attracted great research attention [10].

It is said that IoT is now deployed in very few applications that serve both technology and people. The scope of IoT is very wide and in future, the IoT will be able to live almost all applications. The energy conservation is a vital part of society and that IoT can help improve energy management which saves energy and money. One major setback in achieving the goal is the lack of IoT hardware and software [11].

**Internet of Everything**

Internet of Everything (IoE) is made up of “4 pillars” of people, data, processes and things. The IoT, on the other hand, has only “things” as represented in Figure 1.5. The IoE commerce continues to enrich people’s lives. Formerly isolated devices, including machine to machine and person to person are now connected to the Internet [12-13].



Figure 1.5: Components of IoE

Cities of the future can be seen as scaled down versions of IoE and will benefit most from communications that use smart data to solve problems in the city. This will make it clearer how cities are leveraging IoE and “big data” to become “Smart cities”. Applications using road evaluation methods to maintain the health of highways, manage the traffic, development of education along with health services and monitor the agriculture [14].

**Internet of Nano Things**

Nanotechnology focuses on nanoparticles that are not recognized by previous technologies. Consider some sensors that can detect many things but fails when it comes to identifying nanoparticles. Nanosensors help to gather information from nanoparticles in the world. In medicine, nanosensors are used to detect the level of tumors. Accurate data and analysis down to the cellular level make nanosensors reliable and accurately identify the diseases [15].

Internet of Nano Things (IoNT) is nothing but the interaction of nano-devices with present networks. Thus, it has led to the change of the latest technology in electromagnetic communication of nanoscale devices. IoNT has many ways to offer this great indoor solution. Imagine that you are not at home and there is smoke in kitchen. It might be dangerous and may start a fire from electrical or other causes.

However, with the help of IoNT this can be identified early and alerts us to take the necessary steps to correct the problem. Thanks to the ability of the IoNT to detect nanoparticles, a simple nano-sensor can detect gas leaks and send notifications to take appropriate remedies. IoT application areas can be enhanced with IoNT models to a greater level [16].

**Conclusion**

 One of the biggest security risks of IoT is the ability for hackers to access sensitive data transferred through these devices. These are often small and distributed in nature, it can be difficult to determine if they had been compromised. The rapid development of nanotechnology and its integration with the IoT, smart cities, smart agriculture, healthcare has paved way for the IoT whose applications in fields are increasing exponentially. IoT has become an essential part of our daily lives due to its small size and significant benefits that can be expected compared to IoT.

 While technology has more benefits, the use of IoT costs more than most benefits due to internet connectivity, the presence of vulnerabilities and minor incidents raises security and privacy concerns. These concerns have to be addressed to the maximum possible level.

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