

# Survey of Internet of Things (IoT) Applications

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## Abstract

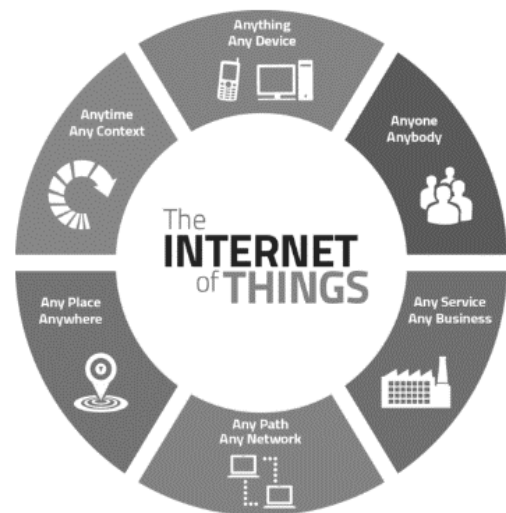
At present, Internet of Things (IoT) technology is interested in the researchers, the graduated people and under graduate students who want to do their products with IoT. The Internet of Things (IoT) is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity which enables these objects to collect and exchange data. Internet of Things will provide smart agriculture, smart cities, smart healthcare, smart homes and smart transport and other important applications. The aim of this paper is to know not only the Internet of Things (IoT) applications that can apply in Shan State but also how the Internet of Things works. These smart applications will be beneficial for the government and countryside.

**Keywords:** Internet of Things (IoT), Smart Agriculture, Smart Cities, Smart Healthcare

## 1. Introduction

Nowadays, there are widely used PCs, laptops, smart phones and tablets which have the capability to connect and communicate through internet. The new technology Internet of Things (IoT) was developed by merging these things and internet. The Internet of Things (IoT) is a new model that is fast gaining ground in the result of modern wireless telecommunications [1]. The internet has a greater impact on education, business, science, communication, government, and humanity [2].

Figure 1 reviews that with the internet of things, any device will able to communicate to the internet at anytime from anywhere by any network to provide any services to anyone [3].



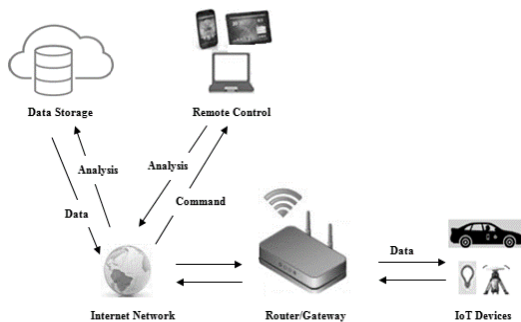
**Figure 1. Internet of Things (IoT)**

The Internet of Things is evolving, growing and becoming popular day by day; around five billion objects have connected through the internet. In 2020, it has estimated that near about fifty billion objects will be connected to the internet [4].

This paper is organized as follows: section 2 presents how Internet of Things works. Section 3 will discuss the applications of Internet of Things such as smart cities, smart agriculture, smart homes, and smart healthcare. The last section concludes this paper.

## 2. How will Internet of Things Work?

IoT is an intelligent technology which includes identification, sensing and intelligence. A complete Internet of Things (IoT) system consists of four components: sensors/devices, connectivity, data processing, and a user interface. In the first step, data is collected by sensors/devices from their environments. Next step, these devices can be connected to the cloud through various types of connections such as RFID, Wi-Fi, Bluetooth, and ZigBee or connecting directly to the internet via Ethernet. Data processing means that once the data gets to the cloud, software performs some kind of processing on it. Lastly, the information is made useful to the end-user in some way. Depending on the IoT application, the user may also be able to perform an action and affect the system. For instance, farmers might remotely test the soil condition via an app on their phone whether the water pours or not.

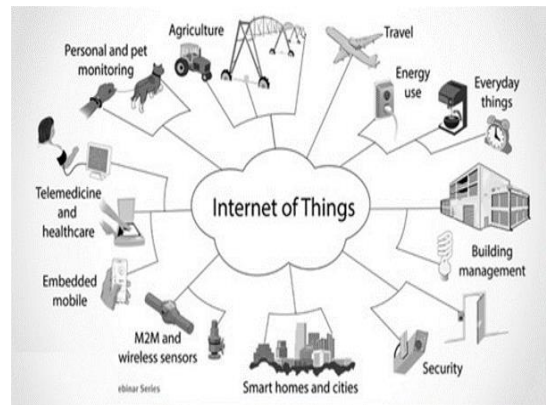


**Figure 2. How the Internet of Things works**

Figure 2 shows that remote controls such as computers, smart phones, tablets and home-control panels connect to the internet via Wi-Fi, which will control each of IoT enabled devices. Storage devices will collect data for future use. The internet will provide the connectivity and a router/ gateway connects via Wi-Fi. Data and analysis flows from IoT device to IoT device and back to the remote and can also be stored either via the cloud, a local database, in the remote device or the IoT device itself [5].

## 3. Internet of Things Applications

There are many applications of Internet of Things (IoT) such as smart agriculture, smart cities, smart homes, smart health and so on as shown in figure (3). The IoT applications will allow users to manage connected devices via their remote control. Some IoT products for each smart application and their functions are shown in the following table 1.



**Figure 3. Internet of Things (IoT) Application**

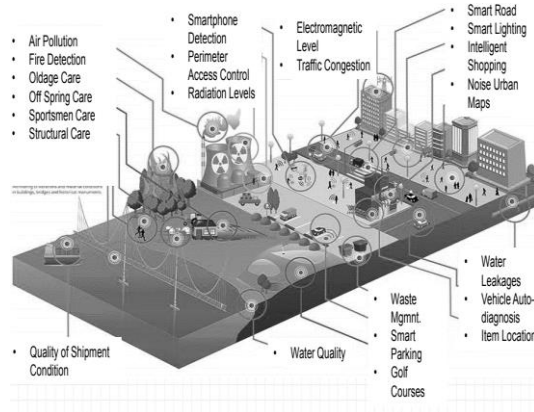
### 3.1. Smart Cities

It is estimated that 70% of the world's population, over 6 billion people, will live in cities and nearby regions by 2050. The rapid increase of the population density inside urban environments, infrastructures and services has been needed to supply the requirements of the citizens. Therefore, cities need to be smart, if only to survive as platforms that allow economic, social and environmental safety. Smart city is the one that uses information and communications technologies (ICT) to make the city services and monitoring more aware, interactive and competent [6].

A variety of sensors, support technologies, and background environments are essential in order to prepare the basic infrastructure of a smart city, and are being employed in urban areas. Among them, the Internet of Things (IoT) is considered one of the most important aspects

for the successful implementation of a smart city [7]. By utilizing multiple technologies to improve the performance of health, energy, transportation, education, and water services leading to higher levels of comfort of their citizens. This involves reducing costs and resource consumption in addition to more effectively and actively engaging with their citizens. The general benefits of using big data are identified to design and support smart city applications [8].

There are many applications in smart cities as shown in figure (4) below. The real application of IoT in smart city services is still in its infancy phase, even in the cities which are leaders in this area. However, the IoT potential has been recognized, and it is not hard to imagine the services reviewed in this paper to become norm in a near future. Even more, new ideas for IoT application and smart services emerge daily, and they will continue to influence our environment and our lives [9] [10].



**Figure 4. Application in Smart Cities**

### 3.2. Smart Agriculture

Nowadays, smart agriculture is already becoming more commonplace among farmers and growers. There are a wide variety of data receiver, Ethernet/Wi-Fi gateway and various sensors such as soil moisture sensor, leaf wetness sensor and soil temperature sensor in smart agriculture [11]. Smart agriculture system refers to precision farming, greenhouse, automation and environment monitoring and control.

A perfect combination of cloud computing, Internet of Things (IoT), visualization and Radio Frequency Identification Technology (RFID) can promote the fast development of agricultural modernization, realize smart agriculture and effectively solve the issues concerning agriculture, countryside and farmers [12][13].

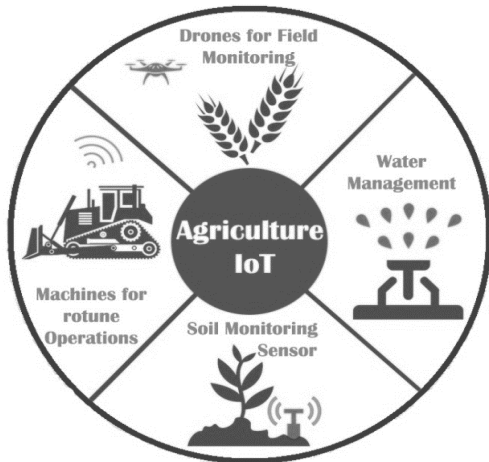
The application of expert system based on the Internet of Things (IoT) in agriculture is rising widely since many years. This system not only use the input data collected in real time but also help to take proactive and preventive actions to minimize the losses due to disease and insects/pests in cotton crop. The first step is the deployment of wireless sensors network (WSN) in the field and the second step is that the collected data from sensors is sent to the server. After that the expert system process to the data and send the recommendations to the farmers about crops [14].

Smart precision based agriculture makes use of wireless sensor networks to monitor the agricultural environment in order to improve the yield quality [15].

Smart GPS based remote controlled monitoring, spraying, moisture and temperature sensing, bird and animal scaring, security, etc. Then, smart warehouse management includes temperature maintenance, humidity maintenance and theft detection in the warehouse [16] [17].

Smart agriculture application areas include vehicle tracking, large and small field farming, soil monitoring, and livestock monitoring shown in figure (5).

Different sensors/ components have been used to tackle different problems of farmers. By using GSM technology, the information message can be sent to the growers. Therefore, a farmer/grower can know the status of his fields in his home whether his crops is needed to irrigate or not [18] [19] [20].



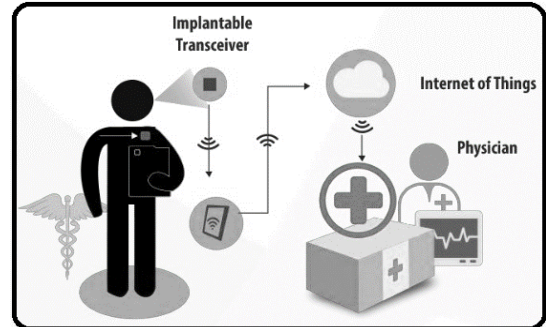
**Figure 5. Smart Agriculture IoT**

There are some benefits of implementing a smart agriculture solution. They are:

- Increased quality of production
- Water conservation
- Real-time data and production insight
- Accurate farm and field evaluation
- Improved Livestock farming
- Remote monitoring
- Equipment monitoring
- Reduce labor cost and manpower
- Lowered operation cost

### 3.3. Smart Healthcare

Internet of Things (IoT) is shaping technology to improve the quality and accessibility of digital products that are revolutionizing the health and fitness industries. At the end of 2012, 2.8 million patients were using a home monitoring system according to a research and markets report. Figure (6) shows Remote patient Monitoring (RPM) that uses digital technologies to collect patient data from a variety of sensors, apply complex algorithms to analyze the data and electronically transmit that information securely to medical professionals who can make health assessment and recommendations [21][22].



**Figure 6. Remote Patient Monitoring System**

Patient's heart rate, body temperature, blood pressure and ECG sends an emergency alert to medical provider with his/her current status and full medical information by using Galileo board, LCD display, web server and Arduino. This healthcare system can also be deployed as a mobile app so that it becomes easier to access anywhere across the globe [23] [24].

The most significant disadvantages include the security risk that comes with having large amounts of sensitive data and possible disconnections from healthcare services if the patient was out of cellular range or their devices ran out of battery [25].

The security risk is been addressed by transmitting the data through the password protected Wi-Fi module which will be encrypted by standard AES128 and the users/doctor can access the data by logging to webpage [26].

The advantages of smart healthcare system are in the following:

- Monitoring patient's health at home can reduce costs and unnecessary go to a physician.
- The time of both patients and doctors are saved.

### 3.4. Smart Home

Smart home or home automation involves the control and automation of lighting, heating, air conditioning, and security, as well as home appliances such as washer/dryers, door locks, ovens or refrigerators/freezers. Wi-Fi or Bluetooth devices are used for remote

monitoring. These services are shown in figure (7) below.

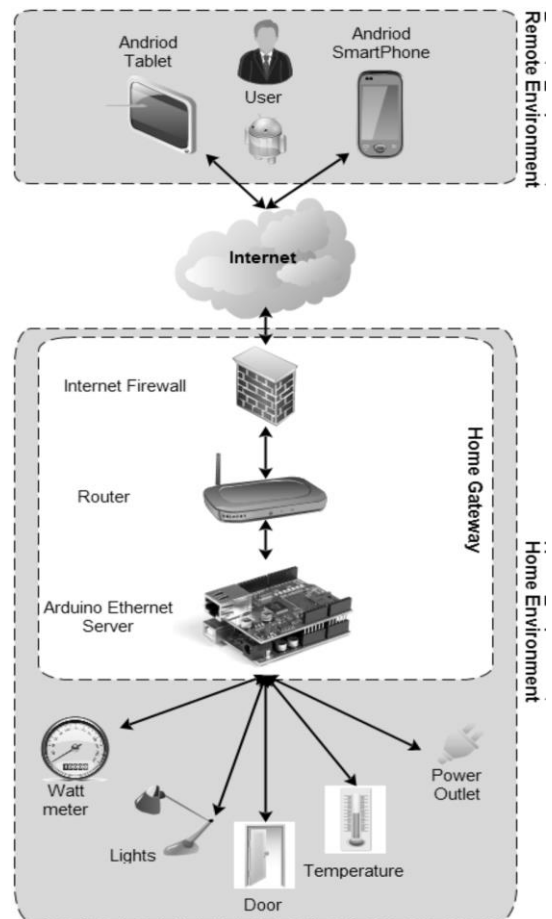


**Figure 7. Examples of some controlled services in Smart Home Environments**

Home automation system is implemented by using Arduino microcontroller with Wi-Fi and smart phone in order to help human desired appliances starting from industrial machine to consumer goods [27][28]. Therefore, adding intelligence to home environment can provide increased quality of life for the elderly and disabled people who might otherwise require caregivers or institutional care. There has been a significant increase in home automation in recent years due to higher affordability and advancement in Smart phones and tablets which allows vast connectivity. With the introduction of the Internet of Things, the research and implementation of home automation are getting more popular [29].

Figure (8) shows the overview of home controlling and monitoring system that is divided into three layers: Home Environment, Home Gateway and Remote Environment. Remote Environment represents authorized users who can access the system on their Smart phone app using the Internet via Wi-Fi or 3G/4G network. Home Environment consists of Home Gateway and a hardware interface module. The primary function of the Home Gateway is to provide data translation services between the Internets. Hardware interface modules are directly interfaced with sensors and actuators through wires. It has the capabilities to control energy management systems like lightings, power plugs, HVAC (heating, ventilation, and air conditioning) systems and security systems such as door locks, and gate. For monitoring Home

Environment, this system supports sensors such as temperature, humidity [30].



**Figure 8. An overview of Home Controlling and monitoring system**

Using the IoT based smart home system can have many advantages. Among them, the main advantage is to save the electric power and human energy. And then this system is flexible and reliable. Communication between home appliances and user is done through internet. Any smart phone that can support 3G, 4G or Wi-Fi can be used for transmitting commands from user to server which is further connected with home appliances. One of prominent advantage of Internet of Things based home automation system is that if Wi-Fi is not available; the user

can switch to 3G or 4G services to control the system<sup>[31]</sup>.

On the other hand, some smart products and some devices can be fairly expensive. Depending on the complexity of the system, installing a home automation device can be a significant burden on the home owner.

Generally, most projects use Arduino rather than Raspberry Pi. Because Arduino is an open source prototyping platform, supported in all operating systems. It is less expensive than other prototyping systems available.

## **4. Conclusion**

This paper surveyed some of the most important applications of Internet of Things (IoT). Furthermore, this paper is mainly intended to some students who want to do their project using Internet of Things (IoT). Some applications like smart cities, smart agriculture, healthcare and home appliances are presented in this paper. We can conclude if smart agriculture will be applied in Shan state, the farmers and the growers would be more increase their living standard because of the economic growth. Personally, the more use the smart applications, the more develop in Shan state.

**Table 1. Some IoT products for each smart application**

IoT Applications		Functions
Smart Cities	Parking Lot Space Sensor	Monitoring of parking spaces availability in the city.
	Automatic Traffic signal controller for reducing congestion work with QTC	It can measure the real-time traffic dynamic data, for traffic flow, vehicle counting, direction, trigger the camera, etc.
	Smart Roads	Highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.
Smart Agriculture	UAVdrone	UAV can produce backspin gas when flying which can spray the liquid medicine into the plant root and neck. The unique innovative design ensures the demand for repeated landing and landing of the aircraft in the plant protection operation.
	Plant Watering Alarm Alerter	This plant watering alarm is putted into the soil near a plant and it emits a tiny chirp when the soil is dry, reminding you to water the plant. As water is consumed by the plant, Chirp will detect the low moisture level and will start to emit rare short chirps. As more water evaporates, Chirp will increase the alarm rate. Chirp can detect if it's day or night by measuring the amount of ambient light and will not make noise when it's dark.
Smart Healthcare	Ever sense XL CGM	The Eversense XL CGM System is for people who want to actively manage their diabetes simply and confidently. It provides continuous glucose monitoring for up to 6 months via an implantable sensor, a removable and rechargeable smart transmitter, and convenient Smartphone app.
	Meridian energy pen	This is the best product for our daily beauty and health care. The electrical pulses generated can stimulate the skin flexible, activate the skin tissue, prevent skin to be sagging and aging, promote blood circulation, and relieve muscle pain.
Smart Home	Face Recognition Door Lock with PIR Sensor	This sensor controls the video camera for catching it for turning on a relay for door unlocking. If the face image is found in the database, the door lock opens.
	iRobot Braava Jet 240	There are three cleaning modes: damp mopping, wet mopping and dry mopping. It automatically switches modes depending on which cleaning pad you attach. The robot emulates mopping and sweeping motions and vibrates as it cleans.

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