

Standardize Exploration on The Internet of Things Applications

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Abstract- Internet of Things is becoming a very important thing in day to day life .Internet of thing can secure easy and comfortable life of the human being. This today's era is mostly digitalized and daily appliances can be operated remotely by person, we call these things as smart things devices, smart home, and smart city smart country etcetera. This paper is the literature survey of the Internet of Things applications in various domains, fields, sectors such as health care center smart cities and homes , railway system, air pollution which is increased in the environment, power sector, agriculture, water monitoring, Space- Internet of Things and specifies the advancements in those areas..

Keywords- Internet of Things, Raspberry Pi, Arduino, RFID

I. INTRODUCTION

The Internet of Things (IoT) is a system of interconnected devices, mechanical as well as digital machines, objects, animals or humans that are provided with unique identifiers and the ability to transfer data over a network without requiring person-to- person or person to computer interaction. "Internet of Things is a system of things those are connected to one another and can collect, transfer data over a wireless network without the help of human. If an object could be connected to the internet and is controlled and information is communicated, then the object can be an IoT device.

In 1999, Kevin Ashton made up the phrase 'Internet of Things'. The communication among electronic devices and sensors through internet is provided by Internet of things. IoT is a solution to many of the problems faced by person. The transformation is observed in our day to day routine as the involvement of IoT devices and technology is enhanced.

The conceptualization of Smart Home Systems (SHS) and appliances that depends on internet based devices, automation system for homes and reliable energy management system is of the development of IoT [1]. As in [2], wireless sensor networks and IoT go hand in hand, as many fields for development of IoT technology included the application of wireless sensor networks

The IoT technology is adopted in most of the applications such as air pollution monitoring, water monitoring, smart cities, railway, power, agriculture, health care space-IoT and many other sectors. This is illustrated in figure 1.

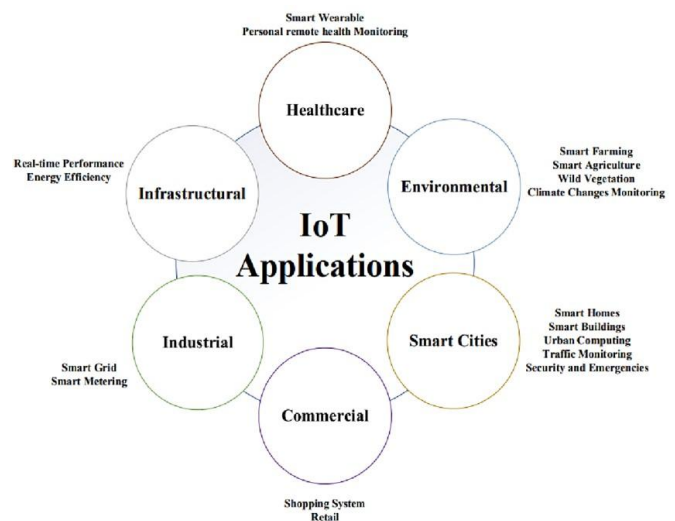


Fig.1. Applications of Internet of Things

After that the literature survey on various applications based on Internet of Things technology is given.

II. LITERATURE REVIEW

The literature survey of the IoT based applications research work carried by different authors in various aspects is given in this paper. This paper will be very helpful for all researchers as most of the IoT applications are generalized and briefed in this survey paper.

1. Air Pollution Control

Air pollution is a huge problem that has been affecting our planet for many years. Thatswhy , there is a need for efficient air pollution monitoring system to protect ourselves from its dangerous effects. An IoT-based air pollution monitoring system is a proper solution that can provide real-time data and about the air quality in a particular area. The air pollution in the environment has to be controlled in the busy areas as in the high traffic roads, industrial and machinery

work fields etc. Here, the following are applications of IoT with air pollution monitoring systems.

The authors in [5] have integrated Single Board Computers (SBC) which is a Raspberry Pi with Wireless Sensor Network (WSN) for Air Pollution Monitoring (AQMS) Systems. The Raspberry pi is a speedy processor and the authors have interfaced ThingSpeak web application with SBC for data monitoring. A mobile App called IoT- Mobair was developed for predicting the pollution level in the air and control it by the users or clients and the microcontroller used here [4] is Arduino. Authors in [3] used Zigbee based monitoring system of air with WSN in mesh topology using 8051 controller. A Node MCU interfaced with sensors and connected to WLAN is used in [7] for air pollution monitoring and ThingSpeak is web application. This work might be used for shorter range purpose. Using grove pi+ board and raspberry pi, the authors [6] have developed an approach for air and noise pollution monitoring in air, so that, the users are alerted with push message on their mobiles.

An interesting air pollution monitoring work was conducted in the paper [9] which is a part of GreenIoT project where the sensors installed on movable bus [8] and also stationary sensors placed in the city centre. The author discusses in [10] about environment monitoring WSN model and this flow mentioned in the paper would be used for most of the other applications based on IoT. Having information and communication technology, the city officials interact with people and the problems can be solved immediately as the system of smart environment monitoring is evolved with the advancement in IoT [11]. Arduino, NodeMCU are applied in real time monitoring of pollution in the air [12] and vehicle user is got alert to drive through another way [15]. The popular PIC microcontroller using RISC program is included in [16]. The Arduino is used in [17], GSM module is used for communication for alerting purpose. The Raspberry pi 3B is used to monitor vehicle pollution in [21] and in [22], RFID for detection and Wi-Fi module is used to alert.

2. Smart Cities

The authors in [1], tell that Smart Home Systems (SHS) should have machine Learning and language processing technologies which are added to help the users in saving energy consumption, security, safety etc. Smart home with IoT application is considered by the authors [22] where the entire house operations could be carried out through a computer and the authors also said us that the system should have a proper security to avoid intrusion. The forest fires also have a huge impact on the city development. Detecting the forest fires by the authorities from the city in a smart way is required. The

earlier technologies consume huge power however, in the paper [23], Lora WAN is used as it is a low power consuming protocol. The status of sensors is known through the use of web map system. Till now we are using 4G technology but the urban and developed areas have already included 5G technologies for their day-to-day life. The authors [24] have concluded that 4G specifications are not sufficient for the demands of smart city applications and therefore the use of 5G wireless system is advantageous.

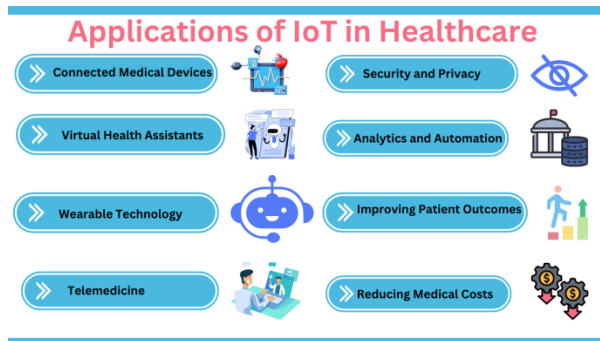
In 5G, HetNets network is used. We get security in 5G but however this issue is always dangerous. The compatible admission control method is introduced by the author to enhance the response time of the IoT traffic for home WIFI IoT system and NS3 simulator is used for observation. The wireless channel impairments are nullified or suppressed. A review paper on 5G technology, also deals with the same issues similar to those mentioned in the previous paper and concludes that artificial intelligence (AI), machine and deep learning must be included for 5G standardization. The rough set technique (RST) in IoT hardware is introduced to reduce the computations that are carried out during processing data. Indoor environment classification, a machine learning approach for indoor tracking and positioning which is sensor based on resulting in improved performance.

In solid waste management, the dustbin level monitoring systems including RFID and WSN are mostly used and these systems are reviewed. The issues with RFID are overcome and the author has introduced system based on LoRa WAN. The existing systems for checking, the authors have proposed a bin level monitoring system which is cost effective and doesn't need additional infrastructure. An Internet of things based system that checks level of casket is developed, in which the BLM unit has life expectancy of near about 1year and is also cost effective when compared to other existing BLM systems. The big data from water waste management, traffic and waste disposal management, resource management faces issues like data privacy, processing as well as quality of data, data reliability is very important on all of the applications similar to smart parking, home, traffic of vehicles as well as surveillance etc. The Arduino board is used in applications of dustbin cleaning, leakage of gas, detection of accident and for some of the other applications RFID is used for detection. Some paper described network protocols used in appropriate applications.

3. Health Care

It is very essential to take care of human health even in a busy lifestyle. With the advancement of several technologies in this era, the health care equipment's, units, devices, etc. are

also adapted to the new technologies introduced in medical field. the following applications of IoT with health care monitoring system.



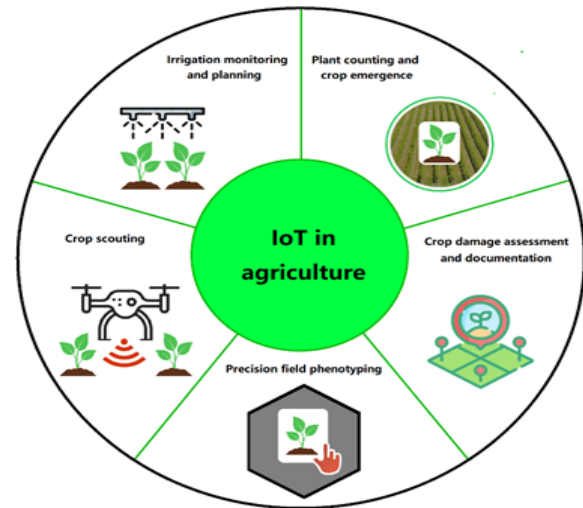
The author in [23] has proposed a design for tracking the health of scavengers and used the Arduino Atmega328 as the main board and the data is sent to cloud for storage. The author in [24] has done intense research in health care sector based on IoT and has concluded that the users are beneficial with the advancement of health units working with IoT technology but only the security issues have to be addressed as it is a challenge. As the security measure is to be dealt, the authors [25] have come up with management model for security risk in IoT to practice securely in Healthcare environment and discussed about COBIT5 for trust in healthcare unit. The WSN with IoT technology faces congestion while gathering data and can affect the reliability of the system and therefore distributed congestion control algorithm is provided whose performance is better compared to previous methods. The authors have used LS-IoT and LAC for transmission of secure data in ECG system and the signal analysis is done using SSA which considerably resulted in less energy consumption of battery.

The incurable disease patients can be remotely observed and the various wireless networking techniques used for this purpose. Comparing different techniques available, the authors have shown that wi-fi technology is more beneficial for transmission of health-related data. The Arduinouno R3 with GSM module is used to check blood pressure, heart rate and temperature. The health check in [5] and [6] is shown using Arduino and Zigbee module. The Arduino board with wi-fi module with Node MCU is used for health check alert. The NB IoT (Internet of thing) protocol is used as it has the advantage of low power consumption. The system for covid curb to care the human society is discussed.

4. Agriculture

Agricultural sector has to be dealt in smart way with new advancements in technology. The IoT based applications

for agriculture are vast and the farmers, researchers, etc., are benefited when applied the IoT technology in agricultural field. Following are applications of IoT in agriculture.



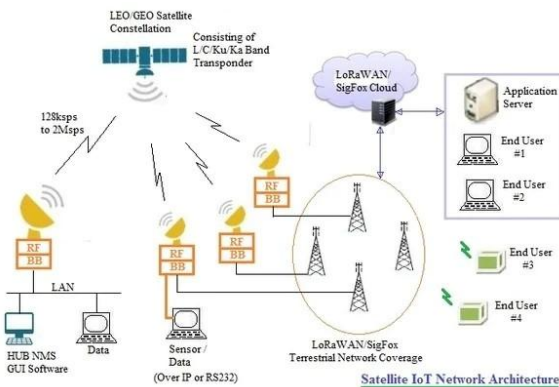
In some paper the authors have combined IoT and data analytics(DA) and enabled high yield and operational efficiency. A survey paper discussed all the possible advancements in agriculture and farming namely, precision agriculture, animal monitoring, tracing, greenhouse farming etc.,. The authors provided the survey paper and listed the strong views on the CS, ML, NOMA and mMIMO connectivity technologies for machine type communications. The temperature and humidity sensors are used for greenhouse monitoring purpose and proposed the remote monitoring method combined with internet and wireless communication, and for data access ADO.NET is used. The pape, provides the smart system for agriculture which is a predefined irrigation schedule for improving the yield. The system includes Arduino for processing and for communication uses GSM. In the sensors are connected to Arduino Uno Board for sensing soil moisture and level of water, the system of smart agriculture is designed which is automated.

The ARM7 is used, in which the WSN connected in star topology. Node MCU connected with sensors for monitoring crops is developed. The AVR microcontroller, raspberry pi with ZigBee module is used to control robot remotely that includes GPS and the success percentage tests for routing using Raspberry pi is 100%. The agro informatics is very advantageous in agriculture and the precision agriculture reduces the resource wastage. The sensing of soil moisture weather conditions, animal warnings through location detection by GPS can help the farmers for high yield of crop. The ATMEGA328P the advanced version is used in and the paper collected data from 2016 to 2019 revealed that farms connected to Internet of Things are about 540 million.

The solar powered system is introduced. using ATMEGA2560.

5. Space-Internet of things

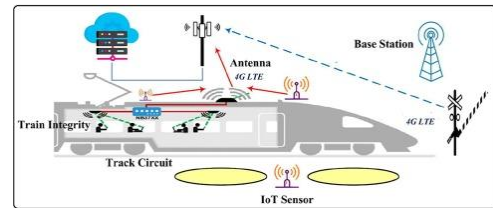
The satellites are helpful in many fields as the humans are largely comforted. Here, the following are some of the applications of satellites in IoT.



The benefits of using satellite IoT networks are reliable, large coverage, security, cost effective multicasting and NB-Internet of things is used to sustain SIoT. The SIoT is analyzed in for spectral efficiency improvement. Earlier GEO stationary satellites were used and even today these GEO satellites are used in some of the applications, but the authors in listed out the advantages of using LEO satellites compared to GEO stationary satellites. The Arduino Uno, GSM module, GPS receiver are used to track the vehicle location [74] and developed a system of antitheft. NB-IoT is energy efficient for SIoT used in long term applications. The IoT applications and its challenges are discussed. The space information network is helpful in machine communication and authors discussed that CoAP is good compared to MQTT. Landsat 8 and Moderate resolution imaging spectroradiometer is used to estimate land surface temperature and evapotranspiration.

6. Railway Systems

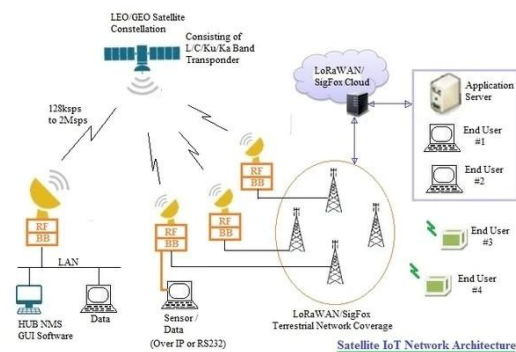
The Indian government highly depends on railway sector for the income. The IoT technology beneficial in railway systems makes the system run smoothly and any faults can be predicted ahead and can be prevented and made good. Here, the following are applications of IoT in Railways systems.



The train when entering a tunnel causes sickness or ringing sound in ears for few people and this happens because of the change in the pressure of air in train. To overcome this issue , the authors have come up with an algorithm named adaptive iterative learning control which can balance the pressure of air. Deals with the idea of smart railway system (SRS). SRS requires data transaction through internet, data storage, processing etc., the network architecture IoT solution is proposed to take care of data distributed in railway area and to check performance, power consumption and concluded that LoRa as IoT network is advantageous in terms of power consumption. The TCAS is controlled with WSN for maintaining train integrity. The authors in provided a network architecture passenger flow distribution model for managing the passenger traffic on train and increases the traffic safety. The authors introduced an adaptive fuzzy controller to adjust airgap and improved apriority algorithm is used for trusted database. Results shown with fuzzy control proposed work is very effective.

7. Power Sector

Enormous benefits also driven when IoT technology is used in Power systems and it may be termed as intelligent power sectors or smart power /energy systems or digitized energy system, etc. following are some of the applications of IoT based on power sectors.



The paper shown that electric power and energy systems are developed using IoT technology and helpful for Distributed Energy Resources by making less energy consumption, expense reduction and more security. The power consumption monitoring system based on IoT is used and power consumption is controlled by supply cut when the limit

is crossed. Here, ATMEGA microcontroller is used for processing, and the whole concept is based on ohms law. Energy management system at home based on IoT is designed in where a current sensor in the form of printed circuit board is connected to all appliances and different loads of power are noted by users. The authors in have reviewed literatures on energy and power sector advancements and have summarized that Variable Renewable Energy resource systems are changed to smart, digitized systems through IoT and the home can be managed by monitoring heat, ventilation, air conditioning. Block chain technology is highlighted. The power theft and power cut manually is avoided based on the proposed work in PIC microcontroller and Node MCU is main units. GSM module is used for alert message and RFID tag for prepaid bill payment to avoid due date issues.

8. Water Monitoring

The water that is the main living for fish. The water parameters are needed to be in control as in suitable for the fish. The quality of water has to be examined in order to have a healthy fish. following are some of the literature papers related to water monitoring system.

The quality of water monitoring for Eel fish using Raspberry pi 3 is ready. Here, the dissolved oxygen is less than the actually needed by the fish. An aquaculture with high density using Raspberry pi is done, in which, the temperature from many tanks can be sensed at the same time. The Arduino is used in and notification alert on phone can be received in the system. The effective system, in which, the self-cleaning sensor probes are equipped. The review on WI-FI, GSM and Zigbee based monitoring systems are discussed. An Approach using NB-Internet of things is having 6LoWPAN, monitoring of water is ready and system increases the work of old traditional monitoring of water. The parameters like pH, dissolved oxygen, water temperature were discussed in and in it are advised not to use a black tarpaulin as pond for fish as it is not a good option.

Inference from the above papers sapped is, the sensor networks that are ZigBee based is recommended and for the quality of water monitoring with self-cleaning probes is a very good option for effective reading of values of results.

Based on the study of the papers surveyed, the conclusion made is listed in tables 1 and 2. The main board either Raspberry pi and Arduino for any application, can be used based on the priorities of the researcher.

Arduino	Raspberry Pi
It is designed to control the electrical components connected to the circuit board in a system.	While Raspberry Pi computes data and produces valuable outputs, and controls components in a system based on the outcome of its computation.
Arduino boards have a simple hardware and software structure.	While Raspberry Pi boards have a complex architecture of hardware and software.
CPU architecture: 8 bit.	CPU architecture: 64 bit.
It uses very little RAM, 2 kB.	While Raspberry Pi requires more RAM, 1 GB.
It clocks a processing speed of 16 MHz.	While Raspberry Pi clocks a processing speed of 1.4 GHz.
It is cheaper in cost.	While Raspberry Pi is expensive.
It has a higher I/O current drive strength.	While Raspberry Pi has a lower I/O current drive strength.
It consumes about 200 MW of power.	While it consumes about 700 MW of power.
It does not have internet support.	It has inbuilt Ethernet port and WiFi support.
It has higher current drive strength.	It has lower current drive strength.
Some of the applications of Arduino are traffic light countdown timer , Weighing machines , etc.	Some of the applications of Raspberry Pi are Stop motion cameras , Robot Controllers , Game Servers.

Table 2. Difference between Raspberry Pi, and Arduino

The figure (see Fig.2.) shows the power consumed by NodeMCU, different Raspberry Pi and Arduino models. The main difference between Raspberry Pi and Arduino is that, Arduino and its models are microcontroller development boards, whereas, the Raspberry pi and its models are like mini computers that needs operating system and therefore, Raspberry pi requires more power compared to Arduino. The speed of Raspberry Pi is faster than Arduino. The Arduino cost is cheaper. That’s why; researcher according to the parameters required for the particular project can choose the specific board.

	Range	Data Rate	Frequency	Power Consumption (active)*
Bluetooth	Up to 100m	3Mbps (EDR)	2.4GHz	115mW
Bluetooth LE	100m+	Up to 2Mbps	2.4GHz	35mW
Zigbee	Up to 100m	250kbps	2.4GHz	120mW
WiFi	50m typical	Up to 1Gbps	2.4GHz and 5GHz	900mW
LoRaWAN	Up to 15km (suburban)	Up to 50kbps	Various	115mW

Fig.2. Power consumption

III. CONCLUSION

The wireless sensor network (WSN) is the sensor network that has been attached to the processor for processing the data and this data is accessed by the receiver on the user side. That's why, all the devices have to be connected through internet and the devices may sometimes be performed remotely and independently. IoT is very suitable to use in this field of work. Internet of Things technology is useful and highly beneficial to be used in the work of sensing and monitoring. The person living to some extent can be eased with the use of the advanced technology. This review paper is more helpful for all the researchers of IoT topic.

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