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Internet of Things(IoT) and its Applications: A Review

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Abstract—**The Internet of Things (IoT) is a rapidly growing technology in today's society (IoT). IoT is an evolving technology that allows physical objects or things to communicate with other devices via network gateways that can transport or receive data. Medical, agriculture, industrial, research, wearables, gadgets, AI, smart homes, automobiles, and many other IoT applications are all part of our daily lives. The goal of the article is to focus on the top five most popular areas where IoT is applied**.

I. *Keywords*-**Internet of Thinks, IoTin Smart Home, IoTin Agriculture, IoT in Automobile Industry, IoTInHealth Care**

II. INTRODUCTION

A network of physical items is referred to as the Internet of Things (IoT). The internet has transformed into a network of devices of all forms and sizes, including automobiles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, and buildings, all connected, all communicating and sharing information based on predetermined protocols in order to achieve smart reorganizations, positioning, tracing, personal security and control, and even personal real-time online monitoring, upgrade, and propulsion [1].We currently observe human-human or human-device communication, but the Internet of Things (IoT) offers a bright future for the internet in which communication is machine-machine (M2M). The Internet of Things (IoT) is constantly expanding and is a trendy research area with numerous prospects [2].

III. HISTORY OF INTERNET OF THINGS

Internet of Things is a rapidly evolving technology that has had a significant impact on the world. Let's take a look at how it came to be. In early 1982, the main theory of smart device networks was introduced, with a modified Coca-Cola vending machine at Carnegie Mellon University becoming the first ARPANET-connected appliance to report whether the drink is cold or not[3][4], and later in 1990, john romkey introduced the internet toaster. Mark Weiser [5] provided the first current picture of IoT in the form of ubiquitous computing in 1991[6], while Bill Joy [7]provided a clue regarding Device to Device communication in his internet taxonomy in 1999.Kevin Ashton, Managing Director of the Auto-Id Center at MIT, founded the Internet of Things in 1999. They also established RFID-based systems for object identification all over the world [8]. In 2000, LG Electronics Giant announced its proposal to sell refrigerators that would now detect whether or not the stored food would be restocked. [5], As part of the Savi Program in 2003, the US Army employed RFID in large numbers. [5], The introduction of IPv6 in 2011 has spurred considerable growth and interest in this sector. Many educational and commercial projects with IOT are being continued by IT heavyweights such as Cisco, IBM, and Ericson [9], the first international conference on the internet of things was held in 2008 [10], and Google began testing self-driving cars in 2009,A Toyota Prius was the first car to take an autonomous ride. On its upper deck, it contained a sensor-enabled gadget that could identify pedestrians, bikers, roadwork, and other useful objects. Now that the software has matured to the point where it can predict the behavior of all road users, St. Jude Medical has become an early adopter of IoT in healthcare. [10], in 2010, the Nest firm began producing smart home appliances. [10] In 2013, Google announced a smart-glasses brand. Google Glass was a head-

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mounted gadget designed to look like a pair of spectacles [10].

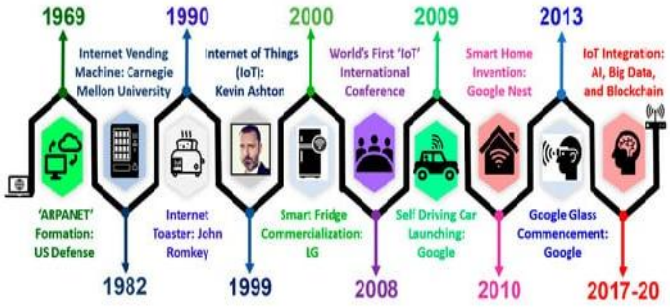

Fig. 1 History ofIoT [11]

Later, many technologies such as AI, blockchain, and big data began to use IOT in their technology, resulting in the notion of IOT expanding today [10].

IV. APPLICATION OF IOT

IoT applications include: There are many different fields where IoT is implemented, and many more are yet to come, which could be a new version of IoT. The Internet of Things (IoT) is an advanced technology that connects things, machines, devices, solutions, and people over the Internet. Smart agriculture, smart transportation, smart cities, health, rescue and disaster recovery, retail, management houses, and green energy are all expected to grow popular with IoT. [12]

A. Education

IoT fills in the gaps and loopholes in the education industry; for example, IoT equipped boards allow us to create digital posters with ease, incorporating photographs, audio, video, text, and hyperlinks. [13]

B. Government

The concept of a smart city is to make better use of public resources, improving the quality of services provided to citizens while lowering the operational expenses of government agencies. The smart defence system improves and supports militia systems and services, as well as providing the technology required to oversee the national defence landscape. It contributes to increased border security by providing more affordable, high-performance devices that are both manageable and impressive.[13]

C. Industry

Smart industry, which uses sensors, software, and big data analytics to create outstanding machines, is empowering industrial engineering. Using digitised machinery that is embedded with an IoT system, workers can obtain information about original equipment manufacturers and report to field engineers[13].

D. Healthcare

The Internet of Things (IoT) is being used in the healthcare sector to improve the quality of human life by supporting humans with simple tasks where Patients' health monitoring equipment can be fitted with sensors.[13]

E. Agriculture

IoT in agriculture which willmonitor Soil nutrition, Light, Humidity etc and improve the green housing experience by automatic adjustment of temperature to maximize the production.[13]

F.Energy

The need for a smart energy system has become crucial. The significance of energy rates has increased. Individuals and organisations alike are on the lookout for ways to reduce and control their energy usage. IoT enables more precise energy usage monitoring not only at the device level, but also at the grid, house, and distribution levels [13].

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G. Environment

In a smart environment, the IoT is employed in a variety of fields to make the environment smarter and safer. Natural calamities such as floods, fires, and earthquakes will be predicted thanks to IOT's revolutionary technologies, which provide weather forecasts with increased precision and flexibility even under extreme climatic situations. The environment's air pollution will be properly monitored [13].

H. Transportation

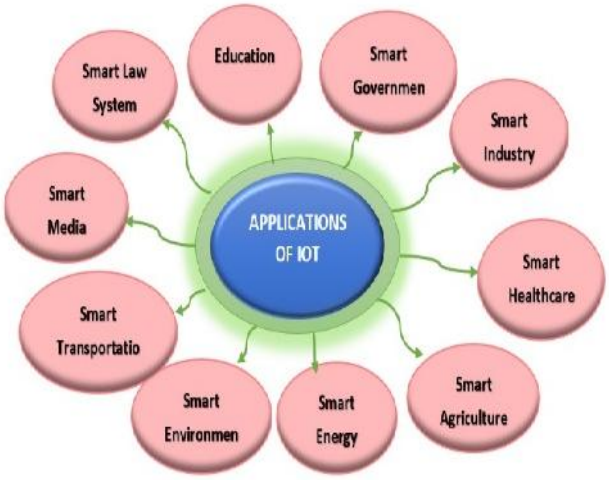
This smart city's smart transportation system will provide diversions in the event of climatic changes or unexpected traffic bottlenecks, allowing driving and pedestrian routes to be optimized. To save energy, the traffic lights system will be weather adaptive [13].

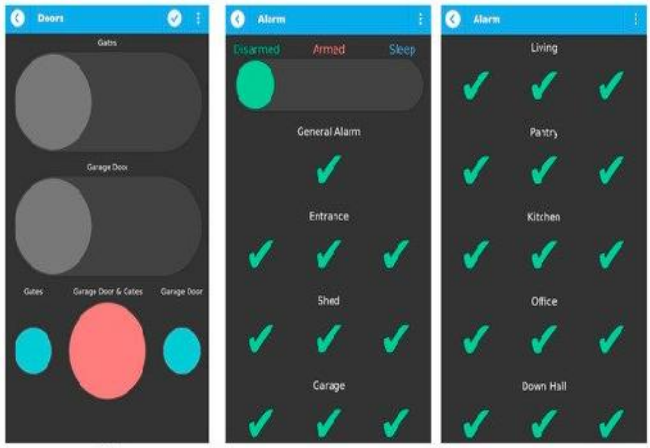
I. Media

The IoT device used in media, marketing, and advertising is a custom-designed experience in which the device analyses and responds to each individual client's desires and interests. This comprises their well-known conduct styles, conduct purchasing, choices, tradition, and various advances [13]

J. Law System

Smart Court systems are made possible by IoT, which brings enhanced analytics, better evidence, and streamlined processes to court systems, boosting strategies, removing inefficient processes





(a) (b)

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Fig. 2. Applications of IoT

V. REVIEW OF LITERATURE

This article focuses on the Internet of Things (IoT) and its applications, with a focus on four well-known IoT applications that are used in everyday life, as well as current trends and well-known works done by these four applications.

VI. IOT IN SMART HOME

In Smart Homes environments, various types of sensors, actuators, and personal devices are connected through use of wireless networks, and are often powered by human machine interfaces based on artificial intelligence to provide smart and automated services for users, with the goal of assisting them in daily tasks such as lighting control, surveillance, managing home appliances and resources, and energy consumption, among others [14][15].

A. Lorawan technology

In 2022,Lorawan technology is being used in home Robolization . To provide complete house robotization, LoRaWAN improvements were combined with the Bluetooth network, a server-based LoRa communication technology. Bluetooth will be used if a client remains within a short range. In the case that the Bluetooth connection is unavailable, a server-based LoRa connection will be used. It will be worked by LoRa if a client stays outside of short and medium-range distant correspondence. The advancements for home robotization that are available on the market rely on stages that help to connect gadgets or objects about the house; the main issue is to make the home smart or savvy quickly.This was accomplished with accuracy through the use of static IP addresses and the ability to recognise the current status of adgets through the use of state work. Overall, it has been discovered that home automation using web of things through LoRa technology and an Android application is both simple to grasp and cost-effective. [16]

B. qToggle system

In year 2021, for numerous house automations, a framework for integrating sensors, actuators, and other data sources is described. qToggle is the name of the system, and it works by using the flexibility and power of an Application Programming Interface (API), which serves as the foundation for a simple and common communication mechanism. The most frequent devices used by qToggle are sensors or actuators with an upstream network connection that implement the qToggle API.ESP8266/ESP8285 chips and/or Raspberry Pi boards are used in the most of qToggle's devices. A smartphone application has been created that allows users to control a range of home appliances and sensors. Through the use of multiple devices and add-ons, the qToggle system is user-friendly, versatile, and expandable. Real-world examples include regulating the AC temperature, controlling the lights (fig 17), monitoring security access points, and controlling with the Toogle app. [17]

C. Home Security System

The usage of monitoring cameras (CCTV) as a medium for monitoring activities that occur at home when it is uninhabited has become a need in today's residential houses. It attempts to use the Internet of Things to construct a system that can document actions that occur in residential rooms. The system includes a Passive Infrared sensor that detects persons in the room and immediately triggers the alarm and camera to snap images when someone is detected in the room, as well as sending image data to a web server and notifications to homeowners via Android smartphones.so that the owner of the house, wherever he is, may see if somebody has entered his home [19]

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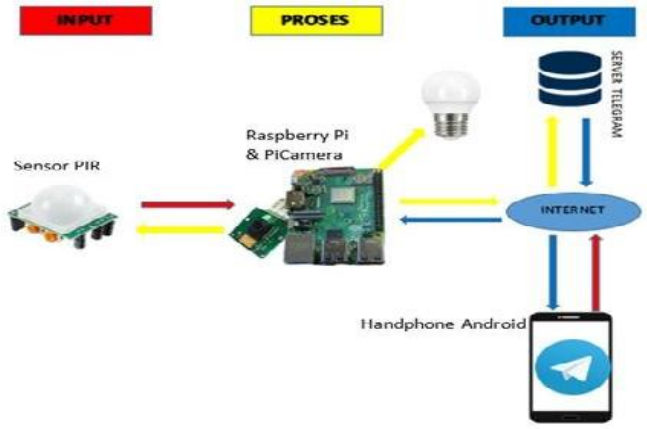

Fig. 3.Access of security [17]

D. Smart Home Implementation in Lower Cost

A multitude of elements, including hardware and software costs, affect the cost of an IoT deployment. The software for a smart home automation system is not expensive. It would take about 80 man hours to build a simplistic web programme to control an on/off switch. To host the application, you'll need a server and IoT hardware such a board, controller, switches, and relays.One of the most significant things to do to achieve the goal of low-cost IoT deployment is to use Aurdino instead of Raspberry Pi. [20], Instead of using the more expensive Raspberry, we can utilise an Arduino board to develop smart home automation based on IoT. The major distinction between Arduino and Raspberry Pi boards is that Arduino boards are microcontrollers, whereas Raspberry Pi boards are microprocessors. We simply required a board that supported bit pins for smart home automation, which the Arduino board does.Every bit pin on an Arduino board, known as GPIO (General purpose input/output) pins, is connected to every physical device through a relay [21].

E. IoTin Doorbell

Users add their Ring Doorbell to their home Wi-Fi network and use the Ring app to view the Ring Doorbell's live video footage, which is saved in the cloud (Derrick, 2019). Users can also get alerts when motion is detected within 30 feet of their door, and they can talk to anyone who arrives to their door even if they aren't home (Derrick, 2019; Watters & House, n.d.). Amazon Alexa devices can be linked to Ring Doorbell (Ring, 2020b) Users connect their Ring Doorbell to their home Wi-Fi and use the Ring app to view the Ring Doorbell's live video footage, which is saved in the cloud (Derrick, 2019). [22]

VII. IoT In Agriculture

IoTbased agriculture applications comprise crop and livestock monitoring, machinery, irrigation, and water quality monitoring, soil monitoring and weather monitoring, disease and pest management, and automation and precise application. The following functions are used to describe IoT-based agriculture applications: monitoring, agriculture, machinery, and precision agriculture [18][23].

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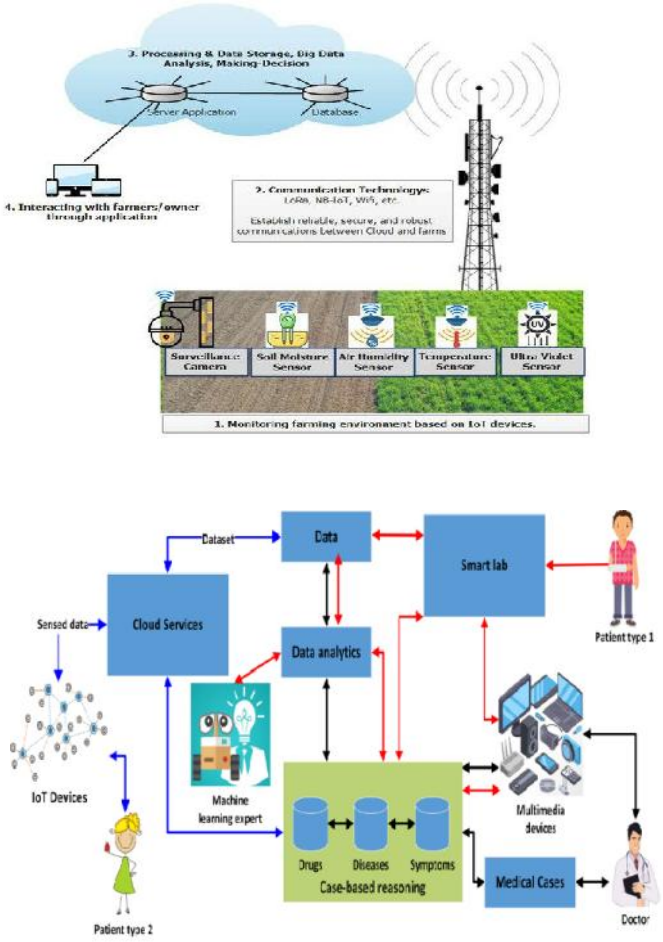

Fig4. Agriculture ofIoT [24]

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A. Agriculture Functions

Monitoring: Monitoring is necessary for managing various factors in agriculture activity, such as soil temperature, moisture, and various levels of gases such as carbon monoxide, carbon dioxide, and toluene, methane, hydrogen and isobutene, ammonia, and nitrogen oxide, which farmers must monitor[25-27][23].

Agriculture machinery: IoT based agriculture machinery that helps farmers enhance productivity and reduce crop loss by collecting data that helps them map out their next season's crop plan, such as fertilisation, irrigation, and nutrition. The farmer will get wind speed, air pressure, and other characteristics via the UAV sensor [28-29][23].

Green house production: Greenhouse production is a technique for growing plants in a controlled environment [23]. This technology creates an environment conducive to the growth of any plant in any location, allowing the farmer to grow plants in any setting that meets his needs. [23]

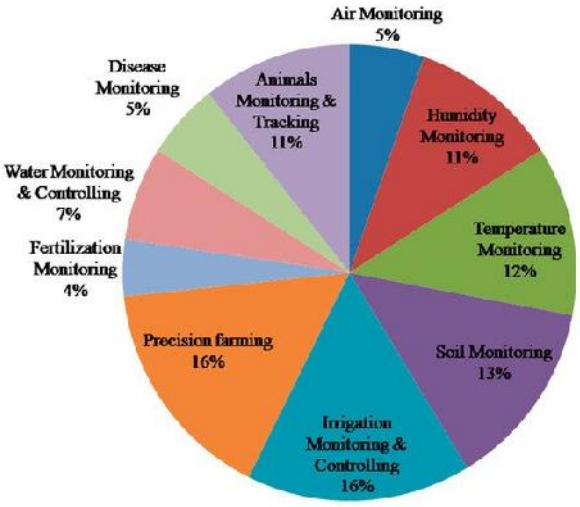

Fig.5. IoT in Agriculture [30]

Using science and technology to improve the entire agricultural process (the closed process, Applying information technology, electronics, and telecommunications to processes ranging from seed preparation, soil, and other aspects of cultivation, breeding, harvesting, processing, preservation, and distribution, to the table, using new technologies such as Artificial Intelligence (AI) to process the collected big data. The collected data must be organised into a large-scale database in order to eventually automate the entire process (i.e., eliminating human "experience" in proactively spotting problems and providing remedies) [23] [31].

B. Authors have found these future challenges are

- LPWA technology deployment: LPWA technology is particularly significant in the field of IoT because devices need to consume less energy and maintain communication with the device for a long time [23] [32].
- Universal platform: In agriculture, the platform should establish a universal platform, not a crop-specific platform, where farmers may find solutions for any crops. The farmer can secure his crops and sell them in the local market with the help of the universal platform. As a result, a universal platform is required [23] [33].
- Security: A key component of IoT based agriculture applications is security. For the IoT application to safeguard the data in the network, end-to-end encryption and decryption is required [23] [34]
- Energy efficiency: Managing energy usage in IoT devices is a difficult problem. It is necessary to investigate how to save energy during data gathering and how to transport data in a timely manner over a lengthy period of time [23] [32].
- Quality of services: The services that ensure the data transmitted to IoT devices is of high quality. This is a significant problem for open research [23][29].

- Data compression: Data compression is a technique for moving large amounts of data via a communication network. The compression technique is used to compress massive amounts of data that have been transmitted to the network's reception device (sensor). Multiplexing approaches aid in the resolution of this issue [23] [35]
- Real-time monitoring: Various types of sensors are utilised in IoT applications to monitor all IoT devices at the same time. In real-time applications, this is a difficult task. The network management protocol that allows IoT devices (Sensors) to communicate with a server database. IoT applications face this challenge [23] [36].

VIII. IoT in Automobile Industry

With advancements in smarter vehicles and accompanying infrastructure, the automotive industry is on the verge of undergoing a disruptive upheaval. The Internet of Things (IoT) lies at the heart of the automotive industry's digital transformation. It establishes links between people, machines, automobiles, auto parts, and services. Streamline data flow, enable real-time choices, and enhance the automotive experience [37]

A. Real Time Driver Monitor

Drivers are tested and assessed on their driving behaviours in order to encourage efficient and safe driving. Advanced sensor-based technologies are evolving to identify and monitor driver behaviour and fatigue levels [38][39], making automobiles more intelligent for preventing road accidents. Systems are being developed for real-time vehicle monitoring [39], which control the vehicle's speed and the driver's fatigue level to prevent accidents [39]. Microcontrollers and sensors [40][39] such as eye blink, gas, impact sensors, alcohol detecting sensor, and fuel sensors will be the major components of such a system. The GPS and Google Maps APIs are utilised to track the vehicle's location, which can then be relayed to a predetermined phone number in the system.

B. Driverless Car

An autonomous automobile, also known as a self-driving car or a driverless car [41][39], is a vehicle that is programmed to sense its surroundings and navigate without the need for human involvement. With the advancement of self-driving cars, network connectivity between the automobile and its surroundings will improve, resulting in a whole new driving experience. Once the destination is set, the IoT powered self-driving car is in charge of itself and communicates with its surroundings and oncoming traffic [42][39]. Self-driving car drivers can use their phones, computers, and other gadgets without fear of being hit.

C. Smart Parking

Finding a free parking spot can be a time-consuming and irritating experience. Smart parking will make the best use of available parking spaces, resulting in more efficient parking and improved traffic flow. Microcontrollers [43][39], sensors, real-time data regarding available parking spaces [44][39], and automatic payment of parking rates can all be used to create a smart parking system. People will be able to secure a parking spot before they arrive at the area, saving time and energy. This also helps to decrease pollution and traffic congestion.

D. Stolen Vehicle Tracking

A tracking device [45][39] placed in the car is combined with a GSM and GPS based Vehicle Tracking System, as shown in Fig.3, to monitor and track the whereabouts of vehicles [46][39]. Satellite signals will be received by a remote application server, which will then calculate position co-ordinates with latitude and longitude. These coordinates can be used to determine the exact location of the vehicle, and owners can be contacted using the GSM system [47][39].

IX. IoT in Health Care

In a healthcare setting, Internet of Things (IOT) sensors are used to assist patients and physicians remotely. To maintain track of their patients' current health status, doctors contact with them. IOT devices, on the other hand, generate a lot of real-time patient data, which makes healthcare data intensive.
Extracting valuable information from real-time data traffic in order to make appropriate patient recommendations is tough. As a result, an intelligent healthcare system must continuously analyse current health conditions and predict appropriate medications based on disease symptoms. The usage of IOT in healthcare is the focus of this research. [48]

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A. IoTin Machine Learning

In 2022, The unique ways of interaction, diagnosis, treatment, and personalization are the basic elements of such a model when IoT is employed in healthcare with the help of machine learning. IoT devices and machine learning are used in the suggested model. The Internet of Things component consists of a series of wearable sensors that collect various symptoms from patients. Simultaneously, the machine learning component is in charge of prescribing appropriate drugs for the patient based on the disease's symptoms. The spark approach is then used to simulate and manage real-time data acquired from patients via IoT devices, before distributing it on spark servers. The k-means clustering technique is used to group patients into groups based on the different forms of hypothyroid illnesses they have. It also examines which diseases people suffer from and which drugs they frequently utilise. The proper medications are then suggested to patients using prediction techniques such as Nave Bayes and random forest [48].

Fig. 7.Healthcare using Machine Learning [48]

B. IoT*in COVID-19*

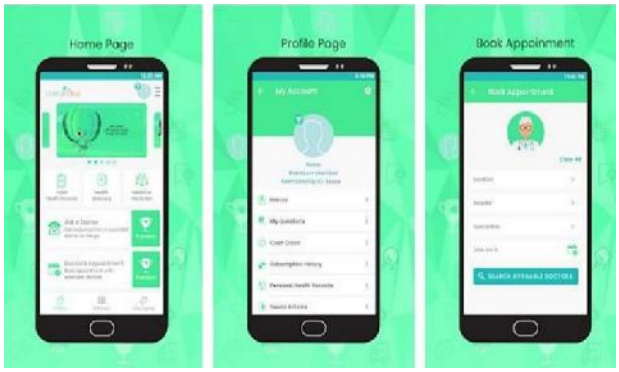
In 2021,COVID-19 cases are increasingly where Internet of Things (IOT) enabled healthcare helps to address the issues of the COVID-19 Pandemic. COVID-19 patient-related data is kept in the cloud, which can further assist in providing adequate care. This device can monitor a person's everyday activities and send out alerts if there is a health problem. [49]-[51] In the medical industry, it is critical to have the right equipment in order to run a successful surgery. IOT has a strong capacity for executing successful procedures and analysing post-surgery improvements. [52]-[55]During the COVID-19 pandemic, the use of IoT allows for better patient care. Real-time monitoring is possible due to the Internet of Things(IOT), and it saves lives from a variety of ailments such as diabetes, heart failure, asthma attacks, high blood pressure, and so on. Smart medical devices are connected to a smartphone, allowing for the seamless communication of needed health data to the physician. These gadgets also capture information on oxygen, blood pressure, weight, and blood sugar levels, among other things[56][57].

C. Rural people benefit from IoT in health care

Smart medical gadgets, mobile phones, mobile and online applications, and computers are used in Bangladesh's IoT-based smart healthcare service for rural people. Patients' health is monitored remotely by experienced MBBS doctors using IoTbased healthcare services, and prescriptions are supplied to patients online; Figure 8 shows a smartphone application for smart healthcare services [58]. Patients' physiological data is measured and delivered to MBBS

Fig. 8.Mobile application for health care service [58]

doctors online via smart medical equipment and smartphone applications. Some companies in Bangladesh have recently begun to offer telemedicine healthcare services. Few of them are solely focused on online telemedicine services based on web and mobile applications. There are only a few companies that offer IoTbased telemedicine healthcare services.[58] Introduction, operation, current condition, and challenges of these types of companies in this industry are supplied and explored in the next part.[58]



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D. Monitoring System

RASPBERRY Pi with an IoT PLATFORM: In recent years, health dangers have increased at an alarming rate on a daily basis. The global average birth rate is 131.4 million per year, with a mortality rate of 55.3 million. The world fact book and the population reference bureau were used as sources. This is a major issue all around the world. As a result, now is the moment to address these issues. By changing the diverse sensor technology, wireless sensor technology gives information about numerous wireless sensors. [59][60]It gets information regarding a person's body temperature (BT), blood pressure (BP), and heart rate (HR) (HB). This is unquestionably more accessible via the Internet's IoT platform. Any doctor can examine and analyse the patient's medical history at any moment[59]. Information about a patient's health is kept on file indefinitely. This paper describes a health monitoring system that uses wireless network technology to identify human body conditions such as blood pressure, body temperature, heart rate, ECG, respiration, accelerometer, and other data on an IoTserver [59]. If any unusual data was identified in an emergency, this system immediately delivered a warning message/call to the patient's carers, the hospital, and the ambulance. The usage of Raspberry Pi and IoT in health monitoring is effective, and this article explains both platforms. The Raspberry Pi platform, which is quite popular, provides a full Linux server on a compact base with IoT at a very low price. The general purpose I/O interface on the Raspberry provides for interface services and methods. The recommended structure is more effective when this combination is used. The Internet of Things (IoT) connects gadgets and improves human interaction for a better life[59][60].

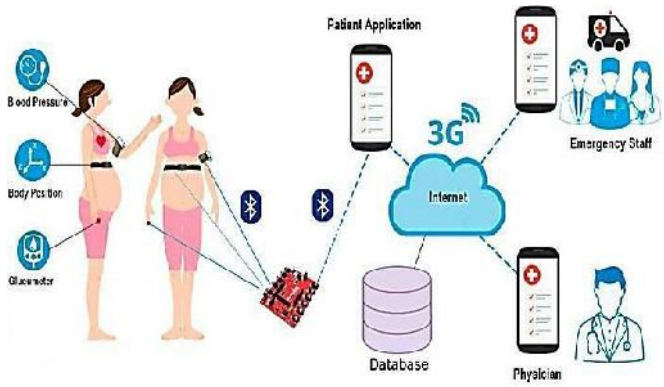

Fig. 9.Monitoring a patient with IoT [59]

X. CONCLUSION

IoT is an evolving technology that incorporates a variety of sectors and makes the world smarter and easier. It is a platform that is utilised to run numerous applications such as medical, industry, automotive, home, cities, government, and others. This paper centers around the Internet of Things (IoT), its set of experiences, and the numerous applications. IoT in the home provides smart home features that can be controlled with an Android phone and include a full security system, and IoT in agriculture provides information such as soil moisture, temperature, and humidity, as well as assisting in the detection of diseases in the soil and determining whether the soil is suitable for farming.IoTis used in the automotive industry to assist in a variety of fields such as vehicle tracking, vehicle recovery, self-driving automobiles, and linked cars. IoT in healthcare is used to track a person's health status using a smartphone, as well as to assist rural residents in finding a hospital in an emergency. The future work is to focus on developing IoTmodel for agriculture field that analysis the soil to find out what

type of crop suitable for the specified land, detection of disease in the crops that helps the farmer to spray required pesticides and also to indicate the rain fall tofarmer that helps them can make the precaution to avoid flood that affects the crops.

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