REPUBLIC OF TURKEY

ALTINBAŞ UNIVERSITY

Institute of Graduate Studies

Information Technologies

AMBIENT INTELLIGENCE AND BIG DATA MERGEED FOR WIRELESS STUDENT HEALTH MONITORING SYSTEM IN AN IOT

Salma ALHADEETHI

Master's Thesis

Supervisor

Asst. Prof. Dr. Ayça KURNAZ

Istanbul, 2022

AMBIENT INTELLIGENCE AND BIG DATA MERGEED FOR WIRELESS STUDENT HEALTH MONITORING SYSTEM IN AN IOT

Salma ALHADEETHİ

Information Technologies

Master's Thesis

ALTINBAŞ UNIVERSITY

2022

The thesis titled " AMBIENT INTELLIGENCE AND BIG DATA MERGEED FOR WIRELESS STUDENT HEALTH MONITORING SYSTEM IN AN IOT" prepared by SALMA ALHADEETHI and submitted on 20/May/2022 has been **accepted unanimously** for the degree of Master of Science in Information Technologies

Asst. Prof. Dr. Ayca KURNAZ

Supervisor

Thesis Defense Committee Members:

Asst. Prof. Dr. Ayca KURNAZ	Faculty of Engineering and Architecture, Altınbaş University	___________________
Asst. Prof. Dr. Abdullahi Abdu IBRAHIM	Faculty of Engineering and Architecture, Altınbaş University	___________________
Asst. Prof. Dr.Serdar KARGIN	Electronic and Communication, Beykent University	___________________

I hereby declare that this thesis meets all format and submission requirements of a Master's thesis.

Submission date of the thesis to the Graduate Education Institute: ___/___/___

I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Salma ALHADEETHI

Signature

ABSTRACT

AMBIENT INTELLIGENCE AND BIG DATA MERGEED FOR WIRELESS STUDENT HEALTH MONITORING SYSTEM IN AN IOT

Alhadeethi, Salma

M.Sc., Information Technologies, Altınbaş University,

Supervisor: Asst. Prof. Dr. Ayça KURNAZ

Date: May/2022

Pages: 64

Students' health and welfare depend upon the understanding of various factors related to it. The use of ambient intelligence (AmI) and the Internet of things to assure healthcare monitoring and individualized health care is an efficient and cost-effective method of doing so (IoT). Because of the vast quantity of data collected by sensors in Internet of Things systems, computational issues occur. As a result, we investigate an ambient intelligence-assisted health monitoring system using the Internet of things (IoT) that is used to monitoring student health. This system is heavily reliant on wireless sensor networks (WSNs), which play an important role. Storage of data, an effective exchange of data across the healthcare network and sustained data analysis is handled by the cloud. The proposed work provides the real time alerts with student health information with big data. This paper gives an efficient, low-cost smart health monitoring system for society by combining present technology with smart sensors in the form of wearable devices, mobile/web applications and AI.

Keywords: Ambient Intelligence, Cloud, IoT, Health Monitoring System, Wireless

TABLE OF CONTENTS

LIST OF TABLES

<u>Page</u>

LIST OF FIGURES

Page

ABBREVIATIONS

(IoT).	:	Internet of Things
(AmI)	:	Ambient Intelligence
(WSNs)	:	Wireless Sensor Networks
(AI)	:	Artificial Intelligence
(OSI)	:	Open System Interconnection
(NFC)	:	Near Field Communication Near Field Communication
(HCI)		Human-Computer Interaction
(BAN)		Body Area Networks

1. INTRODUCTION

A variety of circumstances influences students' health, fitness, and welfare, and a greater awareness of these elements ensures that students are actively involved in their health and welfare. Nowadays, ambient intelligence (AmI) and the Internet of things (IoT) are viable options for providing healthcare monitoring and individualized health care, resulting in more efficient and cost-effective medical services. In an internet of things (IoT) setting, the volume of data collected by sensors may be uncomfortable and provide a computing problem. Ambient intelligence settings' data will be acquired through wireless sensor networks (WSNs). Big data analytics will become more practical as the cloud becomes more capable of dealing with an expanding number of health data, automatically communicating information in creative ways across healthcare networks, and handling an increasing amount of health data. According to the findings of the planned study, leveraging big data to warn students about their health in real time is a significant undertaking. In 1999, Kevin Ashton of Procter & Gamble coined the term "Internet of Things," which has subsequently gained widespread use. In computing, the Internet of Things (IoT) is a network of products that have been combined with sensors, software, and other related technologies. The IoT is mainly used to interact with other devices and systems through the internet and exchange data with them. There is a wide range of complexity in these devices, ranging from simple household items to large-scale commercial and industrial equipment and technology, and everything in between. Individuals, objects/devices, and the internet all interact with one another and with the internet, culminating in the establishment of the Internet of Things (IoT).

Every way we turn, we may come across intelligent gadgets capable of interacting and cooperating with one another. Simple sensors, household items, and telephones are typical examples, as are more sophisticated industrial machines and everything in between. The term "Internet-enabled items" refers to gadgets that can connect with one another across a network (IoT). To summarize, the Internet of Things (IoT) is a network that enables dissimilar products to communicate with one another through the internet at any time and from any location, independent of their physical location. Since the Internet of Things (IoT) was established five to six years ago, academics and businesses have been closely monitoring it. It is now regarded as one of the most critical parts of the business sector. By 2020, over 50 billion Internet of Things devices are expected to be in use, with these devices likely to produce considerable income. Additionally, it is anticipated that the

IoT business would provide financial returns or revenues ranging from $1.6 trillion to $14.4 trillion by 2025, affecting almost every sector of the economy and human life, including transportation, health care, agriculture, and others. Thanks to the Internet of Things (IoT), which was established in 2010, a billion items, products, and devices may now communicate with one another over the internet. By enabling people to collect and exchange pertinent information. The Internet of Things (IoT) is generally recognized as a technique for allowing new applications via the interconnection of sensing and controlling devices running under a common operating system that allows data to be transferred across platforms. The Internet of Things (IoT) seeks to revolutionize the Internet by developing networks that can link anything and everyone at any time and from any location, with the objective of revolutionizing the Internet. This objective is achievable via the use of RFID processing capabilities, increased wireless sensor networks (WSNs), and cost-effective storage capacity. As a consequence, a highly decentralized common pool of resources will be created, which will be connected through a dynamic network. In actuality, the Internet of Things (IoT) facilitates communication between not just individual gadgets, but also between people and their surroundings. To enable IoT devices to interact with one another, unique IDs are necessary. These identities may be found in a variety of places, including automobiles, computers, books, TVs, cell phone towers, clothes, and food. Passports, bags, and other typical things are similarly protected. Individuals, corporations, and the government will all profit from the Internet of Things. Anything from assisting governments to cut healthcare costs and improve living standards to decreasing carbon footprints, opening up educational possibilities for those living in rural regions, or just improving transportation might be considered.

The Internet of Things (IoT) is a term used in computing to refer to a collection of connected networks that allow Internet-connected items to interact with one another. In popular culture, these gadgets are often referred to as 'things.' Every object in our world has a unique set of qualities.

The internet has radically changed the way people work and communicate with one another as a result of the arrival of new technologies such as 5G and new internet protocols such as Li-Fi. The Internet of things (IoT), which links several objects simultaneously over the internet, has expanded this degree of connectivity, allowing machines to communicate for the first time. This skill opened up a universe of previously unimaginable possibilities, both personally and professionally. The Internet of Things is not nearly as difficult to use as it seems, but the audience's level of technical knowledge is critical. Young individuals and their families are expected to seize the chance, whilst the elderly are expected to do so less often than the former. All data created by different Internet of Things devices is collected and transferred through IoT platforms, which link devices equipped with built-in sensors and then use smart analytics to communicate important information with connected apps that are suited to individual needs. These sophisticated Internet of Things systems are capable of discerning which data is necessary and relevant and which data may be discarded. Along with evaluating trends, making suggestions, and detecting potential risks, acquired data may also be utilized to help future decision-makers make better educated decisions.[3] Assume I own and run a sports apparel and accessories business. I'm curious as to which optional sports equipment (fishing tools, skating accessories, and skiing accessories) is the most popular among my consumers (for example, skiing accessories). By implementing an Internet of Things solution, you may be able to accomplish this goal in a short amount of time. Customers spend the majority of their time in the company's most popular locations, which may be recognized by sensors set around the shop. I can use this data to realign my company's strategic direction, to monitor which products are selling quickly, and to guarantee that popular things do not go out of stock, all while saving time and money. It is not required to be in a certain industry to profit from IoT-based ecosystems. The Internet of Things (IoT) offers a broad variety of applications that span almost every area, including but not limited to home automation, automotive automation, factory automation, medical, retail, healthcare, the military, and the financial sector.[4]. The Internet of Things (IoT), which is a worldwide network of linked devices, allows people and things to interact with one another. Machine learning and artificial intelligence (AI) may also be used to improve the data collecting capabilities of Internet of Things (IoT) devices.[2].

1.1 INTERNET OF THINGS (IOT) SYSTEM

Sensor technology enables the Internet of Things (IoT) to address, identify, and locate various equipment and objects in our surroundings. It also allows these devices to be operated remotely through the Internet via wired or wireless networks. Daily things comprise not just standard electronic equipment or technical advancement outcomes such as automobiles, phones, and other such items, but also food, animals, clothing, trees, and other similar items. The IoT system's primary goal is to allow many things to be linked anywhere, at any time, by anyone, via any path/network and facility [1]. This part offers a discussion of the IoT system's technical aspects. It starts by going into its history and how it came to be. Following that, many definitions of the Internet of Things were presented, all of which were provided by various organizations and scholars. The IoT system's structure, needed properties, applications, and problems are also shown.

1.1.1 Architecture of IoT

Many designs give different viewpoints on the IoT and its functionalities for the IoT system.

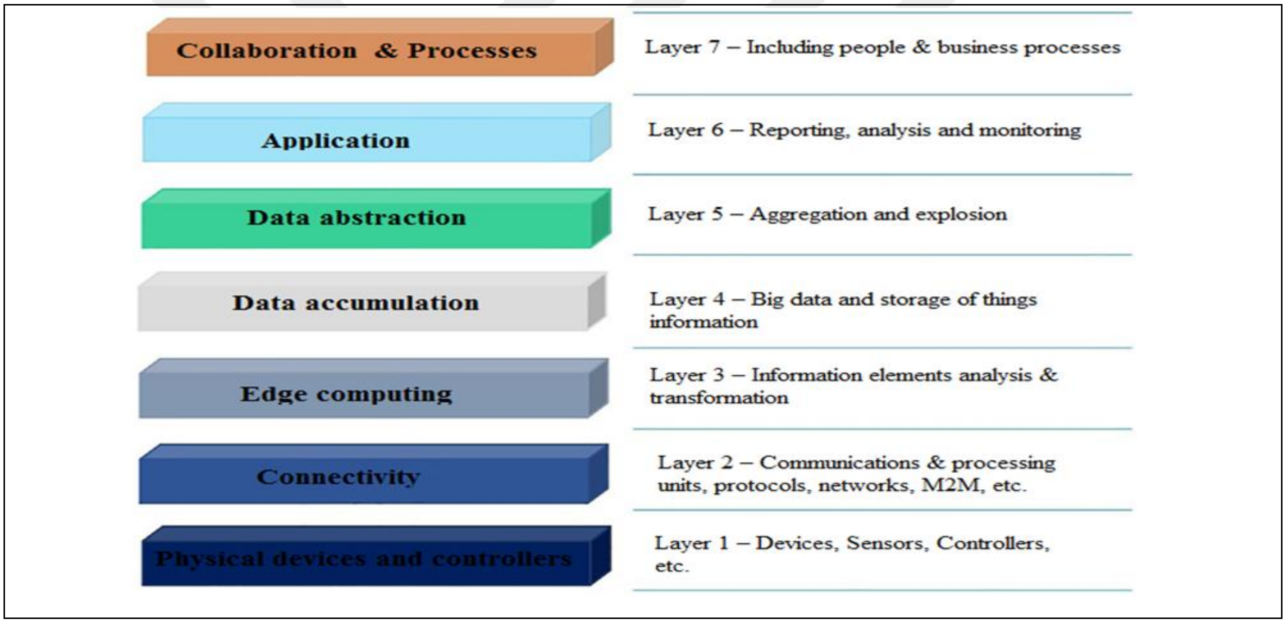

Figure 1.1: Architecture of IOT [3]

The IoT global forum (IWF) architectural committee [2] has created a more standard design for the IoT. As a result of this paradigm, the industry was able to swiftly and effectively implement IoT. Figure 1.1 shows the seven tiers of the IoT reference model, which is comparable to the network's open system interconnection (OSI) reference model in order to facilitate the affiliation and expansion of IoT deployment models. It understands where different types of processing are performed via varying levels of the IoT reference model, allowing numerous manufacturers to create interoperable IoT components that function together equitably and efficiently. In addition, this architectural paradigm transforms the Internet of Things from a notional model to a unique and accessible system [3].

a) The first layer makes up the physical layer. The hardware layer collects data from the physical environment and forwards it to the top layer. Sensors and physical stuff are both included in this layer. Data about the surrounding environment, including temperature, humidity, pressure, water quality, motion detection, and airborne dust are all collected by this layer's main function [4].

b) The second layer is connection. Using connectivity equipment like switches, gateways, and routers, this layer links independent IoT items with one another. It also securely delivers gathered data from sensors to the higher layer for securely processing.

c) Edge computing is the third layer. This layer converts information from the connection layer into data that can be stored and processed at a higher level. The processing sections at this layer operate with a large quantity of data and may conduct various data transformations to reduce the data size.

d) Data is accumulated in layer 4. This layer's primary duty is to store information received from layer 3. It absorbs a significant volume of data and stores it in storage areas that are accessible to higher levels. As a result, for top layers, it simply switches event construct information to query-based processing data.

e) Data abstraction is the fifth layer. This layer takes data from several sources and turns it into the appropriate format for applications logically and systematically [5].

f) The application layer is Layer 6. This layer is responsible for interpreting data from numerous IoT apps. Healthcare, smart cities, smart grids, intelligent homes, linked cars, smart agriculture, and other IoT applications. [6].

g) Collaboration and procedures make up Layer 7. This layer identifies individuals who are able to actively interact and cooperate in order to benefit from IoT data. Other capabilities include graph and business model generation, as well as data recovery from the application layer. It also assists managers in making proper business decisions based on their data analysis [7].

Today's world is ruled by an explosion in the use of low-cost sensor-based processing systems, which is propelling the creation of new technologies. This is only conceivable as a result of the semiconductor industry's exponential expansion. The growth of modern communication technologies such as Bluetooth, 3G, 4G, and 5G has resulted in the emergence of the Internet of Things (IoT) as a new technical enterprise. As a result, companies and end users will be able to take advantage of a varied range of simple-to-create and simple-to-deploy IoT-enabled applications. Several examples of IoT under the umbrella term include wireless sensor/actuator networks (WSNs), Internet-connected wearables, RFID-enabled tracking, mobile phone interaction with the physical world (e.g. sensing), devices with Bluetooth-enabled mobile phones connecting to the Internet, smart homes, and connected cars. Each place has unique needs, and no one architectural style can meet them all. While not ideal, a reference model that is adaptive and capable of supporting a diverse set of requirements across a diverse set of use cases is both achievable and beneficial in today's technological environment. Internet of Things solution architects may use the Reference model as a jumping-off point and foundation for further development of their concepts. Cisco, INTEL, and IBM, among others, have produced standard reference designs. Researchers and IoT enthusiasts are harmed by a lack of comprehensive understanding about IoT designs, which makes it impossible to make an informed decision. The Reference Model should not constrain the breadth or location of Internet of Things components. Each Internet of Things device may be constructed to fit into a single rack of equipment or may be dispersed throughout the world, depending on its physical layout. If we want to research and construct the Internet of Things successfully, we must look at data generated by devices rather than data generated by humans. Data is sent via the internet using the seven-layer Open Systems Interconnection (OSI) paradigm. The Internet of Things (IoT) is a paradigm shift akin to the internet paradigm in which data producers replace individuals as network nodes. The Internet of Things (IoT) was originally meant to have a three-layer design based on protocol-based architecture, but has now evolved to a seven-layer architecture based on current standards. Additionally, three-layer and five-layer designs are available. The invention of the three-layer design initiated the research process. This architecture specifies the barest minimum requirements for devices to connect to the World Wide Web. Despite this, study will continue to seek for finer details in the model, ultimately resulting in a five-layer and finally a seven-layer structure. When five-layer models are used, data transmission between the perception (from the device) and application layers occurs at the transport layer, which corresponds to the Network layer in three-layer models. According to the five-layer design, a pattern that is stored, evaluated, and processed by the extra processing layer may be used by the business layer. The exact location of the CPU layer in the architecture described above is unknown. Fog and cloud ideas were created in response to these queries. Large-scale data processing is accomplished via the use of cloud computers, which are incorporated into certain system designs. A cloud-centric architecture enables the deployment of apps and smart devices on top of and underneath the cloud. Cloud computing is gaining popularity in the corporate sector due to its high degree of flexibility and scalability. It provides a range of services, including infrastructure, platform, software, and storage. Under some conditions, developers may provide data mining, machine learning, and visualization capabilities over the cloud. Applications that are data-centric, such as video surveillance, need data processing to occur closer to the device in order to work efficiently. Sensors and network gateways are increasingly doing data processing and analytics as part of the Internet of Things (IoT). As a consequence, the Internet of Things (IoT) has recently developed into a new system architecture dubbed fog computing. There are various steps to consider when it comes to fog architecture, including preprocessing, storage, and security before information going to the cloud.

1.2 NEED OF A HEALTH MONITORING SYSTEM

Health care nowadays is a very much a topic of concern that need to be solved with quick and effective remedies. Where the major role of IOT come into scenario, where the patient can concern their respective doctor from their home and can get treated on time, irrespective of only the treatment, IOT can help the patient to take test regarding their concern issue and even share the result (report) to the person or doctor of their choice. Where the doctor can see the reports of the patient and guide them in particular concern areas, even one can book appointments for the doc visit that also online via a face time call, where the patient a consult the doctor in front of them, though sitting at home, and doesn't require to travel a long distance, which could benefit them in several ways. The basic idea of this project is a health monitoring system. It tells us about a particular person's medical parameters like a heartbeat, temperature, etc., during emergencies. It also tells us about the medical observations and remote observations. Using emerging technologies such as mobile networks and cloud computing platforms, create tailored and high-quality health monitoring. This cloud computing platform-based project framework for a health monitoring system is intended to achieve ubiquitous health monitoring.

1.3 BIG DATA

Numerous inventive Internet of Things and Big Data deployments have emerged across all facets of business and society, illustrating the technology's potential. Additionally, research reveals that the advancement of innovation and the internet have provided the learning sector with a variety of teaching, learning, and assessment approaches that may be used on and off campus, in the classroom, or in a virtualized environment. Corporate data duplication has risen as a consequence of the growth of data in social media, the Internet of Things (IoT), and structured or unstructured multimedia. This is a consequence of a growth in organized and unstructured data in social media, the Internet of Things (IoT), and multimedia. Thanks to digital technology and social media, individuals from all walks of life may now participate in online and distant education at a low cost and from anywhere in the globe. The Internet of Things (IoT)[1] has significantly aided the big data environment by increasing the amount of data collected and made accessible. As a consequence, big data analytics has run into difficulties as a result of the processing and collection of data by a high number of sensors in an Internet of Things context. Recent study indicates that the Internet of Things (IoT) and Big Data are inextricably linked. In other words, the Internet of Things (IoT) is both a massive source of big data and a powerful instrument for optimizing IoT operations and services via the application of big data analytics methodologies. Big data is described as a large volume of data that needs the application of advanced analytical techniques in order to extract useful information. The Internet of Things (IoT) is a technology that enables data to be transferred across many kinds of devices that are linked to the internet through a network of cables. According to research, the big data business will grow to over US$125 billion in sales by 2019. The Internet of Things is expected to grow at a rate of up to 7.1 trillion dollars per year by 2020, while the market for sensory devices is expected to reach 190.6 billion dollars by 2021. With a trillion sensors, the Internet of Things will become the primary source of Big Data's most critical data, including heterogeneity, variety, and unstructured data. This is a problem for Big Data because of the Internet of Things' need to link sensors and other equipment to the Internet, which provides context data. Additionally, the marriage of Big Data with IoT results in Big Data processing being enabled for IoT data, which results in the creation of new IoT solutions[1]. IoT According to current study, Big Data has the following characteristics: Numerous terminals create vast volumes of semi-structured or unstructured data, and the data produced is crucial once analyzed. Due to the growing use of smart devices, the Internet of Things enables any gadget to connect with other gadgets worldwide, and the server may be given at any moment the user chooses (IoT). Throughout this time span, the present explosion in big data has led in a fast digital transformation of society, with several successful implementations occurring globally. In comparison, the Internet of Things (IoT) and big data have made significant contributions to digital transformation via the creation of a number of creative applications that have been adopted by a diverse range of enterprises and social organizations. Integrating Big Data and Internet of Things technology has the potential to benefit not just smart cities, but also academic research, which is an incredible opportunity. Numerous research on big data and Internet of Things (IoT) technologies have been undertaken.

1.4 IOT BASED SMART HEALTH MONITORING SYSTEM

Internet of things (IoT) is a promising next-generation technology which interconnects network of smart devices [8] [9]. IoT provides solutions to the real-life problems in traffic management, industries, emergency services like healthcare sector [10]. Specific methods and architectures in IoT can be used as a base to enhanced healthcare systems. In order to implement cost effective interoperability between devices, applications and systems, open-source platforms and operating systems can be of help enhancing characteristics of healthcare system. Various open-source tools can be utilized to ensure quality, security and availability in current systems and to build new systems [11]. These IoT based systems make use of compatible and regularly wearable devices for alerting and coaching. Mobiles are the best instruments that can be used to monitor and collect the data by using inbuilt sensors in it. Healthcare systems are essential tools for medical treatments and continuous patient monitoring irrespective of the issues like availability, reliability, performance etc. associated with it [12].

IoT is being called the next technology revolution because of its ability to connect anything in the last decade. Smart parking [15], smart housing [16], smart city [17], smart climate [18], industrial places [19], and agricultural regions [20] are a few examples of IoT applications. Continuous health and environmental monitoring is a critical IoT use in healthcare management. Using sensors and networks, the Internet of Things (IoT) connects computers to the Internet [21]. Health monitoring systems might make advantage of these interrelated components[22]. [23] The data is sent using M2M technology, which includes computer systems and mobile devices such as smartphones. Monitoring and enhancing therapy for any health problem is now easier and more efficient thanks to this technology. By offering a configurable user interface [24], assistive gadgets [25], and mental health management, modern technology today helps individuals live a smarter life [26].

The heart rate and body temperature are the two most essential indices of human health in the modern day. The heart rate of a person is measured in beats per minute, which is often referred to as the pulse rate of that individual. It's possible to tell how fast your heart is beating by how much blood is flowing through it. Between 60 to 100 beats per minute, a person's heart rate is considered healthy. As adults, men and women have a resting heart rate of 70 beats per minute (bpm) and 75 beats per minute (bpm). Using scientific methods, researchers have determined that the temperature of the body is a function of how much heat is released by the body. Body temperature is influenced by factors such as the weather, gender, and dietary habits of the typical person. In healthy people, the temperature is most likely to be between 97.8 °F (36.5 °C) and 99 °F (37.2 °C).

A decline in body temperature may be caused by the flu, low-temperature hypothermia, or any other condition or illness. Having a fever may be a sign of practically any disease [28]. Heart rate and body temperature may be determined using invasive or non-invasive techniques. Non-invasive techniques have proven accurate and convenient for clients over time [29]. As a healthcare facility, it is recommended to offer patients with comfortable room arrangements. [30]. Room humidity, CO2 levels, and other gases may all influence the quality of a room's atmosphere. Toxic gases and certain humidity levels endanger patients. For best comfort, the humidity level in the room should be between 30 and 65 percent. Some research [31] [32] is undertaken only for a smart home as opposed to committed healthcare.

Heart disease [33], diabetes [34], breast cancer [36] [37], liver disease [38], and other severe medical conditions are only a few examples. As far as our system is concerned, the most important goal is to monitor the fundamental symptoms of all kinds of patients and their surroundings. Using a patient's pulse and body temperature, this study suggests a personalised healthcare system, ambient humidity, CO, and CO2 gas levels using sensors. It transmits data over Wi-Fi, enabling medical workers to access it. Aside from modifying critical health-related criteria, the suggested solution overcomes the difficulty of maintaining a single patient database at hospitals by leveraging a web server.

A remote health monitoring system, which operates as an extension of a hospital's medical system, It is possible to monitor the vital physiological condition of a patient from a distance. Detecting systems were formerly accessible primarily in hospitals and were distinguished by large, complicated circuitry that needed a significant amount of electricity to run. Sensors are becoming smaller, quicker, less power-hungry, and more inexpensive as semiconductor technology advances. Recent years have seen advancements in the area of remote monitoring of patients, particularly the elderly. In the following circumstances[5], it may be required to implement a remote health monitoring system:

Patient X has a medical ailment induced by an unstable regulatory body system. This is critical when administering a new drug to a patient for the first time.

a) A patient has a history of heart attacks or is at an increased risk of experiencing one in the future. When vital signs of the body are monitored, it is possible to be notified when any anomalies are identified.

b) Vital organs in the human body

c) These are the elements that contribute to the development of a potentially fatal illness or injury. This service is available to the elderly and individuals whose health is deteriorating.

d) Athletes in the middle of a workout.

The purpose of this research is to determine the most effective training programs. Numerous technologies have been created in recent years to address the issue of remote health monitoring. This wireless detection system transmits sensor data through radio waves to a distant server, where it may be examined. Numerous businesses have even embraced a subscription-based service model. This is a problem in developing nations, since many people are unable to take benefit of them owing to their high cost. Additionally, the availability of high-quality internet connections is a concern, since many gadgets need real-time remote access through high-speed internet. In undeveloped nations, internet connection is still a challenge. Many of these technologies were created in industrialized nations, such as the United States. It is customary for systems to be adapted for usage in underdeveloped nations. If the remote detection technique is designed with the very minimal resources available in underdeveloped nations in mind, these difficulties may be mitigated[5]. The amount of parameters detected by a patient monitoring system may be used to approximate a simple design. Certain scenarios may need the simultaneous detection of many parameters.

The following factors influence how easily parameters may be detected:

A. The electrocardiogram (ECG) measurement is the sole parameter monitored in this scenario. Depending on the technology utilized, it is possible to get several readings from an ECG or the detection of heartbeat. An ECG may be used to determine a patient's heart rate and oxygen saturation.

B. It is a multi-parameter monitoring system that simultaneously monitors a large number of parameters. This kind of technology is used in high dependency institutions, intensive care units (ICUs), operating rooms, and post-operative recovery units in hospitals. The electrocardiogram (ECG), blood pressure, and respiratory rate are only a few of the indicators measured. The multiparameter monitoring system ensures the patient's survival to a substantial extent. When they are no longer needed to engage in their typical job routines, the bulk of the senior population in developing nations relocates to rural regions. It is feasible that industrialized nations will provide assisted living facilities. In this case, a remote health monitoring system may be beneficial.

1.4.1 IOT Application in Healthcare

Applications aimed towards improving people's health and well-being are highlighted in this area.; they are separated into two categories: general and clinical applications.

a) Healthcare

Increased healthcare costs, as well as the increasing availability of innovative personal health gadgets, have accelerated the Internet of Things concept in connected healthcare. As new technology tools become accessible, the notion of linked healthcare expands. With the use of IoT and current technology, a fitness app may be built that automatically prompts patients to check their blood glucose levels in the morning and records the results. According to the connected healthcare vision, patients are individuals who take responsibility of their health, leading to a better bodily and emotional well-being, as a consequence of their implementation. Enabling an Internet of Things (IoT) realistic scenario in health care adds to better health management and control as well. Because of the Internet of Things, doctors will be able to respond swiftly in a crisis and collaborate with hospitals all over the world to monitor a patient's state. Home monitoring, particularly for senior persons with special requirements or severe conditions such as diabetes or heart problems, uses IoT applications. Other IoT applications include patient's information, that aims to avoid unpleasant events for patients, as well as the management of fully digital medical data. [Rghioui and colleagues, 2016]. In the medical area, the Internet of Things relies on RFID tags to permit quick and precise detection of every intelligent creature, allowing global and quick access to personal health data via the Internet.

b) People with disabilities

External or internal (implanted in the ear) hearing aids may assist people who are very noisy. Wireless, low-cost gloves, on the other hand, are intended to allow the deaf to speak with persons they are unfamiliar with. Hand signals are recognized and transformed into verbal communication with a Java-enabled monitoring center (mobile phone). Bend sensors (passive resistive devices that detect bending or flexion) are included into the glove's fingertips. Individuals with visual impairments shop on their own in another circumstance. They can find their way inside a shop using the blind navigation technology. RFID technology may be used with software to assist visually challenged people when shopping. The store is organized into compartments, each with its shelf. RFID tags may be seen scattered across the floor. The individual with a vision impairment may choose which supermarket department to visit using the module monitoring station (smartphone).

Car components are also being monitored and controlled through the Internet of Things. As early as 2014, Ford and Intel collaborated on face recognition research and the development of a smartphone app. Automatically boost privacy characteristics depending on individual choices by identifying different drivers [39].

c) Tracking and monitoring of objects and persons

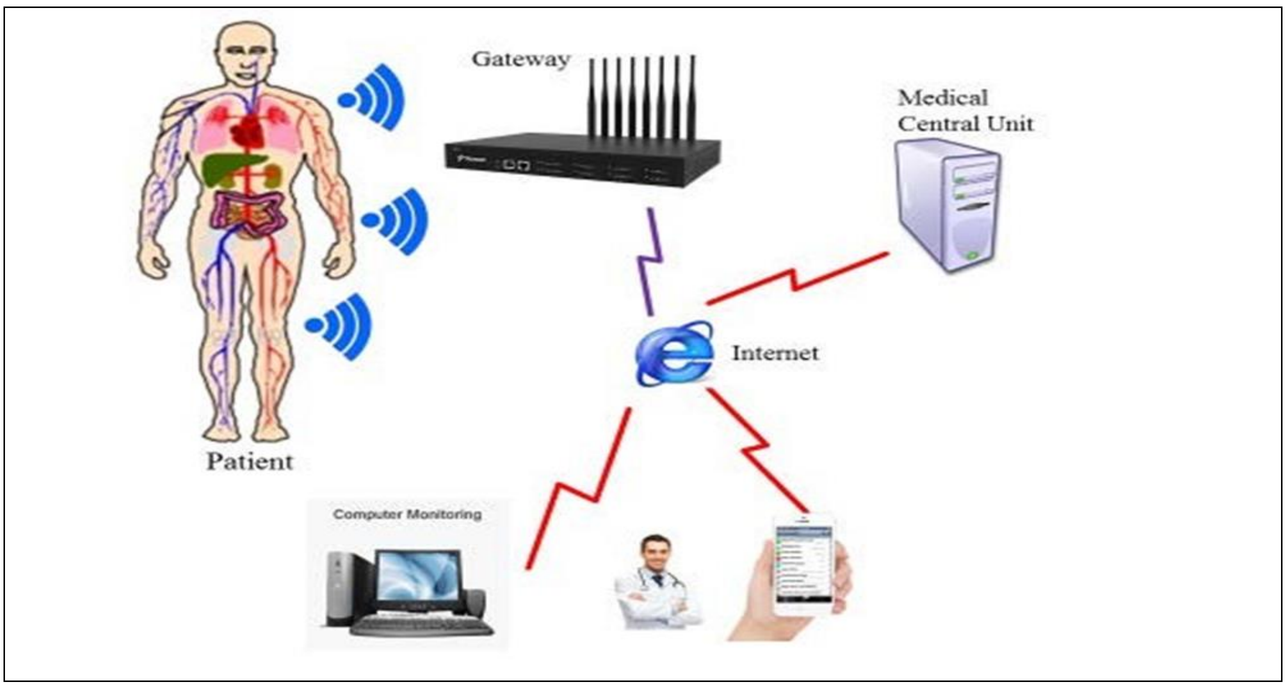

Figure 1.2: IoT Healthcare Monitoring System [40]

Monitoring is a function that seeks to identify a person or an object moving [40]. Patient management tracking and monitoring in health to boost hospital workflow and motion detection via critical locations access to certain locations, for example. ; More often than not, follow-up is used rather than a permanent collection of monitoring data (for example, for maintenance, availability in an emergency, and use monitoring) and material tracking to reduce operational risks.

d) Identification and AUTH identification

The registration of patients is used to minimize malignant patient instances (e.g., incorrect drug/dose/time/procedure) as well as the identification of the entire and current medical file. In terms of staff, recognition and verification are mainly used to allow access and increase employee satisfaction focusing on the safety of patients. [41].

e) Transport and Data Collection

A variety of Bluetooth short-range wireless technologies, including Near Field Communication (NFC), ZigBee, and Bluetooth Low Energy, are currently being used to link personal health equipment (BLE). The objective of data exchange and automated data collecting is to minimize the time required to complete forms and simplify healthcare systems' care, examination, and monitoring. Additionally, this function pertains to the usage of RFID technology.

f) Clinical Care

Sensors will enable hospitalized patients to walk freely across the clinic, unrestricted by particular rooms or equipment. They will alleviate the hassle of moving from one place to another for examination and analysis. It will aid caregivers by enabling remote monitoring of the patient's health and cross-disciplinary collaboration to study their situation. Additionally, physicians would save time by avoiding the necessity to switch patients to ascertain their health state. The ability to react promptly in an emergency and coordinate with foreign organizations to track the development of a patient would be greatly enhanced as a result.

1.5 AMBIENT INTELLIGENCE

Refers to the combination of IoT sensors, sensor networks, and human-computer interaction (HCI) technologies powered by pervasive-ubiquitous computing, big data and artificial intelligence frameworks. This technology paves way to a futuristic world where sensors, embedded in everyday use devices will create an intelligent environment that adapts to the user's needs and wishes seamlessly.

Ambient intelligence can be leveraged in a wide range of technologies viz., biometrics, affective computing, RFID, Bluetooth low energy, microchip implants, sensors like the thermometer, motion detectors, photo-detectors, proximity sensors, and nano-biometrics. The sensors will gather data that shall be interpreted and analysed to adjust or predict user expectations.

AmI systems have the ability to significantly improve the healthcare area. Ambient intelligence technology, for example, can be used to assess the health of seniors or persons with chronic illnesses, as well as offering supportive care for people with physical or mental disabilities. It can be used to create persuasion services that encourage individuals to live healthier lives. It can also be utilised in therapeutic settings or to improve people's overall health. Finally, it can assist healthcare providers by offering innovative communication and monitoring tools. These systems will enable health monitoring efficiently and transparently. Figure 1.3 shows how AmI systems can be incorporated into various contexts and devices as coherent services.

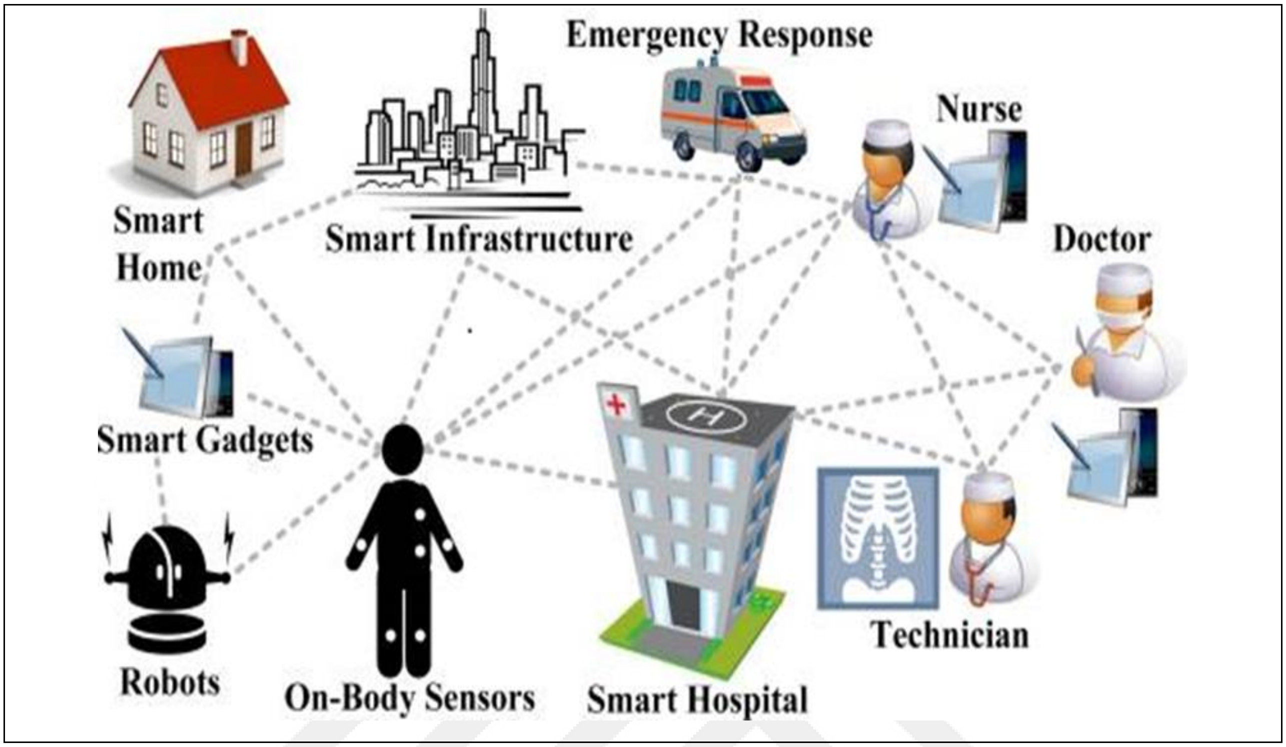

Figure 1.3: Interconnected world of AmI health services [42]

Ambient intelligence-powered environments have the following characteristics:

a) Awareness of the presence of individuals

b) Recognition of the individual's identities

c) Understanding of the contexts

d) Recognition of activities

e) Adaptation to the needs of people who change over time.

1.5.1 Wireless Sensor Networks in AMI Systems

In order to improve the AmI environment, WSNs (Wireless Sensor Networks) are an essential technology. They allow users to get services depending on their location, which helps to improve the AmI environment. These networks offer a sophisticated and adaptable framework for delivering data from background sensors and other sources. The AmI services are developed utilizing the data that has been supplied, as well as information gathered from the data management sensors system. The WSN enables the collection of data about the environment and the user.

The WSN's most notable feature is its ability to wirelessly communicate data collected by sensors in various surroundings to other sites for processing. Because there are so many nodes in the WSN, This kind of node must have particular design features in order to work successfully, such as low power consumption, compact size, low cost, and minimal complexity, among other things. When developing a WSN, the network architecture and principles are taken into consideration in order to simplify node performance and minimize power consumption to the greatest extent feasible, according to the specifications. The star topology is often used in the construction of wireless body area networks (WBANs) [43]. The BAN is formed up of tiny units that send important signals to a doctor or hospital[45] when they are needed. There are several applications that make use of the BAN to monitor the patient's condition, including the Mobi Health monitoring system for vital signs [44], in which ECG, blood pressure, respiration, and temperature sensors are all included, as well as Bluetooth communication between the central device and the intra-BAN [46].

The AmI paradigm offers a strategy for providing information to social services and customers by embracing Internet services. The user and the system intelligence may access services, allowing for automated service delivery. The user will use interfaces to interact with the services. Consequently, If you are going to execute services based on this paradigm, you will need to identify the user context first, which will need the implantation of sensors in the patient's body as well as in their immediate surrounding surroundings. Using the use of AmI services, it is possible to compromise the selected service through natural interfaces, therefore gaining this power. These networks must also be compatible and connected with local, personal, and other network settings. Traditional healthcare is available at hospitals and medical centers. Finding active ways to improve healthcare has become a difficult challenge for the scientific community. One of the critical requirements is post-surgery surveillance. Patients also need to be able to contact their doctors reliably. Traditional treatments for these elements, on the other hand, are cumbersome, expensive, and inefficient for patients who need periodic examinations. As a result, the primary goals of E-health are to increase the quality and effectiveness of health treatment. In order to provide personalized healthcare and healthcare monitoring, the AmI environment has become essential for directing healthcare services from a hospital to the home. Anxiety disorders may be treated using virtual reality and computer-aided surgery systems [47, 48]. AmI has worked on several healthcare initiatives [48].

For patients, AmI provides a link between their daily lives and their electronic health systems through wearable medical devices and intelligent environments software. Environmental and user-supplied data such as ambient temperature and light levels and physiological data like pulse and blood pressure constitute part of context. Wi-Fi, Bluetooth and Radio Frequency Identification are just a few of the WSN technologies used to gather the requisite AmI data (RFID). The development of AmI systems needs dynamic artificial intelligence-based approaches and mechanisms (AI).

1.5.2 Application of AmI

a) Data analysis for health AmI environments

b) Behavior analysis in AmI to assist living environments

c) Mobile devices and wearable systems developments in activity recognition systems

d) Ubiquitous healthcare applications

e) Machine learning techniques supporting disabled people in AmI systems

f) Monitoring of chronic diseases in AmI environment

g) Physiological data acquisition system in AmI environments

h) Privacy and security in AmI systems

i) Big data, data management and sensing in AmI environment

j) Smart homes based on AmI systems

k) AmI in intensive care units

AmI is being heralded as a new paradigm for future information society applications, Interactive interfaces that are capable of providing intelligent services depending on the context of the user's interaction Ambient intelligence is becoming more important in the healthcare industry. In this thesis, we study ambient data in it based wireless student health monitoring system. In this thesis, we study ambient data in it based wireless student health monitoring system.

1.6 PROJECT CONTRIBUTION

Figure 1.4 depicts the recommended methodology. There are three phases to the IoT-based smart student impacting healthcare system framework. In the first phase, data on student health will be collected from medical equipment and sensors. Using a gateway or a regional processing unit, the obtained data will be transferred to a cloud subsystem (LPU). Medical metrics will be used by the medical diagnosis system in phase 2 to make a cognitive conclusion about student health. In phase 3, parents and caretakers will receive warnings about their children's health. Furthermore, if an emergency situation arises, an alert will be sent to a local hospital so that the medical issue can be handled.

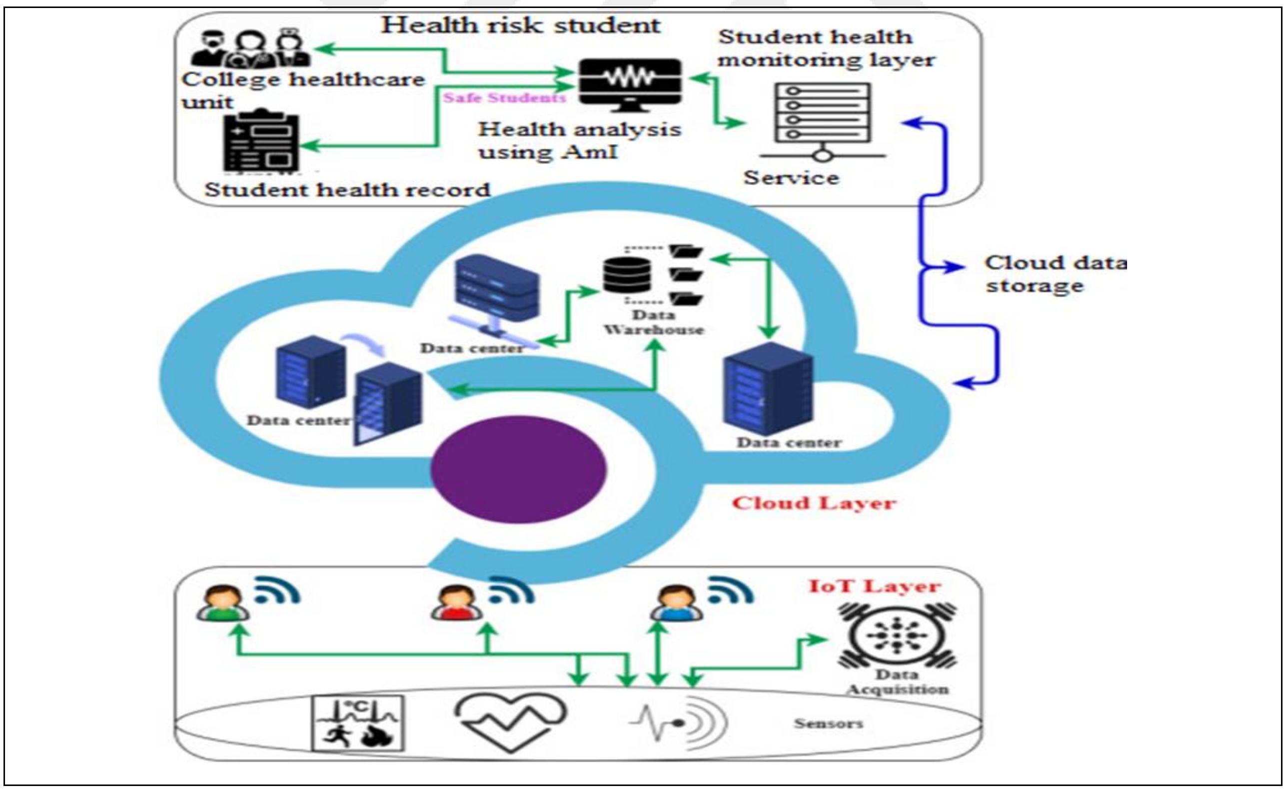

Figure 1.4: Architecture of IoT Based Ambient Intelligence Assisted Health Monitoring System [49]

1.6.1 IoT Layer

The proposed architecture is multi-tiered, with component clearance at each level (node, gateway, and cloud) to monitor and respond autonomously in the event of a module vulnerability. The diagram illustrates a structure based on the typical centralized notion. However, utilizing the gateway as a major element introduces decentralised structure aspects. This is due to the fact that each node has just one interaction link. This means that the gateway will monitor and manage any connections to other nodes. As a result, local resource control is possible, with the cloud module functioning as a controller. In an IoT security architecture, it's important to have a secure infrastructure that allows data from end-point sensors to be sent to cloud services in ambient intelligence apps.

1.6.2 Cloud Layer

The cloud, a supplier of infrastructure as a service, stores student health data (IaaS). The data was captured and retrieved consistently across time. Consequently, a cloud storage repository is created at the server level to store data and facilitate optimal cognitive decision-making. Secular mining is used to gather health data, subsequently sent to a medical diagnosing system. A deliberate student health index is employed and a diagnostic approach to identify the degree of disease.

1.6.3 Student Health Monitoring Layer

The data collecting system provides students with real-time health information. This allows for the easy and continuous integration of intelligence, low-power sensors on a small scale, and other medical devices. To monitor body function, these sensors are strewn throughout the human body, on it, and surrounding it. In our suggested system, a person's body sensor network in the school setting is made up of both wearable and implanted sensor devices.

1.7 OBJECTIVES

a) Using IoT devices, construct an ambient intelligence aided health monitoring system (AmIHMS).

b) To maintain student health, stability and to improve academic quality

c) Test the system setup in simulation and improve the reliability, data accessibility, and accuracy compared to other methods.

1.8 OUTLINE OF THESIS

Chapter 2: This chapter provides an overview of Internet of Things (IoT) technology and their applications in the healthcare sector, as well as some promising research fields and additional studies on IoT in healthcare.Chapter 3: This section presents the methodology of ambient intelligence in IoT based wireless health monitoring systems.Chapter 4: In this chapter, discuss the result and check the reliability and accuracy of this method Chapter 5: This chapter explains the conclusion.

2. LITERATURE REVIEW

The Internet of Things (IoT) provides new methodologies, structures, and solutions for improved healthcare systems and the ability to enhance medical procedures in order to provide more personalised care Opening up open-source platforms and operating systems to the healthcare industry may benefit the industry by enhancing the quality of care, security, and availability. They may be able to improve the development and efficiency of healthcare systems via the use of enablers like as devices, applications, and approaches. There will be more interoperability, and the cost of maintaining and controlling varied device networks will be lower. There are currently a plethora of open-source technologies accessible that provide safe and cost-effective platforms for creating and prototyping revolutionary healthcare systems. These might be Internet of Things-based devices that are compatible with smartphones and smartwatches, since these are commonplace in everyday life and valuable tools for giving alerts and active coaching. Several sensors are now available on mobile devices, enabling for real-time monitoring and data collecting in order to enhance medical treatment options Despite all of the benefits of healthcare systems,, issues like availability, reliability, mobility, performance, scalability, and interoperability remain unresolved. Such healthcare systems are required to make medical treatments and supervision easier.

Healthcare systems should encourage strong security measures for reliable operation during regular supervision of patients. Users' rights should be safeguarded with certain rules and regulations. Safe and trustworthy infrastructures with strong ethical base acknowledge the use of encryption techniques and security measures to make systems invulnerable to cyber-attacks [50] [51].

The rapid growth of healthcare services has generated a large amount of complex and diverse data creating design problems on access and structure of this data. So extra work must be done to provide a uniform standard and unified programming interface for management of diverse data and service objects [52].

Data transmission and sharing can be done within the framework via Internet with the help of wireless communications technologies. The protocols like Bluetooth and Zigbee can be used for point-to-point communication and 3G/4G for the network. To develop systems that are accessible anytime and anywhere, remote access to collected data using the Internet should be provided. With their sensing and processing capabilities, the mobile units can be used for real-time patient monitoring offering behavioral recognition, alert generation for the medical team and caregivers to avoid any unwanted situation ensuring patient well-being. The design and development of open-source technologies is required irrespective of limitations of AI [53] [54].

Interoperability in IoT needs to follow certain communication protocols which is important for healthcare systems where availability anytime anywhere is a must. Patient monitoring is done through different IoT layers including software and hardware so that the service can be distributed and provided anytime and anywhere. This can be achieved with the inclusion of mobiles in the healthcare environment. Services without interruption except from change in gateways can be guaranteed with mobile compatible platforms extensively [55].

Interoperability and scalability are of utmost importance in continuous improvement and increase in the performance. Interoperability between IoT devices, services with different platforms, and data management techniques can be provided. The healthcare systems generate large amount of diverse data in diverse format making data extraction complex. The data heterogeneity issues can be resolved with interoperability. Thus, IoT developers and constructors should consider interoperability for performance improvement [56].

The sensing technologies decide the design and configuration of healthcare sensors specifically, wearable sensors like EGG, ECG, etc. [57]. We commonly position these sensors on the wrist, waist, hand, and/or chest in order to capture data as quickly and efficiently as possible. Built-in sensors such as the GPS, camera, and microphone are utilized to collect data from mobile devices at the same time, allowing for more efficient data collection. Additionally, mobile devices may be employed as processing units for analyzing the data that has been collected. Activity recognition and monitoring can be done using assistive robots with ambient sensors. [58].

2.1 INTRODUCTION

Developed a personal health diagnosis based on analysis of disease and its risk from large data. Franca discussed that continuous patient monitoring and efficient medical staff has made revolution in the development of healthcare systems [59].

Developed an approach in which the data of patients from across the different parts of the world was accessible to medical staff and healthcare systems in order to create alerts for precautionary measures taken by staff [60].

States that the retrieval of diverse data collected from wireless sensors in systems can help to build real time applications. Emergency healthcare services can be offered to patients through IoT techniques with the help of mobiles [61].

Discussed remote monitoring of patient can be done by adopting a health monitoring system for patient under frequent hospital visits or long-term illness. It alerts medical staff in case of emergency and ensures services anytime anywhere [62].

Table 2.1: Comparison of Literary Review

Reference No. and year	Research Problem	Explanation
[63], 2015	The research proposed the vitality effective long haul ceaseless personal health monitoring framework.	This outcome gives the review of huge hole among the vitality and capacity necessity for persistent monitoring and abilities in current gadget improvement. For the improvement the presentation of the framework dependent on sensor based innovation overhead the remote transmission and security issues of the information.
[64],2016	This examination proposed improvement of intelligent healthcare wear framework hic are utilized obtain the essential sign towards the monitoring of personal health	This research gave the proposed framework to monitoring and examining the essential signs which used in the savvy healthcare framework utilizing the bio-sensor framework. This framework actualized a major information stage based on fundamental sign and Hadoop based innovation. This framework is checked the clinical data and physical exercises of the patients.
[65] 2017	This exploration structure and model of personal health the executive's framework utilizing the remote system used on the standard cell phones.	The research made a model for remote based health monitoring framework towards the ECG and heart rate monitoring. This framework is control and overseen utilizing the smartphone. The proposed models are valuable for the ECG and heart rate monitoring framework.
[66], 2018	This examination proposed a smart personal health council (SPHA) for complete and wise health monitoring and direction.	The proposed model is proposed to assess the general health status of the client. At last, a tried for check of achievability and appropriateness of the proposed framework was created. The trial and reenactment results have demonstrated that the proposed approach is effective for legitimate client state monitoring.

2.2 IOT BASED HEALTH MONITORING SYSTEMS

Since the improvements in mobile technology and information and communication technology, several innovations in the healthcare industry have happened, and this is just the beginning (ICT). The capacity of remote patient monitoring was quite well serviced by wireless and ubiquitous

[67] ,2019	Study has taken the advanced mobile phone based personal healthcare monitoring framework and proposed the framework utilizing smartphone towards the health monitoring.	This exploration proposed the overview on past examination has been done in the territory of personal health monitoring framework. Proposed and tried the smartphone based gadget towards the monitoring.

sensing technology. Pharmaceutical companies in the healthcare sector Developed by [68], the Internet of Things (IoT) is a method for real-time health monitoring. In terms of reviewing healthcare data and reducing mortality, the suggested method has great promise. To gather patient data, this system made use of a variety of medical equipment and sensors. Researchers claim to have devised a technique of securely transferring patient data to cloud robots, where it can only be accessed by healthcare professionals with the appropriate credentials. In addition, measures such as signal amplification and watermarking have been included into this framework to protect health professionals' information and prevent clinical mistakes. [69] the Internet of Things (IoT) has made use of basic technological components in the form of body sensor networks (BSN). Patients in this network might be monitored using a network of tiny, light, powdered sensor networks. Furthermore, a secure IoT-based healthcare system, BSN-Care, was developed to enable comprehensive security services that protect patient privacy. [70] analyzed the cost, accuracy, and data security of a real-time health monitoring system for distant cardiac patients. The technology was designed to create a two-way communication link between the doctor and the patients. Furthermore, to improve the functionality of the proposed model, alert messages are sent to remote patients in critical moments.

Gelogo et al., (2015) The Internet of Things was used to construct For the urban health-care system, a non-invasive monitoring system was developed. As part of this method, an integrated u-healthcare architecture is defined, which includes an area network, an intelligent medical server, and an integrated hospital system. For the aged and disabled, [70] created a people-centered sensing system. The technique's purpose was to offer a service-oriented emergency response if a patient's condition became abnormal. [71] designed a crisis condition monitoring system based on context motion tracking for patients with chronic conditions. Based on contextual information, the system evaluates the patient's current condition and offers essential information by studying the patient's daily behaviors. Conducted a study on recent developments in IoT-based healthcare solutions. They looked at the most up-to-date network architectures/platforms, apps, and IoT-based healthcare solution trends [72].

Using a conceptual data model [73] In IoT systems, the issue of data format heterogeneity was addressed. In addition, a strategy for resource-based data accessing was created to gather and analyze Internet of Things data on a global scale, hence increasing the accessibility of IoT resources It was also shown how to capture, integrate, and flexibly interoperate IoT data via the use of an IoT-based system for dealing with medical situations. Home Health-IoT is an intelligent home-based platform that promotes health, was designed and validated. This platform contains an intelligent medical platform built on an open platform with better connectivity for various devices and services[74]. The proposed methodology also includes smart pharmaceutical packaging and bio-medical sensor-enabled devices. Eco Health, a Web middleware platform for linking patients with doctors via wearable body sensors, was presented by [75]. This platform combines data collected from a variety of sensors. Using Internet standards, this information was then used to transmit real-time notifications about the patient's status and vital signs. [76] Presented a mobile health interconnection framework based on the ubiquitous sensing capability of IoT devices. They demonstrated technological advancements that will enable health monitors and patient devices to connect to the Internet.

2.3 MINING METHODOLOGIES IN IOT HEALTH ENVIRONMENT

A feasible method for obtaining health statuses and identifying probable illness from health settings acquired It has been suggested to use personal Internet of Things devices[77]. They created a prototype of a disease diagnosis scheme by converting physician illness detection methodologies into machine-readable representations and then testing it. A novel strategy for distinguishing the similarity of two multi-attribute time series was provided by [78] that relied upon the modification of Smith-Waterman, a well-known bioinformatics tool, to identify the similarity of two multi-attribute time series. The use of this approach for reviewing sensor data helps to resolve data ambiguity and aggregation challenges. The researchers combined data from an electronic health record with non-wearable sensors implanted in a Tiger Place condominium in the United States in order to test their theories.

MDL is an unique feature finding approach for large-scale time-series presented by [79]. Patterns are similar sequences or patterns that are frequently seen in cardiac patients' ECGs and play an important role in understanding their patterns. Furthermore, this approach enhances the reuse of current data by utilising the relationship between existing and newly incoming data. [80] This article discusses and illustrates the first and most up-to-date techniques and algorithms for processing data Because of the use of wearable sensors in the field of health monitoring. Analyzing continuous time series data from wearable sensors, anomaly detection, prediction, and decision-making were used. The Support Vector Machine, the Decision Tree, the Gaussian Mixture Model, and the Hidden Markov Model, among others, are among the most well-known machine learning algorithms in the health care industry (HMM). A new Internet of Things-based Intensive Care Unit patient monitoring system was unveiled by (ICU).[80] These challenges were addressed, including the efficient evaluation of multiple events with temporal links and the development of a technique for providing time-sensitive alerts in a timely manner. Previously, researchers were unable to come up with an appropriate method of communicating time-sensitive information on student health to caregivers or doctors in a timely manner. As a result of this defect, the suggested technique delivers time-sensitive remote patient health information to caregivers or healthcare experts. The notion of temporal extraction was used to the creation of a student health index, which was then followed by the implementation of an alarm production system.

After literature survey on previous research papers, it was found that the all previous methods neither straight forward or nor cost capable and low accuracy. Therefore, ambient intelligence health monitoring with IoT based system is proposed. This system is more reliable, data accessibility and more accurate compare to other system.

This study addressed the concept and outline of increasing empowerment via the Internet of Things by focusing on three fundamental pillars of society. Intelligent gadgets, sensors, and online and mobile apps include health, education, and wealth. In this study, With the use of a block diagram, we demonstrated how low-cost and practical solutions such as "smart health monitoring," "smart education," and "smart wealth system" may provide equitable services and opportunities for everyone on the earth. Modern technology and sensors, such as smart watches, smartphone applications, web applications, and artificial intelligence (AI), are being used, to demonstrate how to construct a system that is efficient for society was one of the best answers presented [81].

One of the most critical Internet of Things-enabled applications available today is smart and interactive healthcare. In order to gather detailed information on our mental and physical health, Internet of Things (IoT)-based sensors are either worn on the body or incorporated in the living environment, as seen below. It is also possible to transform the current reactive healthcare system into an IoT-based proactive and preventive one by using mobile computing technology. In this regard, an Internet of Things (IoT)-based smart student m-health monitoring framework is described. Historical data from medical and other Internet of Things (IoT) devices was used to create this model, this strategy predicts a student's likelihood of becoming sick and the severity of that illness. An architectural model for a smart student health care system has been developed in order to properly evaluate student healthcare data. We simulated waterborne diseases in this case study using data from a cohort of 182 students who were considered at risk. This information is then used to verify our model, which is accomplished via the use of the k-cross validation technique. Depending on the precision, sensitivity, specificity, and reaction time of various classification algorithms, a pattern-based diagnostic scheme is employed. According on the above-mentioned parameters, decision trees (C4.5) and k-nearest neighbors outperform other classifiers. In addition, the suggested method aids decision-making by providing the caregiver or clinician with time-sensitive information at a given moment in time. Finally, the suggested approach's temporal granule pattern-based presentation yields good diagnostic results [96].

Wireless technology's integration with conventional medicine, including disease diagnosis, monitoring, and treatment, is transforming health care. The number of tools available for monitoring and identifying sickness from a distance is increasing. It's becoming increasingly usual to be able to manage drugs and health devices remotely. Thanks to sophisticated and intelligent algorithms, our knowledge of how heredity influences sickness susceptibilities is growing. These trends suggest that a health-care revolution is on the horizon. The Internet of Things is enhancing the function of wireless health even further (IoT). With exciting technical, economic, and social implications, The Internet of Things (IoT) revolution is transforming the way healthcare is delivered today. Internet of Things-based healthcare services are expected to reduce costs, increase quality of life, and improve the overall user experience, according to industry experts. Regulatory constraints, privacy concerns, and interoperability standards are among the challenges that IoT-based healthcare faces, despite its immense promise and a substantial quantity of previous research. Health care experts throughout the globe are working hard to address the promise of the

Internet of Things in the healthcare area while taking into account the numerous practical challenges that must be taken into account. IoT-based wireless health support solutions are examined in this Special Issue.

Articles in both the theoretical and practical realms are requested in the following interconnected areas: Algorithms, system design, performance analysis, and experimental studies are all examples of what is covered.. The keywords mentioned below are just a few examples of possible topics:

a) IoT-based wireless health network designs and platforms.

b) IoT-based wireless health applications and industry trends.

c) IoT-based wireless health security and privacy aspects.

d) Policies and laws governing wireless health enabled by the Internet of Things.

e) Integration of big data and ambient intelligence with wireless health enabled by the Internet of Things.

f) Sensors and wearables for wireless health applications based on the Internet of Things.

The Internet of Things (IoT) is evolving in a way that will change the whole landscape of the future Internet, and gadgets have become more prevalent in recent years, opening up new areas for automation and integration of real-world things. IoT-based cloud systems have been utilized in the past, and there is a rising interest in using IoT-enabled smart devices to create large amounts of data for mass manufacturing. As a result, an integrated IoT-cloud-based big data analytics (BDA) framework is required to improve IoT-based device usage performance. As a result, this study proposes a BDA IoT-based cloud system for storing real-time data created by IoT sensors as well as analyzing the data collected by smart devices. The framework will be evaluated on a large data Cloudera platform for database storage, with the system architecture being done in Python. The framework's usefulness is shown by a real-time analysis of patient data for automated management of body temperature, blood glucose, and blood pressure. Patients' health monitoring circumstances have improved as a result of the system's integration. The technology notifies doctors and medical professionals in real time about changes in patients' health conditions and suggests preventative steps to save lives.

Known as the Internet of Things, this rapidly developing technology allows for improved communication between millions of different devices, allowing for the provision of ubiquitous services without the need for human involvement. The Internet of Things paradigm has arisen as a result of the possible expansion of electronic devices in sensing systems, Sensor-based apps that interact with the environment and gather data in real time are becoming more popular. Nowadays, smart apps must be able to acquire data quickly, analyze it in parallel, and share resources dynamically. Unfortunately, owing to a shortage of processing resources and resource sharing, these criteria cannot be met effectively with standard Wireless Sensor Networks (WSNs). If you want to create creative applications for these limited devices, you'll need to customize and improve your app. As a result, this research investigates a cost-effective solution to these issues utilizing Cloud Computing and Virtualization Techniques. Resources may be shared across different apps thanks to virtualization, and the cloud delivers a massive amount of processing power and storage space. The downsides and constraints of traditional networks may be addressed, allowing for more flexible application development, by merging the Internet of Things Wireless Sensor Network with a Cloud-based Virtualization Environment Improvements in the Internet of Things (IoT), virtualization, and cloud computing that have happened in recent years are also covered. On the basis of the Sensor-Cloud paradigm, a new general architectural vision for the sensor-cloud paradigm is offered, which includes its primary components, basic principles, lifecycle operation, and advantages and drawbacks, as well as how sensor networks are combined with cloud-based virtualization. Lastly, we take stock of the current state of the art, address the most pressing concerns, and provide research recommendations for the near future.

Ambient intelligence refers to electronic environments that are aware of human presence. It is the future technology's light. To achieve their aim, all AMI subsystems communicate with one another. The environment is defined by AMI apps that communicate directly. It demonstrates that this process is not caused by the human environment. The AMI systems should be able to recognize the many emotions that people go through. AMI systems may additionally emphasize the user's conversation. The AMI systems are made up of robots and sensors.

The ubiquitous learning environment (ULE) has grown over the past several years into a mobile and sensor-based technology equipped setting that fulfills today's education discipline demands. Ambient Intelligence (AmI) makes the ULE substantially smarter by applying optimization and intelligence methodologies. Various contributions have been made so far to the development of such smart settings. As a result, research is necessary to determine the different degrees of intelligence contained in their contributions. In this context, this article first provides an overview of infrastructure improvements for ubiquitous learning. Following that, this article examines several remaining problems, challenges and demands, technological barriers, Future developments in Ubiquitous Learning Environments and Ambient Intelligence Assisted Learning Environments are expected to be significant (AmIALE). A Ubiquitous Learning Environment that is enabled by the Internet of Things is then proposed in order to successfully provide additional smarter levels such as energy efficiency, connectivity and specialized requests. Smarter levels such as multi-modal human computer interaction, self-optimization, and self-discovery are also suggested as further smarter levels. In our research, we are certain that it will help academics to begin to think in new ways in order to find solutions to a wide range of modern issues, such as climate change [97].

3. METHODOLOGY

To deliver excellent and cost-effective healthcare system, real time analysis of patients is necessary which is possible due to the latest developments in the IoT technology. Treatment process with reduced cost and reliable communication between patient and medical team is possible due to the big data and cloud computing. IoT applications can be classified into two types as HIoT based device services and healthcare applications with disease diagnosis based on measured health parameters [82] [83].

IoT framework is arrangement of IoT healthcare system in healthcare environment with integration of IoT and cloud computing. The protocols for communication within the framework are fixed for a particular network. IoT system is formed by the publisher who sends this information to a broker continuously over a network, brokers that store and process this information, as well as subscribers who keep track of patient data on-the-the-go and may access it through any mobile devic. A network of sensors comes under the publisher, which collects important parameters of patient's health. The publisher processes these data and gives feedback about the patient's health [82].

Blockchain: HIoT network is based on data sharing within the network which finds data fragmentation as a major concern. The gap in information is observed resulting into insufficient data which affects treatment. Blockchain technology solves the problem of data fragmentation by establishing a safe and secure connection for data sharing within the network. It also promotes qualitative research by collaborating with healthcare providers and organizations [83] [84] [85] [86].

3.1 STUDENT SUBSYSTEM

In this module, each student is initially enrolled using mobile apps that are installed on the parent's phone. The student must first fill out his health information. Each and every enrolled student is given a unique registration number that is created automatically by the system. Furthermore, the data gathering system, which comprises of wearable smart sensors that monitor body function, is necessary to provide students with real-time health data in addition to previous data.

In the educational environment, this methodology's body sensor network comprises wearable and implanted sensor devices. Biosensors such as ECG/EEG, blood pressure, and others are installed in each sensor node. A Local Processing Unit (LPU) or gateway, which may be a portable device or a smartphone, collects students' physiological characteristics in both structured and unstructured formats. Additionally, this gateway uses wireless communication networks like 3G/CDMA/GPRS to interact with cloud storage repositories. In addition, for security and privacy, the Secure Socket Layer (SSL) encrypts the communication channel. Security options for cloud storage protection include third-party encryption, user authentication, and credential mapping.

3.2 CLOUD SUBSYSTEM

Cloud is used as an infrastructure provider which stores the health-based sensory IoT data of students. During various time units, this data is sensed and retrieved regularly. As a result, a server-side cloud storage repository is established for storage and effective decision-making. Temporal parameters from patient health are given as input to medical diagnosis system. Disease severity can be found out based on the calculations from student diagnosis system which are in the form of student health index. Medical books, practical experience and opinions of experts act as a base for deciding diagnosis method. Only authorized doctors and caretakers have access to whole cloud data for security purpose. The data for development of new medicines is shared data containing student health parameters.

3.3 STUDENT HEALTH DIAGNOSIS PROCESS

The system diagnoses are based on the student health information from IoT devices by the student health diagnosis process. The measurement of the context values is done to generate student diagnosis results and describe the student's health status as a result. Various diseases take into consideration in the disease name set.

3.4 SERVICES AND APPLICATION OF HIOT

3.4.1 Services

Services and ideas that answer diverse healthcare concerns have altered the healthcare business. The rise in healthcare needs and technological advancements are bringing more services online every day, and they're becoming an essential aspect of developing an HIoT system. A collection of healthcare solutions is provided by each service whose definition is not unique and is dependent on its uses in an HIoT context. As a result, giving a broad description of any notion is difficult.

3.4.2 Ambient Assisted Living

Ambient assisted living (AAL) is a special branch of AI which focuses on IoT based application for real time monitoring of aging/elderly people at their home making their lives safe if any emergency situation arises. Advanced artificial intelligence technologies, detailed data analysis, machine learning, and their application in healthcare make this approach conceivable. Detection of emergencies comes under activity recognition. Many authors proposed a framework with a modular architecture design for the AAL with a closed-loop communication service based on different communication protocols that were further used to develop more advanced protocols to design advanced AAL systems (smart objects, devices, and kits) [Maskeliunas, 2019].

3.4.3 Blood Pressure Monitoring

The manual blood pressure measurement is a traditional way in the diagnosis process.IoT and other sensing technologies have transformed this process by the use of wearable sensors measuring systolic and diastolic pressure and storing the data in clouds. Long term real time monitoring of BP was implemented by Guntha with the help of cloud computing and fog computing with storage capacity. A time domain deep learning-based CNN model was used to measure BP in further studies. [87] [88][89][90].

3.4.4 Oxygen Saturation Monitoring

One of the potential uses of AI is IoT-based pulse oximetry, which is a non-invasive measurement of oxygen saturation for real-time monitoring. A non-invasive tissue oximeter that measures blood oxygen saturation, heart rate, and pulse records the data and sends it to the server through Zigbee or Wi-Fi. When the oxygen saturation level reaches a critical level, the patients are notified, and medical action is performed. [91],[92]. Zigbee and Wi-Fi may also be used to transport data to the server. The information gathered was put to good use in determining the best course of treatment. If the patient's oxygen saturation dips below this threshold, the patient will be warned. The Blynk server is used to link a pulse oximeter and a wireless network. System for real-time monitoring of distant patients has been developed using a low-power, low-cost method.

3.4.5 Temperature Monitoring

Doctors can predict a patient's health condition by keeping track of the change in body temperature as a warning over time. The traditional thermometer method for temperature measurement is uncomfortable and more prone to spreading infection. IoT-based systems were proposed to measure body temperature using wearable sensors with processing units. Temperature measurements were saved in a database and shown on a website. Some devices may also be used to notify caregivers when the temperature rises over a crucial level [93],[94], [95].

4. RESULTS

The performance of healthcare systems is a challenging aspect to implement. In collecting personal health and medical data, these systems use a wide range of heterogeneous devices. As a result, improved data security and privacy solutions must be included in healthcare systems to ensure high-performance metrics.

Figure 4.1 depicts the recommended technique. The following steps make up the conceptual structure of an IoT-based bright student interactive healthcare system. In phase, I, data on students' health is collected through medical equipment and sensors. A Local Processing Unit is used to send the obtained data to the cloud subsystem (LPU). In phase II, the medical diagnostic system uses medical measures to make cognitive decisions about student health. In phase 3, parents or caregivers get warnings about their children's health. Furthermore, if an emergency scenario happens, an alarm is sent to the nearest hospital to treat the medical problem.

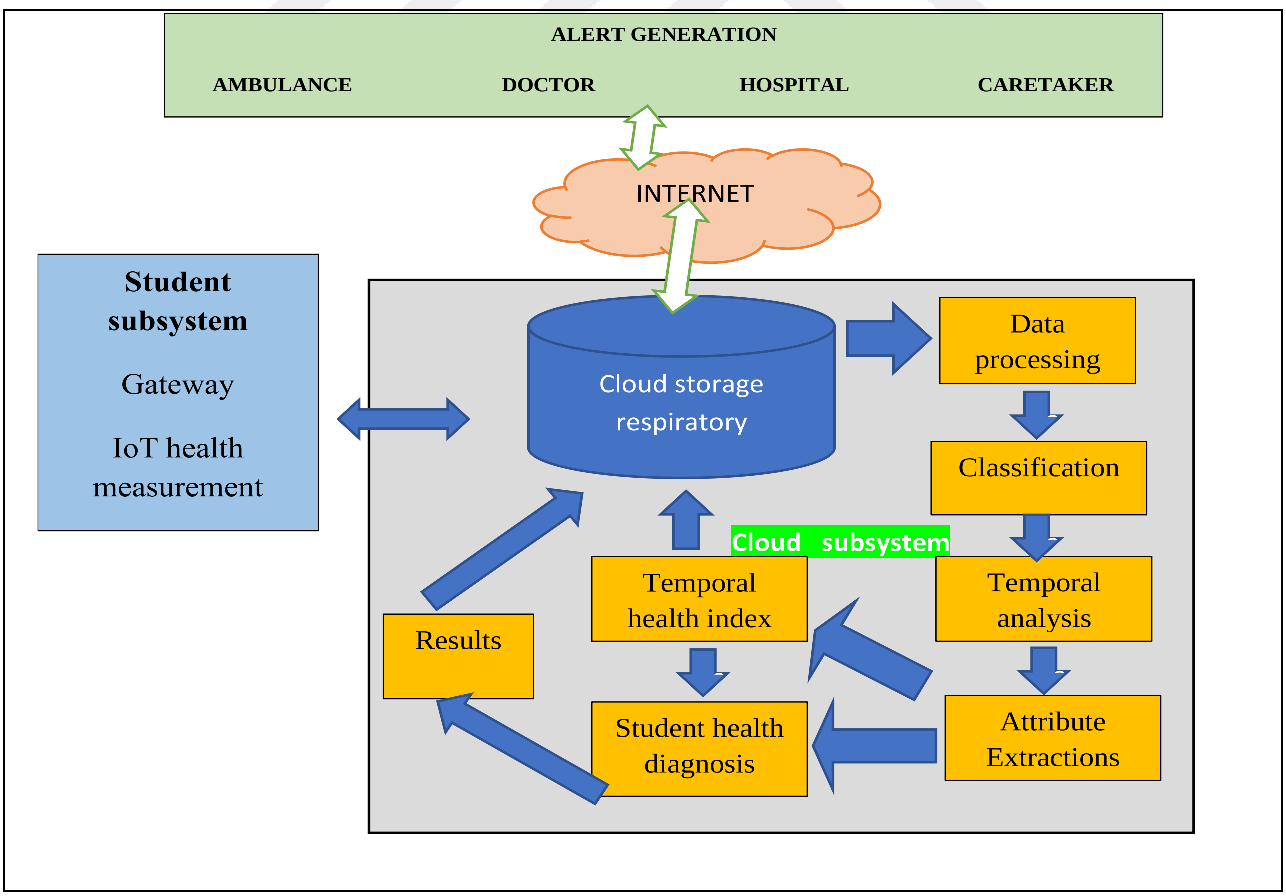

Figure 4.1: Block Diagram

Above result shows the sample status of the ten students. Figure 4.2, 4.3 and 4.4 represent students' temperature, oxygen level and blood pressure values, respectively. If the health parameters are abnormal in range, then the alters signals will be generated. These signals are transformed to the respective alert section, where actually reset signal is processed. Whole information of the student is processed to cloud storage, i.e. network layer. By IOT whole system is performed from the student end of the hospital.

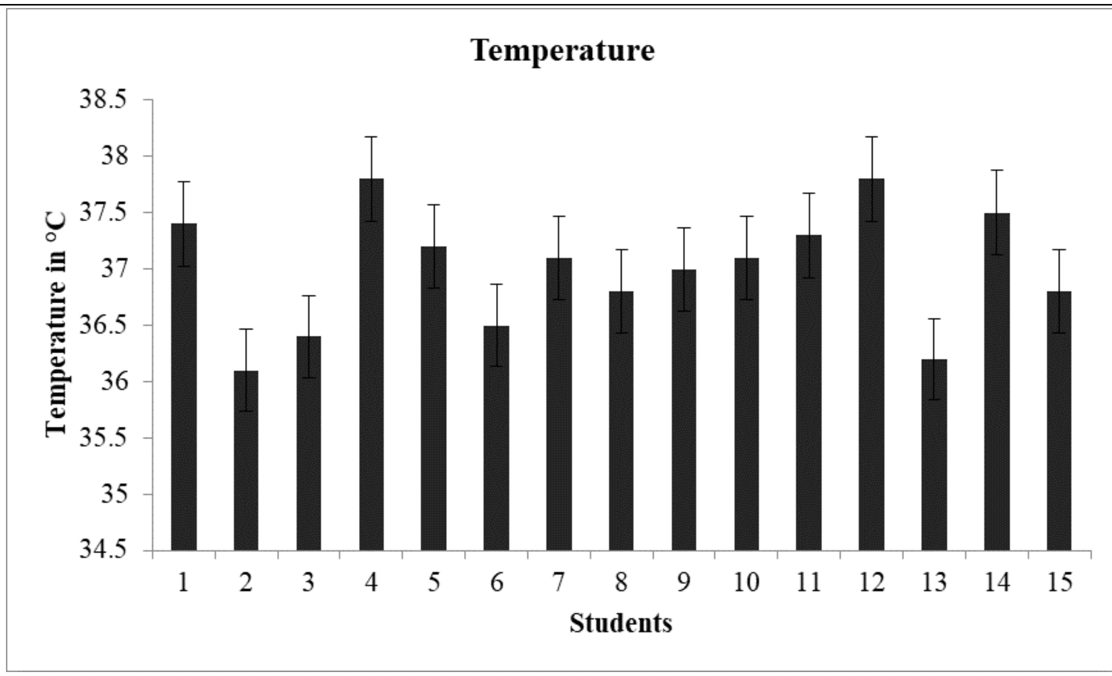

Figure 4.2: Temperature of Enrolled Students

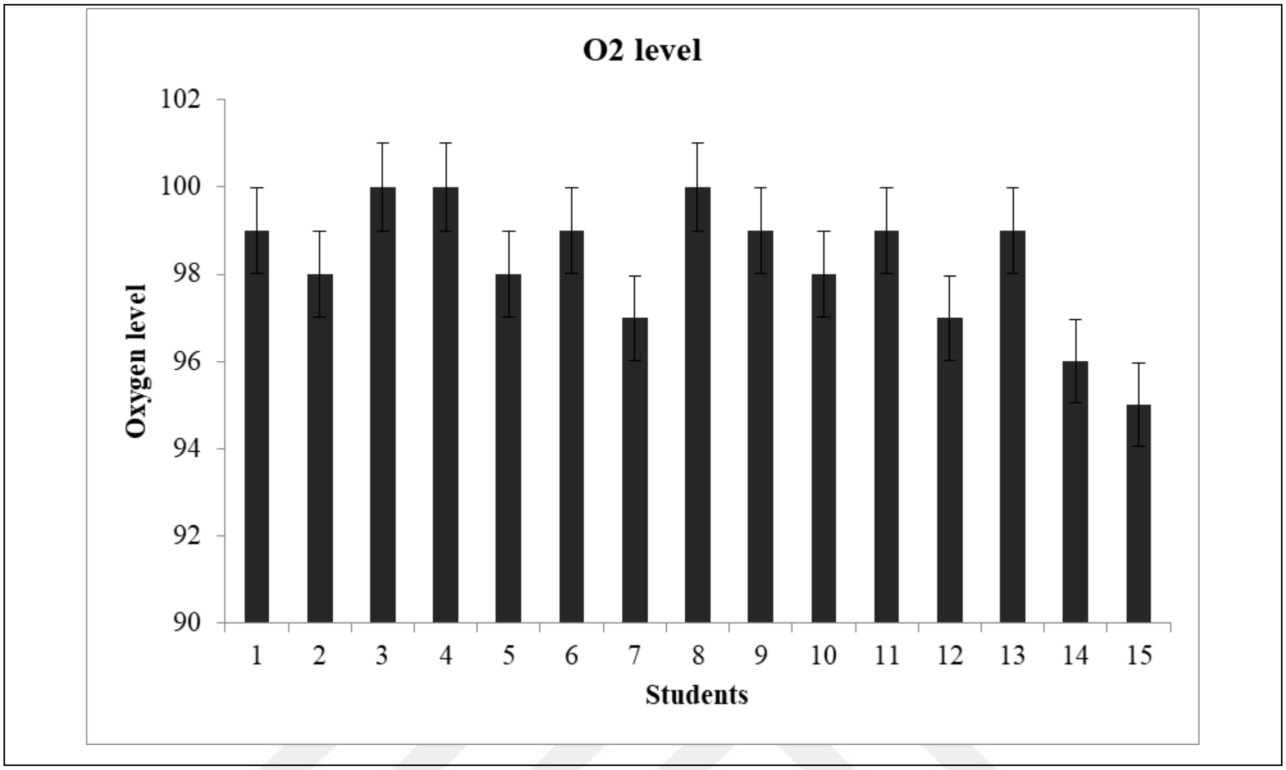

Figure 4.3: Oxygen Level of Enrolled Students

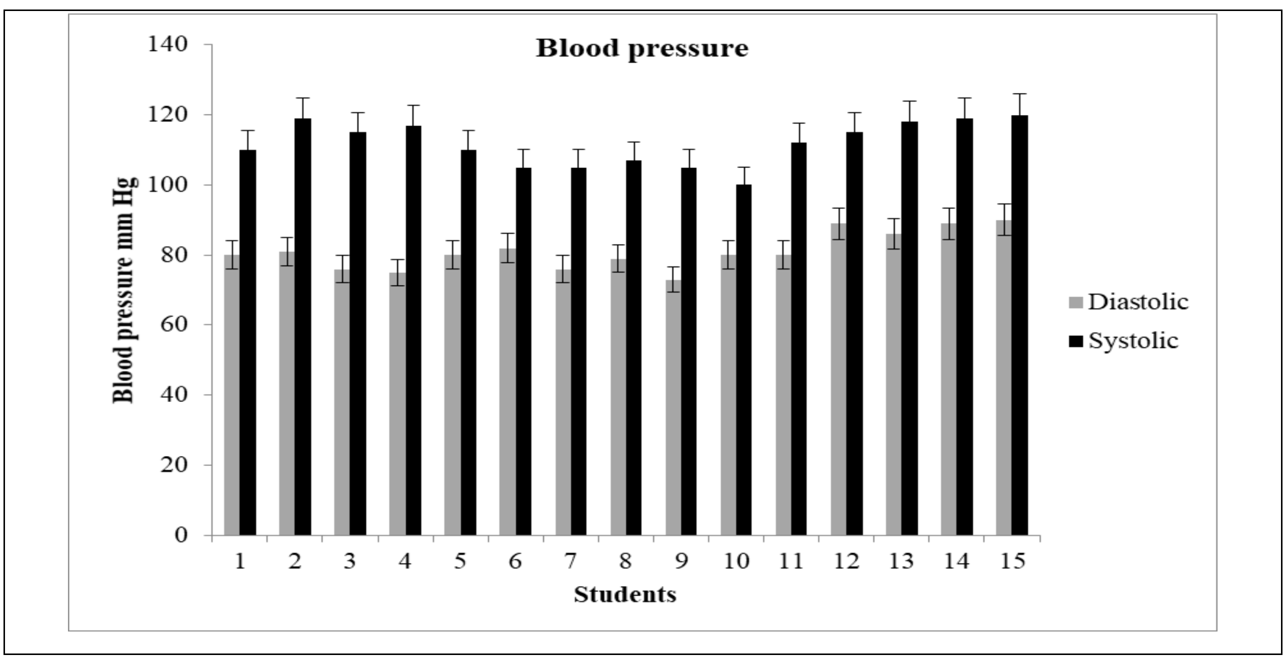

Figure 4.4: Blood Pressure Parameter of Enrolled Students

Table 4.1 shows parameter considered in the study along with five samples. The parameters were used to further analysis in software.

Table 4.1: Variables Considered in the Study

	1	**2**	**3**	**4**	**5**
Temperature	36	35	33	35	50
Blood pressure	85	90	100	35	50
Oxygen level	99	98	99	35	60
Other symptoms	0	0	0	35	98

Figure 4.5 showed command window of MATLAB analysis. All the values of Table 4.1 were included in the analysis. Command window shows the parameter value for the temperature, blood pressure, oxygen level and other symptoms like cough, headache, etc.

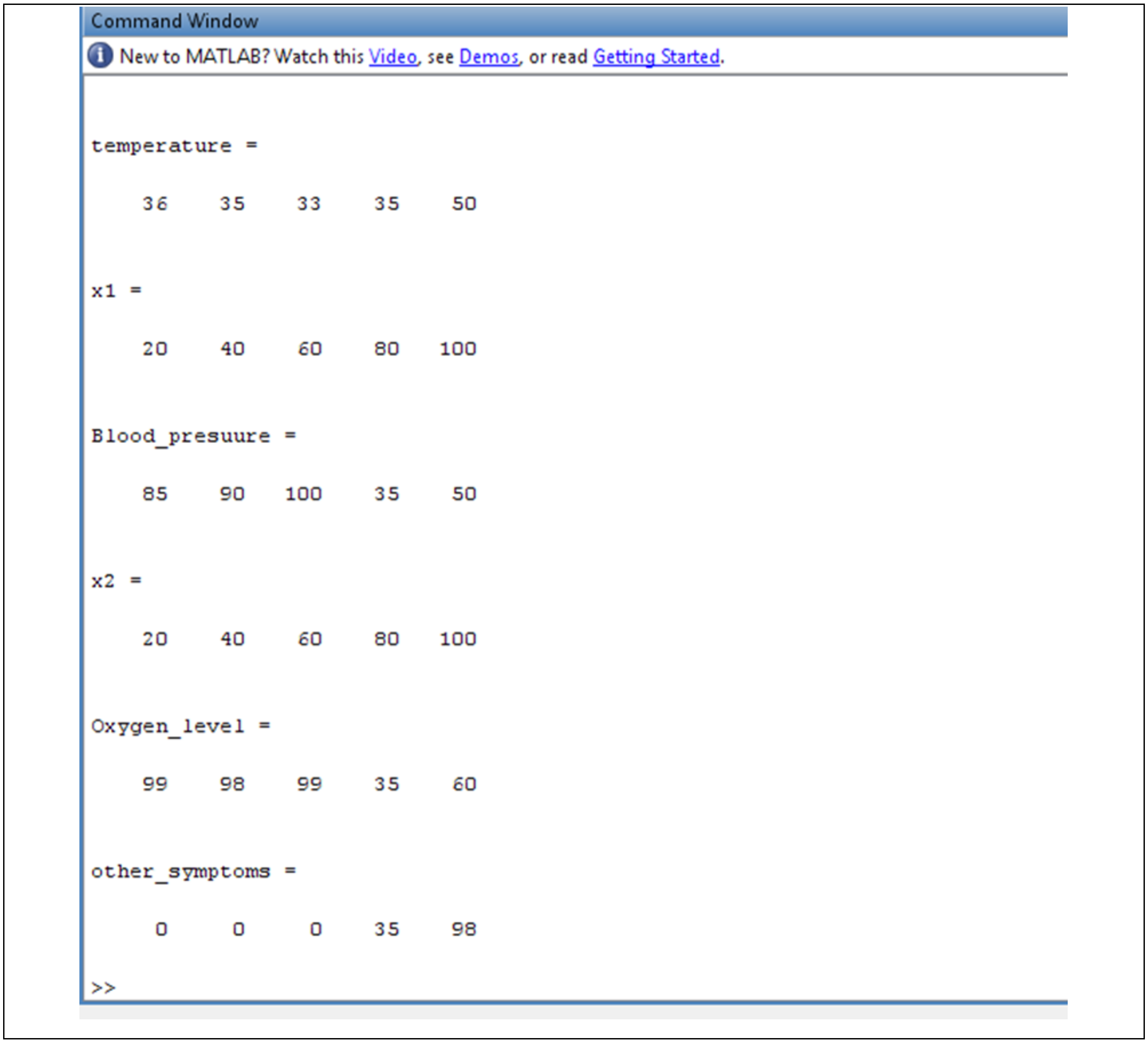

Figure 4.5: Command Window View

The vertical axis (y axis) represents the parameter temperature. The x axis represents the scale. This graph varies student to student temperature. Five students are considered for the analysis. Normal body temperature is 37°C. The range of the temperature was between 35°C to 43°C, respectively. One sample showed 43°C indicats high fever, in degree farad it is 109.4.

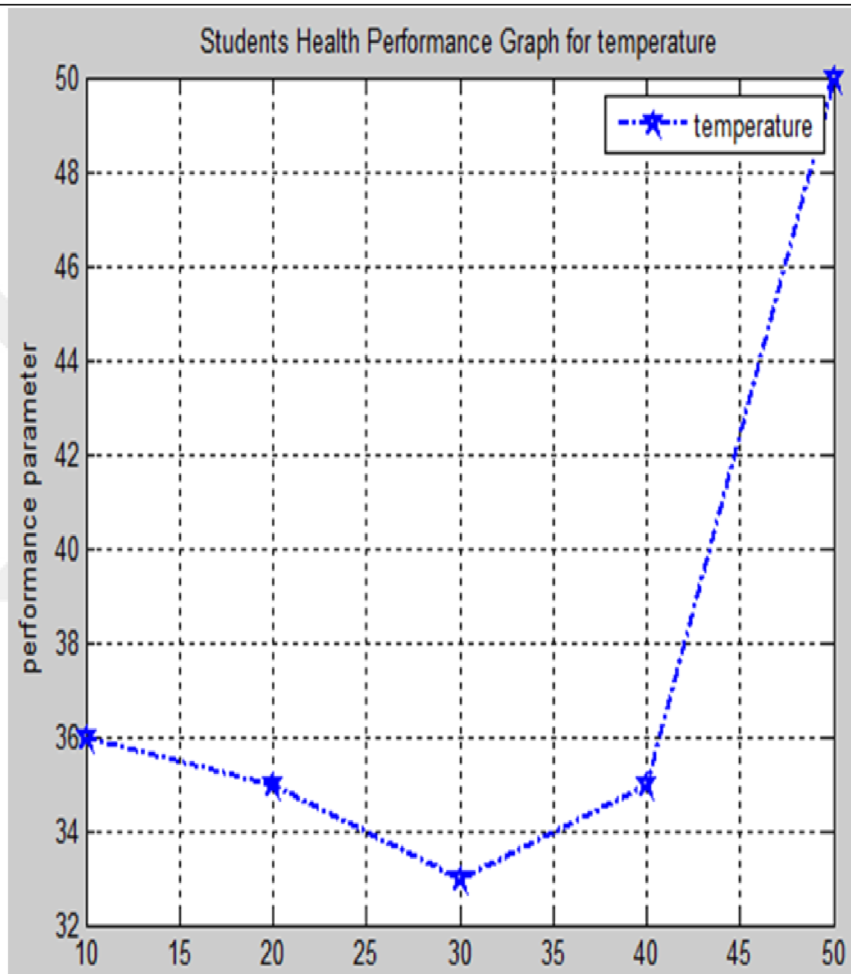

Figure 4.6: Student's Health Performance Graph for Temperature

The vertical axis (y axis) represents the parameter blood pressure. The x axis represents the respective scale. Blood pressure varies student to student. In the present study, we have considered five students blood pressure (Figure 4.7).

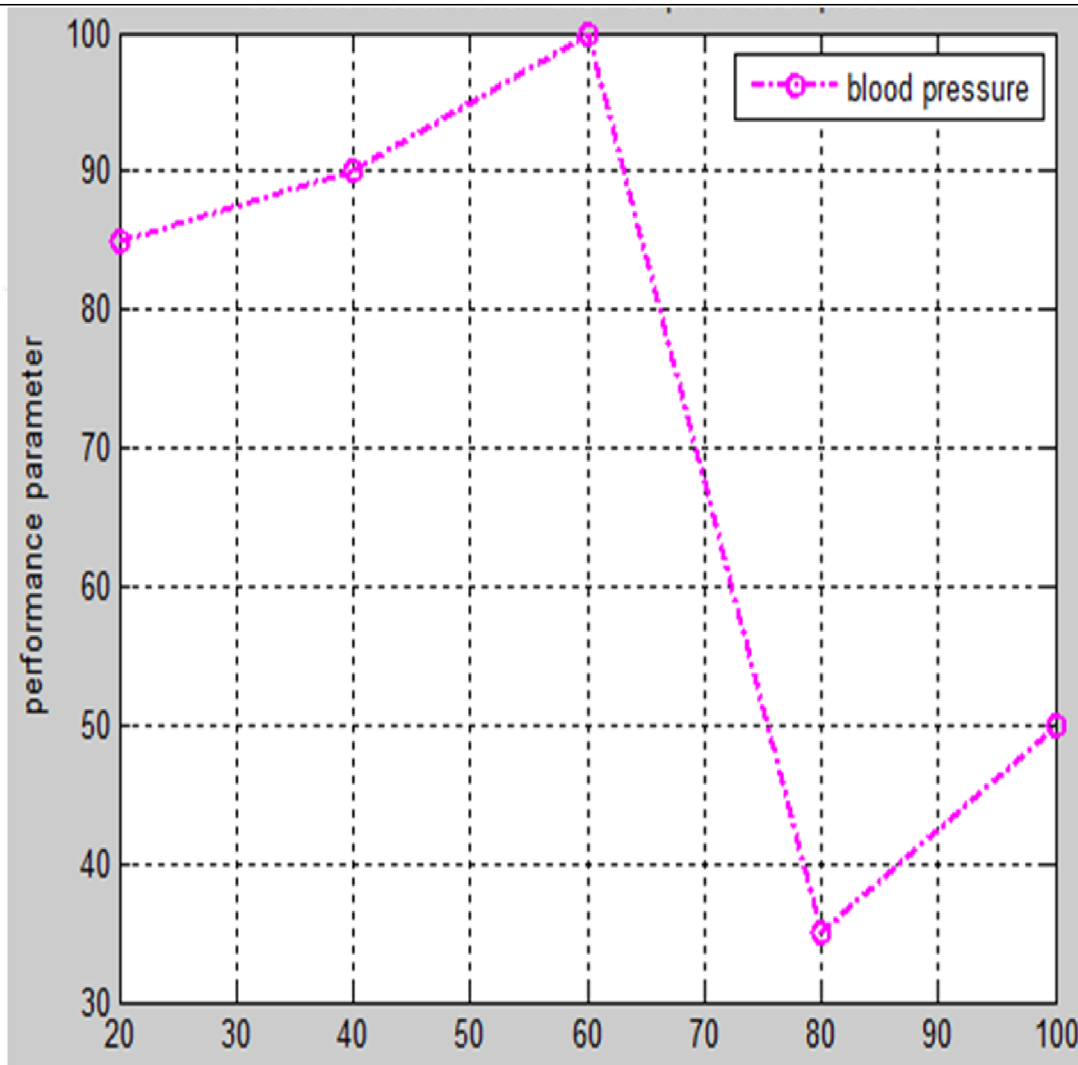

Figure 4.7: Student's Health Performance Graph for Blood Pressure

The vertical axis (y axis) represents the health status related issues like cough, headache, etc. The x axis represents the respective scale. Blood pressure varies student to student. In the present study, we have considered five students (Figure 4.8).

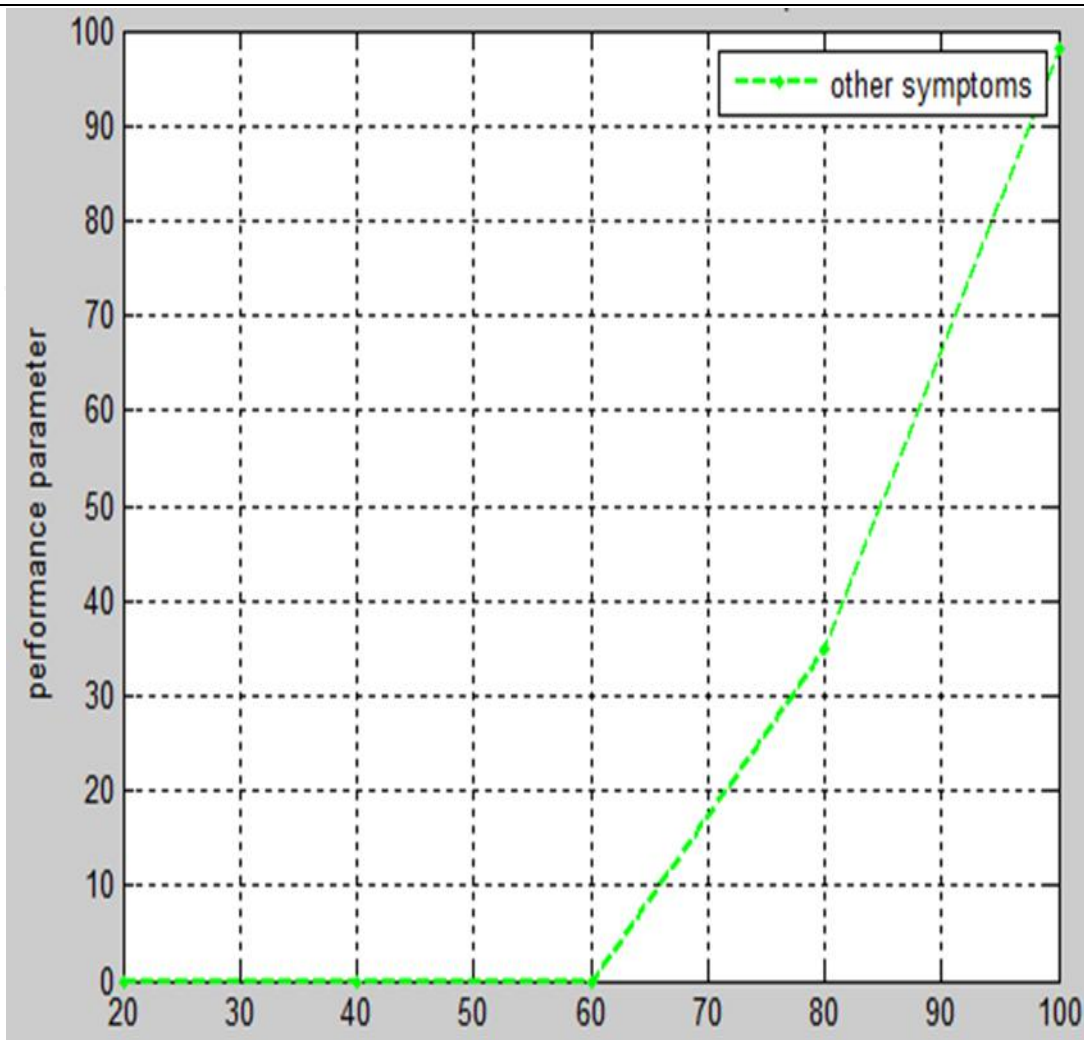

Figure 4.8: Student's Health Performance Graph for Other Symptoms

Figure 4.9 represents students' health performance graph for oxygen levels. The vertical axis (y axis) represents the parameter oxygen level. Normal oxygen level is more than 95. The Lower value of the oxygen level indicates serious health issues.

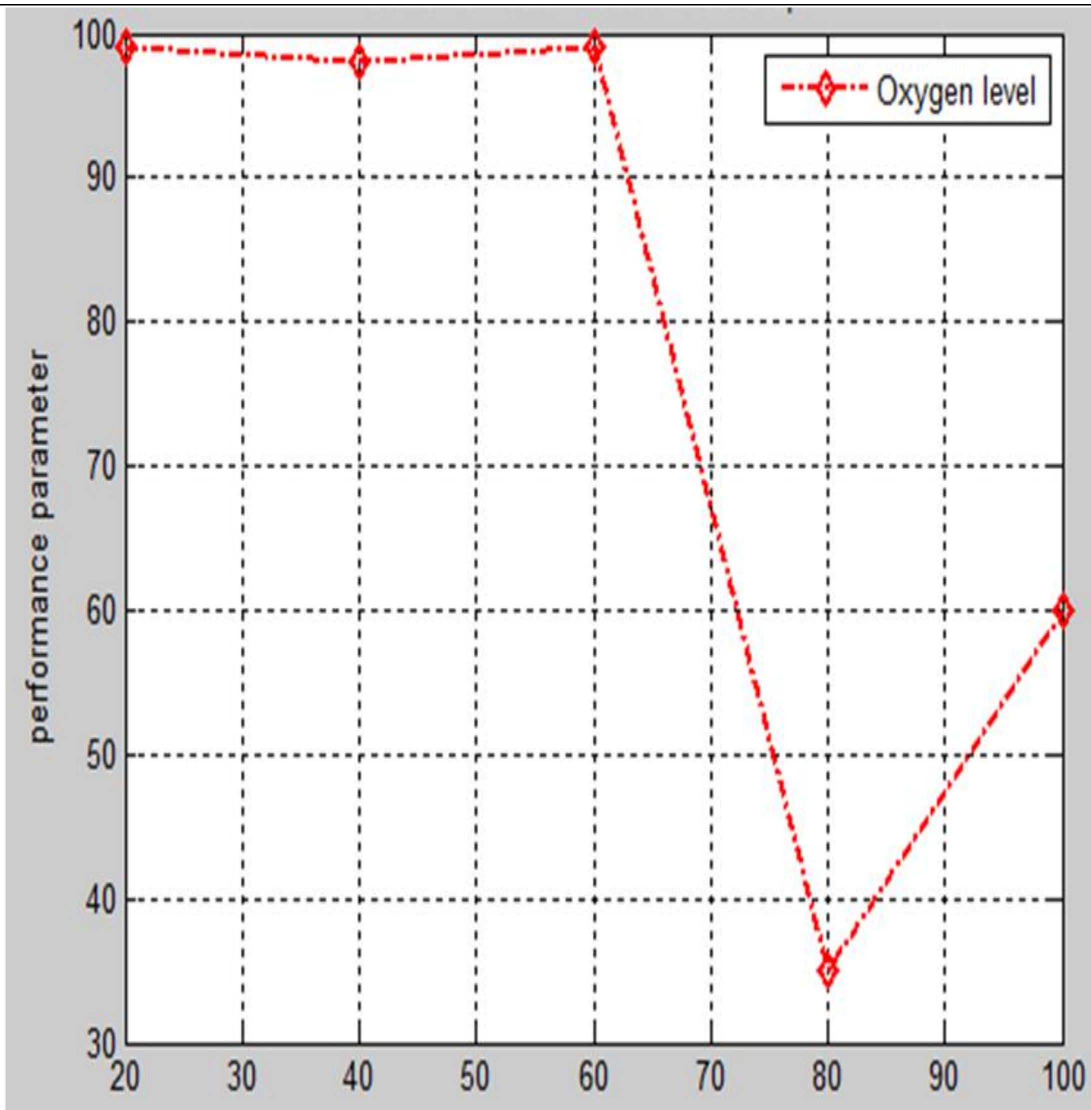

Figure 4.9: Student's Health Performance Graph for Oxygen Levels

Figure 4.10 shows the combined analysis of the all the parameters. The student with the normal range of all parameters shows good health status. While, those who did not showed normal health values indicates some health problems. According to the health status, the student report was transmitted with it to the hospital and then necessary action was taken.

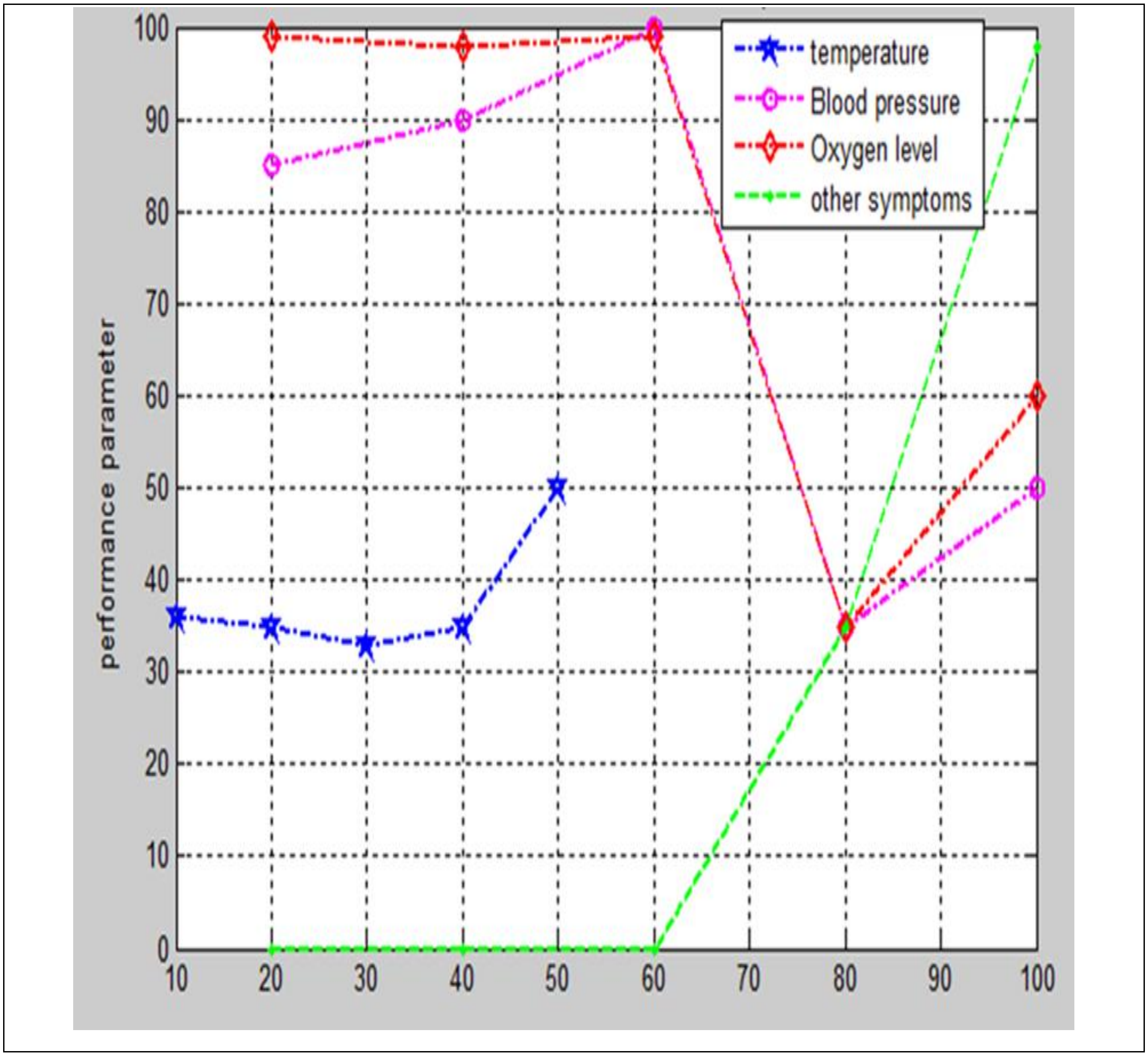

Figure 4.10: Student's Health Performance Graph for all Parameters

5. CONCLUSIONS

This project develops a cutting-edge student healthcare monitoring system that maximizes student performance via ambient intelligence and the Internet of Things. The AmIHMS platform comprises three layers: an IoT layer, a cloud layer, and a layer for monitoring student health. The researchers integrated Ambient Intelligence into student health monitoring via four supervised learning algorithms. The SVM classifier outperformed the others. Sensitivity, specificity, and accuracy measurements were used to assess the classifiers' performance. The data accessible ratio of cable networks was examined and compared using different methodologies. The parameter reliability was used to evaluate AmIHMS' performance, and it was shown to be superior than other models. The model's health monitoring capacity will be expanded in the future by integrating external parameters that may impact student health. Additionally, deep learning will be implemented in student health monitoring. Here the recent scenario related to the medical field along with emerging technologies such as IoT is studied as it can handle the big data with efficiency and accuracy. We have discussed the proposed model and its component how it is responsible to monitor the patient means students health with some major parameters such as blood pressure, body temperature etc. IoT is one of the best technologies which can support the healthcare professionals for diagnosis of the diseases. Though these systems have some limitations and challenges, it is the most promising and accurate system in the medical field.

6. CHALLENGES, SUGGESTION, FUTURE SCOPE

The growing concerns in IoT based healthcare systems are communication protocols, privacy and secrecy, safe and cryptic environment along with data management. Though it is feasible architecture for healthcare systems, it demands more research on security mechanisms, data management, encryption techniques and usability of the systems. Ethical and social issues are also major concerns in developing these systems as non-authorized sources can intercept the user data and steal it for misuse.

Large scale healthcare systems can be initiated by adding new systems and services in the basic network improving quality of service. It is a big challenge as there is availability of wide range of software and hardware platforms and number of communication protocols in use. Standardization can be a solution on scalability and interoperability within the systems as suggested by researchers.

There are chances of denial-of-service attacks on healthcare systems if proper encryption mechanism is not adopted in order to safeguard the system on network layer. The other concerns are technical problems related to system, infrastructure planning and management. Security of enhanced healthcare systems should not be compromised at any cost.

Attacks can be observed on any layer of OSI model such as physical layer, network layer etc. Hardware attacks are not as easy as software attacks. Software is vulnerable due to the involvement of network layer. If the encryption key or cipher text is found, the security can be exposed. IoT based systems are prone to these attacks due to the wireless technology used in the framework. As data transmission is in the form of broadcast, secrecy and authentication issues arise. [Bulhe et al.2021].

There are good ways to deal with medical service frameworks, taking into account new research that allows for the description of new advanced ways to treat different diseases, like by checking chronic infections to figure out which medications are best by a medical team. Despite the benefits of the IoT perspective and new ideas for medical services, there are still a lot of problems that need to be solved, even if IoT has a massive economic impact, and it is unclear whether there are any constraints to the adoption of IoT frameworks.

REFERENCES

[1] H.F. Atlam, R.J. Walters, G.B. Wills, “Internet of nano things: security issues and applications”, in: 2018 2nd International Conference on Cloud and Big Data Computing, (2018a), pp. 71–77.

[2] H.F. Atlam, R.J. Walters, G.B. Wills, “Internet of Things: state-of-the-art, challenges, applications, and open issues”, Int. J. Intell. Comput. Res. 9 (3) (2018b) 928–938.

[3] W. Stallings. “The Internet of Things: network and security architecture, Internet Protoc”. J. 18 (4) (2015) 381–385.

[4] S.H. Shah, I. Yaqoob. “A survey: Internet of Things (IOT) technologies, applications and challenges”, 2016 IEEE Smart Energy Grid Engineering, 1, 2016, 381–385.

[5] Cisco, “The Internet of Things Reference Model”, White Paper, (2014), 1-12.

[6] H.F. Atlam, G. Attiya, N. El-Fishawy, “Integration of color and texture features in CBIR system”, Int. J. Comput. Appl. 164, (2017) 23–28.

[7] M. Muntjir, M. Rahul, H.A. Alhumyani, “An analysis of Internet of Things (IoT): novel architectures, modern applications, security aspects and future scope with latest case studies”, Int. J. Eng. Res. Technol. 6 (6) (2017) 422–447.

[8] Atzori L, Iera A, Morabito G, “The Internet of Things: a survey. Comput Netw”, 54(15), (2010), 2787–2805

[9] Gubbi J, Buyya R, Marusic S, Palaniswami M, “Internet of Things (IoT): a vision, architectural elements, and future directions”, Future Gen Comput Syst 29(7): (2013), 1645–1660.

[10] Baig MM, Gholamhosseini H, “Smart health monitoring systems: an overview of design and modeling”, J Med Syst 37(2): (2013), 1–14.

[11] S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K.-S. Kwak, “Internet of things for health care: a comprehensive survey”, IEEE Access, vol. 3, (2015), 678–708.

[12] Y. Yuehong, Y. Zeng, X. Chen, and Y. Fan, “Internet of things in healthcare: an overview”, Journal of Industrial Information Integration, vol. 1, (2016), 3–13.

[13] Rahaman A, Islam M, Islam M, Sadi M, Nooruddin S. “Developing IoT based smart health monitoring systems: a review”. Rev Intell Artif. (2019); 33: 435–440.

[14] Riazul Islam SM, Kwak Daehan, Humaun Kabir M, Hossain M, Kwak Kyung-Sup. “The Internet of Things for health care: a comprehensive survey”. IEEE Access. (2015);3:678–708.

[15] Lin T, Rivano H, Le Mouel F. “A survey of smart parking solutions. IEEE Trans Intell Transp Syst”. (2017);18:3229–53.

[16] Al-Ali AR, Zualkernan IA, Rashid M, Gupta R, Alikarar M. “A smart home energy management system using IoT and big data analytics approach”. IEEE Trans Consum Electron. Volume: 63, Issue: 4, (2017), 426 - 434

[17] Zanella A, Bui N, Castellani A, Vangelista L, Zorzi M. “Internet of Things for smart cities”. IEEE Internet Things J. (2014); 1: 22–32.

[18] Mois G, Folea S, Sanislav T. “Analysis of three IoT-based wireless sensors for environmental monitoring”. IEEE Trans Instrum Meas. (2017); 66: 2056–2064.

[19] Chen B, Wan J, Shu L, Li P, Mukherjee M, Yin B. “Smart factory of Industry 4.0: key technologies, application case, and challenges”. IEEE Access. (2018); 6: 6505–19.

[20] Ayaz M, Ammad-Uddin M, Sharif Z, Mansour A, Aggoune E-HM. “Internet-of-Things (IoT) based smart agriculture: toward making the fields talk”. IEEE Access. (2019); 7: 129551–83.

[21] Hasan M, Islam MM, Zarif MII, Hashem MMA. “Attack and anomaly detection in IoT sensors in IoT sites using machine learning approaches”. Internet Things. (2019); 7: 100059.

[22] Nooruddin S, Milon Islam M, Sharna FA. “An IoT based device-type invariant fall detection system. Internet Things”. (2020); 9: 100130.

[23] Islam M, Neom N, Imtiaz M, Nooruddin S, Islam M, Islam M. “A review on fall detection systems using data from smartphone sensors”. Ingénierie des systèmes d Inf. (2019);24:569–76.

[24] Mahmud S, Lin X, Kim J-H, Iqbal H, Rahat-Uz-Zaman M, Reza S, Rahman MA. “A multi-modal human machine interface for controlling a smart wheelchair”. In: 2019 IEEE 7th conference on systems, process and control (ICSPC). IEEE; (2019). p. 10–3.

[25] Mahmud S, Lin X, Kim J-H. “Interface for Human Machine Interaction for assistant devices: a review”. In: 2020 10th Annual computing and communication workshop and conference (CCWC). IEEE; (2020). p. 768–73.

[26] Lin X, Mahmud S, Jones E, Shaker A, Miskinis A, Kanan S, Kim J-H. “Virtual reality-based musical therapy for mental health management”. In: 2020 10th Annual computing and communication workshop and conference (CCWC). IEEE; (2020). p. 948–52.

[27] Reddy GK, Achari KL. “A non invasive method for calculating calories burned during exercise using heartbeat”. In: 2015 IEEE 9th international conference on intelligent systems and control (ISCO). IEEE; (2015). p. 1–5.

[28] Santoso D, Dalu Setiaji F. “Non-contact portable infrared thermometer for rapid influenza screening”. In: 2015 International conference on automation, cognitive science, optics, micro electro-mechanical system, and information technology (ICACOMIT). IEEE; (2015). p. 18–23.

[29] Teichmann D, Brüser C, Eilebrecht B, Abbas A, Blanik N, Leonhardt S. “Non-contact monitoring techniques—principles and applications”. In: Conference proceedings of the IEEE engineering in medicine and biological society; (2012).

[30] Yang C-T, Chen S-T, Den W, Wang Y-T, Kristiani E. “Implementation of an intelligent indoor environmental monitoring and management system in cloud”. Futur Gener Comput Syst. (2019);96:731–49.

[31] Patil K, Laad M, Kamble A, Laad S. “A consumer-based smart home with indoor air quality monitoring system”. IETE J Res. (2019);65:758–70.

[32] Marques G, Pitarma R. “An indoor monitoring system for ambient assisted living based on Internet of Things architecture”. Int J Environ Res Public Health. (2016)13:1152.

[33] Ayon SI, Islam MM, Hossain MR.” Coronary artery heart disease prediction: a comparative study of computational intelligence techniques”. IETE J Res. (2020).

[34] Islam Ayon S, Milon Islam M. Diabetes prediction: “A deep learning approach”. Int J Inf Eng Electron Bus. (2019);11:21–7.

[35] Islam MM, Iqbal H, Haque MR, Hasan MK. “Prediction of breast cancer using support vector machine and K-nearest neighbors”. In: 2017 IEEE Region 10 humanitarian technology conference (R10-HTC). IEEE, (2017). p. 226–9.

[36] Hasan MK, Islam MM, Hashem MMA. “Mathematical model development to detect breast cancer using multigene genetic programming”. In: 2016 5th International conference on informatics, electronics and vision (ICIEV). IEEEl; (2016). p. 574–9.

[37] Haque MR, Islam MM, Iqbal H, Reza MS, Hasan MK. “Performance evaluation of random forests and artificial neural networks for the classification of liver disorder”. In: 2018 International conference on computer, communication, chemical, material and electronic engineering (IC4ME2). IEEE; (2018). p. 1–5.

[38] A. Rghioui, S. Sendra, J. Lloret, A. Oumnad, “Internet of Things for Measuring Human Activities in Ambient Assisted Living and e-Health”, Network Protocols and Algorithms, vol.8, no. 3, (2016), pp. 15-28.

[39] M. C. Domingo, “An overview of the Internet of Things for people with disabilities”, Journal of Network and Computer Applications, vol. 35, (2012), pp: 584–596.

[40] H. S. Kim, et al., “A Daily Activity Monitoring System for Internet of Things-Assisted Living in Home Area Networks,” International Journal of Electrical and Computer Engineering (IJECE), vol/issue: 6(1),(2021), pp. 399-405

[41] M. Anwar, A. H. Abdullah, K. N. Qureshi, A. H. Majid, “Wireless Body Area Networks for Healthcare Applications: An Overview”, TELKOMNIKA Telecommunication, Computing, Electronics and Control., vol. 15, no. 3,(2017), pp. 1088-1095.

[42] Lo, B., & Yang, G. Z. (2005, April). “Key technical challenges and current implementations of body sensor networks”. In Proc. 2nd International Workshop on Body Sensor Networks (2005).

[43] Konstantas, D., Jones, V., Bults, R., & Vierhout, P. “Healthcare PANs: Personal Area Networks for trauma care and home care”, (2001).

[44] Schmidt, R., Norgall, T., Mörsdorf, J., Bernhard, J., & von der Grün, T. “Body Area Network BAN– a key infrastructure element for patient-centered medical applications”. Biomedizinische Technik/Biomedical Engineering, 47(s1a), (2002), 365-368.

[45] Lo, B. P., Thiemjarus, S., King, R., & Yang, G. Z. “Body sensor network–a wireless sensor platform for pervasive healthcare monitoring”, (2005).

[46] Barrett, W., Hoeffel, D., Dalury, D., Mason, J. B., Murphy, J., & Himden, S.. “In-vivo alignment comparing patient specific instrumentation with both conventional and computer assisted surgery (CAS) instrumentation in total knee arthroplasty”. The Journal of arthroplasty, (2014), 29(2), 343-347.

[47] Chicchi Giglioli, I. A., Pallavicini, F., Pedroli, E., Serino, S., & Riva, G. “Augmented reality: a brand new challenge for the assessment and treatment of psychological disorders”. Computational and mathematical methods in medicine, (2015).

[48] J.Gomez, B.Oviedo, E.Zhuma, “Patient Monitoring System Based on Internet of Things”, Science Direct, (2016), pp. 90 – 97

[49] G.Tartarisco, G.Baldus, D.Corda, R.Raso, “Personal Health System architecture for stress monitoring and support to clinical decisions”, (2012), pp. 1296-1305

[50] F.Delmastro, “Pervasive Communications in Healthcare”, (2012), pp. 1284-1295

[51] Prof. M.M. Bulhe, Yash Vaidya, Sara Shaikh, Prerna Rankhambe, Asmita Donde, “IoT based Health Monitoring System and Challenges”, (IRJET), Volume: 08 Issue: 05, (2021), pp. 2395-0072.

[52] S.Eeshwaroju, P.Jakkula, I.Abdellatif, “An IoT Based Three-Dimensional Dynamic Drone Delivery (3D4) System”, IEEE Cloud Summit , (2020), PP. 119-123

[53] L.H.Tan, K.C.Hua, B.A.Muthu, C.B.Sivaparthipan, “Big data and ambient intelligence in IoT-based wireless student health monitoring system” (2021).

[54] Hossain MS, Muhammad G, “Cloud-assisted industrial Internet of Things (IIoT) enabled framework for health monitoring”. Comput Netw , (2016) 101:192–202

[55] Gope P, Hwang T, “BSN-Care: a secure IoT-based modern healthcare”. IEEE Sens J 16(5): (2016) ,1368–1376

[56] Priyanka K, Tripathi NK, “A real-time health monitoring system for remote cardiac patients using smartphone and wearable sensors”. Int J Telemed Appl, (2015).

[57] Gelogo YE, Hwang HJ, Kim H, “Internet of Things (IoT) framework for u-healthcare system”. Int J Smart Home 9(11): (2015) ,323–330

[58] Hussain A, Wenbi R, Lopes A, Nadher M, Mudhish M, “Health and emergency-care platform for the elderly and disabled people in the Smart City”. J Syst Softw 110: (2015) ,253–263

[59] Kim SH, Chung K, “Emergency situation monitoring service using context motion tracking of chronic disease patients”. Clust Comput 18(2): (2015) ,747–759

[60] Catarinucci L, De Donno D, Mainetti L, Palano L, Patrono L, Stefanizzi ML, Tarricone L, “An IoT-aware architecture for smart healthcare systems”. IEEE Internet Things 2(6): (2015) ,515–526

[61] Xu B, Da Xu L, Member S, Cai H, Xie C, Hu J, Bu F , “Ubiquitous data accessing method in IoT-based information system for emergency medical services”. IEEE Trans Ind Inf 10(2): (2014) ,1578–1586

[62] Box IM, Yang G, Xie L, Mäntysalo M, Zhou X, Pang Z, Da Xu L, Member S , “A health-IoT platform based on the integration of intelligent packaging, unobtrusive bio-sensor and intelligient medicine box”. IEEE Trans Ind Inf 10(4): (2014) ,2180–2191.

[63] Maia P, Batista T, Cavalcante E, Baffa A, Delicato FC, Pires PF, Zomaya A, “ A web platform for interconnecting body sensors and improving health care”. Proced Comput Sci 40: (2014,)135–142

[64] Jara J, Zamora-Izquierdo M, Skarmeta F, “Interconnection framework for mHealth and remote monitoring based on the Internet of Things”. IEEE J Sel Areas Commun 31(9): (2013) ,47–65

[65] La HJ , “A conceptual framework for trajectory-based medical analytics with IoT contexts”. J Comput Syst Sci 82(4): (2016) ,610–626

[66] Hajihashemi Z, Popescu M, Member S, “A multidimensional time-series similarity measure with applications to eldercare monitoring”. IEEE J Biomed Health Inf 20(3): (2016) ,953–962

[67] Liu B, Li J, Chen C, Tan W, Member S, Chen Q, Zhou M, “Efficient motif discovery for large-scale time series in healthcare”. IEEE Trans Ind Inf 11(3): (2015) ,583–590

[68] Banaee H, Ahmed MU, Loutfi ,”A Data mining for wearable sensors in health monitoring systems: a review of recent trends and challenges”. Sensors 13(12): (2013) ,17472–17500

[69] Bhatia M, Sood SK ,”Temporal informative analysis in smart ICU monitoring”: m-healthcare perspective, (2016).

[70] Giovanni A, Diane J, Parisa R, Athanasios V, “A Survey on Ambient Intelligence in Health Care”,(2013), pp 2470-2494.

[71] Y. Fu and J. Liu, “System design for wearable blood oxygen saturation and pulse measurement device,” Procedia Manufacturing, vol. 3, pp. 1187–1194, 2015.

[72] Atzori L, Iera A, Morabito G, (2010), “The Internet of Things: a survey. Comput Netw”, 54(15):2787–2805.

[73] Gubbi J, Buyya R, Marusic S, Palaniswami M, (2013), “Internet of Things (IoT): a vision, architectural elements, and future directions”, Future Gen Comput Syst 29(7):1645–1660.

[74] Baig M.M, Gholamhosseini H, (2013), “Smart health monitoring systems: an overview of design and modeling”, J Med Syst 37(2):1–14.

[75] S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K.-S. Kwak, (2015), “Internet of) things for health care: a comprehensive survey”, IEEE Access, vol. 3, pp. 678–708.

[76] Y. Yuehong, Y. Zeng, X. Chen, and Y. Fan, (2016), Internet of things in healthcare: an overview”, Journal of Industrial Information Integration, vol. 1, pp. 3–13.

[77] J.Gomez, B.Oviedo, E.Zhuma, (2016), “Patient Monitoring System Based on Internet of Things”, Science Direct, pp. 90 – 97.

[78] G.Tartarisco, G.Baldus, D.Corda, R.Raso, (2012), “Personal Health System architecture for stress monitoring and support to clinical decisions”, pp. 1296-1305

[79] F.Delmastro, (2012), “Pervasive Communications in Healthcare”, pp. 1284-1295.

[80] M.M. Bulhe, Yash Vaidya, Sara Shaikh, Prerna Rankhambe, Asmita Donde, (2021), “IoT based Health Monitoring System and Challenges”, (IRJET), Volume: 08 Issue: 05, pp. 2395-0072.

[81] S.Eeshwaroju, P.Jakkula, I.Abdellatif, (2020), “An IoT Based Three-Dimensional Dynamic Drone Delivery (3D4) System”, IEEE Cloud Summit ,PP. 119-123

[82] L.H.Tan, K.C.Hua, B.A.Muthu, C.B.Sivaparthipan, (2021), “Big data and ambient intelligence in IoT-based wireless student health monitoring system”.

[83] M. Khan, K. Han, and S. Karthik, “Designing smart control systems based on internet of things and big data analytics,”Wireless Personal Communications, vol. 99, no. 4,pp. 1683–1697, 2018.

[84] P. S. Mathew, “Applications of IoT in healthcare,” in CognitiveComputingforBigDataSystemsoverIoT,pp.263–288,Springer, Berlin, Germany, 2018.

[85] V. Jagadeeswari, “A study on medical Internet of things and Big Data in personalized healthcare system,” Health Information Science And Systems, vol. 6, p. 14, 2018.

[86] A. Ahad, M. Tahir, and K.-L. A. Yau, “5G-based smart healthcare network: architecture, taxonomy, challenges and future research directions,” IEEE Access, vol. 7,pp. 100747–100762, 2019.

[87] M. N. Birje and S. S. Hanji, “Internet of things based distributed healthcare systems: a review,” Journal of Data, Information and Management, vol. 2, 2020.

[88] K. T. Kadhim, “An overview of patient’s health status monitoring system based on internet of things (IoT),”Wireless Personal Communications, vol. 114, pp. 1–28, 2020.

[89] R.Maskeliunas,“A review of Internet of things technologies for ambient assisted living environments,” Future Internet, vol. 11, p. 259, 2019.

[90] A. Sharma, R. Tomar, N. Chilamkurti, and B.-G. Kim,“Blockchain based smart contracts for internet of medicalthings in e-healthcare,” Electronics, vol. 9, no. 10, p. 1609,2020.

[91] X. Zhang and S. Poslad, “Blockchain support for flexible queries with granular access control to electronic medical records (EMR),” in Proceedings of the 2018 IEEE International conference on communications (ICC), pp. 1–6, Kansas City, MO, USA, May 2018.

[92] X. Zhang, “Block-based access control for blockchain-based electronic medical records (EMRs) query in eHealth,” in Proceedings of the 2018 IEEE Global Communications Conference (GLOBECOM),pp.1–7, AbuDhabi, UAE, December 2018.

[93] T. N. Gia, M. Ali, I. B. Dhaou et al., “IoT-based continuous glucose monitoring system: a feasibility study,” Procedia Computer Science, vol. 109, pp. 327–334, 2017.

[94] B. Sargunam and S. Anusha, “IoT based mobile medical application for smart insulin regulation,” in Proceedings of the 2019 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), pp. 1–5, Erode, India, October 2019.

[95] H. Ota, M. Chao, Y. Gao et al., “3D printed “earable” smart devices for real-time detection of core body temperature,” ACS Sensors, vol. 2, no. 7, pp. 990–997, 2017.

[96] P. Verma, S. K. Sood, and S. Kalra, “Cloud-centric IoT based student healthcare monitoring framework,” *J. Ambient Intell. Humaniz. Comput.*, vol. 9, no. 5, pp. 1293–1309, 2018, doi: 10.1007/s12652-017-0520-6.

[97] K. Shafique, B. A. Khawaja, F. Sabir, S. Qazi, and M. Mustaqim, “Internet of things (IoT) for next-generation smart systems: A review of current challenges, future trends and prospects for emerging 5G-IoT Scenarios,” *IEEE Access*, vol. 8, pp. 23022–23040, 2020, doi: 10.1109/ACCESS.2020.2970118.