E-GARMENTS FOR HEALTH MONITORING IN METAVERSE

A MULTIDISCIPLINARY PROJECT REPORT

Submitted by

AISHWARYA MARIAM AMBI	**[Reg No: RA1911009010074]**	**- B.Tech in Biotechnology**
SREE RESHMA PARAMEL	**[Reg No: RA1911009010111]**	**-BTech in Biotechnology**
SNEHAM NAYYAR	**[Reg No: RA1911042010009]**	**-B.Tech in CSE (CSBS)**

Under the guidance of

Dr. R. RAJKUMAR, (Assistant Professor, Department of Data Science and Business Systems)
Dr. Y. RAVICHANDRAN, (Assistant Professor, Department of Biotechnology)

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BONAFIDE CERTIFICATE

Certified that this multidisciplinary project report titled **"E-GARMENTS FOR HEALTH MONITORING IN METAVERSE"** is the bonafide work of **Ms. AISHWARYA MARIAM AMBI , Ms. SREE RESHMA and Mr. SNEHAM NAYYAR ",** who carried out the project work under our supervisions. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Dr. R.Rajkumar
GUIDE 1
Assistant Professor
Department of
Data Science and Business Systems

Dr. Lakshmi M
HEAD OF THE DEPARTMENT
Department of
Data Science and Business Systems

Dr. Y.Ravichandran
GUIDE 2
Assistant Professor
Department of Biotechnology

Dr.R.Nazeer
HEAD OF THE DEPARTMENT
Department of Biotechnology

Signature of the Internal Examiner

Signature of the External Examiner

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ABSTRACT

A metaverse is an alternate dimension which includes components of social networking, online gaming, virtual reality, augmented reality, and cryptocurrency. Nowadays, the term "metaverse" is extensively employed to represent a rapidly-evolving world that has a chance to drastically alter the way we work, live, and play. A metaverse is neither device-independent nor held by a single company. It is a self-contained virtual economy supported by electronic currencies and non-fungible tokens (NFTs). The Metaverse core pillar is virtual reality. The integration and overlapping of the digital and physical worlds, the integration of digital and real economics, the connection of electronic and interpersonal relationships, It incorporates high-speed networks for communication, the Internet of things (IoT), augmented reality (AR), virtual reality (VR), edge computing, cloud computing, blockchain, artificial intelligence (AI), and other technologies. Metaverse allows users to engage, socialize, and work with one another using virtual reality in three dimensions (3D). Users may connect and play with one another in the world of digital media by attending musical performances and conferences, playing virtual football, and other activities. Avatars could be customized, and their cultural, physical, and social traits differ from those of reality. The avatar can interact with other creatures and accomplish tasks. Their most apparent use in healthcare is in the administration and protection of our immensely important health data. Now, data is frequently exchanged between numerous organizations in ways that are both wasteful and opaque to the data's owners. The proposed work is to design wearable garments (Shirt / T-Shirt) to record health parameters and to be viewed virtually in a 3D environment in Metaverse.

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LIST OF SYMBOLS AND ABBREVIATIONS

IOT	-	Internet of Things
AR	-	Augmented Reality
VR	-	Virtual Reality
NFT	-	Non- fungible Tokens
3D	-	3 Dimensional
AI	-	Artificial Intelligence
XR	-	+Extended Reality

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The metaverse, frequently referred to as internet 3.0, represents a significant advancement in how people may socialise with others irrespective of distances in geography or regional boundaries. The Metaverse is poised to usher in a transformative revolution in a wide range of industries, including healthcare. For many years, establishing a diagnosis, obtaining medical care, or performing surgical operations required a physical encounter between a patient and a doctor; however, with the rise of telehealth services, that have grown into an element of the patient-doctor interacting via digital means as well as the Internet, this has changed significantly. Nevertheless, with virtual reality (VR) and augmented reality (AR) enabling previously imagined opportunities, solutions for digital health are poised to grow in size and volume in new ways. Because it blends virtual reality, or VR, and augmented reality, or AR, to work in virtual settings, the metaverse has immense promise: The metaverse was identified as a disruptive movement in the medical field, with benefits such as enhanced surgical precision, therapeutic utilisation, social-distancing accommodation, and more.

The Metaverse may be defined as an aesthetically rich virtual realm with a verisimilitude bias in which individuals can do whatever they do in real life, such as purchase goods, play, socialise, and party. The epidemic has boosted digital-age innovation. Other critical advances in the domains of artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and blockchain technology go beyond revolutions in telemedicine, payments, remote monitoring, and safe data-sharing.

The goal of the fashion sector's digital revolution was to encourage longevity while improving the design, manufacture, and business of physical objects for the real world. Nonetheless, with the more recent invention of the metaverse, a parallel world in virtual reality, a new frontier in digital fashion has opened. The metaverse, as the name suggests, is an augmented world/virtual reality interface that immerses users in visual, aural, and haptic sensors to allow them to interact with other users in a virtual environment. To facilitate ownership and payment via the internet,

traceability, and other services, the metaverse may be expanded utilising Web 3 technology such as blockchain.

Users engage in online activities in the metaverse, which produce real-world experiences and consequences, resulting in a flood of apps that are transforming the way we interact. The metaverse is a form of parallel universe that people may explore via the use of virtual and augmented reality technologies. The term derives from the science fiction novel "Snow Crash," published in 1992, and alludes to being immersed in an illusory, digitally produced reality.

According to specialist sources, the following seven technologies will have the most influence on metaverse growth during the next decade:

1) Internet of things
2) artificial intelligence
3) extended reality
4) Interfaces between the brain and the computer
5) Spatial and computing at the edge
6) 3D modelling and reconstruction
7) blockchain

Medicine is maybe one of the most fascinating ecosystems in the metaverse. Even faultless digital services are now hampered by real-world limits. The concept of the Metaverse is still in its early stages and changing rapidly, but it has enormous promise in health care to merge AI, AR/VR, web 3.0, the Internet of medical devices, quantum computing, and robots to provide healthcare systems a new direction. The Metaverse has the potential to significantly impact the industry, from boosting surgical accuracy to therapeutic applications and beyond. During an online appointment, for example, a patient can only see the doctor in two dimensions.

The implementation of digital health services employing digital and internet tools has had a huge influence on the connection between patient and physician, with changes seen as a result of technologies like as Blockchain technologies, Augmented Reality (AR), and Virtual Reality (VR). The doctor inquires about the problem, the patient describes it, and the results of at-home tests such as blood pressure, body temperature, and so on are occasionally transmitted. The doctor must

rely on the data provided by the patient. This is a digital representation of a traditional appointment, which can be time-consuming at times.

The metaverse is another realm in which the real world is augmented, connected, and replicated using virtual reality. It's also worth emphasizing that the metaverse is and will continue to be a part of the digital native generation's daily life. These are critical issues, especially in light of the 2019 pandemic coronavirus illness, which hastened and implemented metaverse development.

As the metaverse evolves and becomes more widely used in healthcare settings, expect new avenues in healthcare to emerge, such as Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Extended Reality (XR). Internet of Medical Devices, Web 3.0, Intelligent cloud, Edge computing, and robotics. When the COVID-19 outbreak raged throughout the world, bringing economies to a standstill, the internet and the resulting Work at Home technical solutions enabled enterprises to stay afloat and, in some circumstances, even grow dramatically. Various industries, like as education, have seen considerable modifications because of the epidemic and have become more technologically demanding.

The concept of the Metaverse is just another term in a long line of recent technological advancements, but unique from others, it is currently gaining societal acceptance. Because Covid-19 is hastening large-scale digitalization and forcing everyone all over the world to spend time in the digital domain, seeing the Metaverse as a fantasies, sci-fi future is no longer feasible. It is one of the options that is the most likely to become a complete reality. According to employment specialists interviewed by technology journalist Lawton, creating effective metaverse work settings will involve far more than grafting current office spaces and regulations onto virtual places. Indeed, preliminary research indicates that just converting existing offices into 3D virtual counterparts may decrease efficiency and even trigger nausea and motion sickness. The COVID-19 epidemic heightened curiosity about the metaverse as more individuals worked from home and attended education online. Obviously, there are fears that, even in a post-COVID era, the metaverse could render it much simpler for individuals to spend time apart.

Companies are trying out metaverse apps in the workplace, which expand on online applications firms built to assist distant work during the epidemic. Workplace training is an initial application of metaverse technology. A number of hospitals are already using virtual reality and augmented

reality to provide instruction for common medical procedures. The Metaverse is more vulnerable to security threats; because of the diverse components engaged in the patient healthcare system, guaranteeing security for user-sensitive information is the duty of the healthcare provider. To enhance the deployed system, existing Metaverse systems rely on periodic security fixes and updates.

The reliance on VR technology has hampered metaverse development and widespread acceptance. Because of portable hardware limitations and the need to strike a balance between cost and design, there is a shortage of excellent graphics and mobility. Lightweight wireless headphones have failed to attain the pixel density required for visual immersion on retina displays. Another barrier to widespread adoption is the high cost of consumer VR headsets, which range in cost from $300 to $3500 in the year 2022.

Another issue to be concerned about is user addiction and inappropriate social media use. Addiction to the internet disorder, social media addiction, and addiction to video games can have long-term mental and physical consequences, such as anxiety, depression, and other harms associated with sedentary lifestyles, such as a higher likelihood of obesity and coronary artery disease. Researchers are additionally worried that the metaverse, like existing internet technologies, may be exploited as a 'escape' from reality. Since associated businesses are expected to gather users' private details through conversations and biometric data gathered from gadgets augmented and virtual reality devices, information privacy is a concern for the metaverse. They focus marketing within their metaverse, which raises further concerns about the spread of disinformation and the loss of personal privacy.

Skeptics see the metaverse as just an extension of today's digital experiences, rather than anything transformational – and perhaps worse: an amplifier of present social media evils such as misinformation campaigns, addictive behaviour, and violent inclinations. The reason for our project is to create convenience for both human beings and doctors. This project mainly focuses on the virtual interaction between patients and doctors. Doctors can treat and diagnose patients upon virtual interaction using the concept of Virtual Reality, Augmented Reality and Internet of Things. No matter the geographical boundaries, a doctor can always interact with the patient via the Internet. Patients' health might be tracked remotely using comfortable, form-fitting clothing.

An E-Garment is designed in such a way that the patient has to wear the garment, in order for the health parameters to be collected from the garment. Three different kinds of sensors such as: Temperature sensor, Pulse sensor and SpO2 sensor. These sensors collect the health vitalities of the patient and send the data to a cloud service provider: Alibaba. This cloud platform will be available and viewable to the doctor and will show the health parameters of the patient, and then the doctor will suggest what has to be done. This project can be carried out in rural areas where old, aged people and people with disabilities can wear the garment and can virtually connect with a doctor. A pop up notification can be sent out to the doctor regarding the health condition of the patient. If the patient's health is critical, a message will be sent mentioning the patient is critical and this will help the patient to receive proper and correct diagnosis and can travel to hospital and get proper treatments.

1.2. OBJECTIVES

- To experience the metaverse will offer three dimensional (3D) experiences that we are unable to have at present.
- To discover a decentralized metaverse has one key feature: all assets and user activity are recorded in blockchains, allowing the user to create their avatars and monetize them in the metaverse.
- To add further layers that aid in decreasing congestion and boosting bandwidth including the 5G network to collect data for healthcare.
- To improve people's quality of life by integrating sensory information about users.

1.3 PURPOSE OF THE PROJECT

1. The reason for our project is to create convenience for both human beings and doctors. This project mainly focuses on the virtual interaction between patients and doctors. Doctors can treat and diagnose patients upon virtual interaction using the concept of Virtual Reality, Augmented Reality and Internet of Things.

2. No matter the geographical boundaries, a doctor can always interact with the patient via the Internet. Patients' health might be tracked remotely using comfortable, form-fitting clothing. An E-Garment is designed in such a way that the patient has to wear the garment, in order for the health parameters to be collected from the garment. Three different kinds of sensors such as: Temperature sensor, Pulse sensor and SpO2 sensor. These sensors collect the health vitalities of the patient and send the data to a cloud service provider: Alibaba. This cloud platform will be available and viewable to the doctor and will show the health parameters of the patient, and then the doctor will suggest what has to be done.

3. This project can be carried out in rural areas where old, aged people and people with disabilities can wear the garment and can virtually connect with a doctor.

4. A pop-up notification can be sent out to the doctor regarding the health condition of the patient. If the patient’s health is critical, a message will be sent mentioning the patient is critical and this will help the patient to receive proper and correct diagnosis and can travel to hospital and get proper treatment.

5. **1.3. MOTIVATION AND SCOPE**

- According to recent estimates, by 2028, India is going to be the most populated nation with the most elderly and old people in the world. As we know technology is very limited among old people, we are planning to use our E-Garment in rural areas, where people residing there have no hospitals nearby or less medical facilities. The sensor-embedded clothing may be tailored to fit closely against the wearer's body.

- This form of sensing might be used to monitor sick individuals at home or in the hospital, as well as sportsmen and astronauts. Because they are customizable and non-invasive, we can create clothing for anyone who needs physical data from their body, such as temperature,

respiration rate, and so on. This will help in obtaining health parameters like heart rate, temperature, etc. and will be stored in a cloud platform, which we are using is Think Speak.

- These data from the cloud will be directly visible to the doctor who is in some other geographical location. A doctor or physician will then check the data stored in the cloud platform and treat or diagnose the patients and suggest what has to be done next.

1.4. METHODOLOGY

This project is about creating wearable clothing (T-shirts, shirts) with sensors to monitor health indicators including blood pressure, heart rate, and body temperature. This system is one good method to help the rural people who find it difficult to travel from remote areas. Our major aim was to assess the body's physical activity in terms of temperature, respiration, and acceleration from the same body part without the need of a fixture or tape. The garment we are using is “cotton”, keeping in mind that we are working with sensors and wires. This cotton material will keep us safe from electrostatic discharge and prevent sensors from getting short circuit and keeping our body safe from electrocution. Cap is used to store the battery and connect all the wires and sensors from one source and provide power to the sensors. The use of Metaverse, with inclusion of Virtual Reality, Augmented Reality and Internet of Things, will make it possible for patients and doctors to communicate electronically in a 3D environment.

Agreements about health monitoring may be required as the usage of metaverse technologies expands. One of the factors is Data privacy which prevents unauthorized gathering, use, or release of a person's private medical information, any health monitoring carried out in the metaverse would need to be subject to strict data privacy safeguards. Users would need to give their explicit consent and be fully informed about the nature and goals of any health monitoring that occurs in the metaverse. We discovered the sensors for the garment— a heart rate sensor and a pulse sensor— to track the patient's pulse and heart rate. We used jumper wires to attach sensors to the Arduino board, upload the necessary code, and get the sensors up and running. took the functional sensors' readings

CHAPTER 2

LITERATURE SURVEY

2.1 REVIEW OBSERVATIONS

The metaverse, which is an amalgamation of technological gadgets, is linked to the Internet of Things, blockchain, artificial intelligence, and all other tech sectors, including the medical one. Metaverse makes the most utilisation of Internet of Things (IoT) gadgets of any virtual workspace, combining IoT and Metaverse digital siblings. This data is utilised as traceable data in the a blockchain-based Metaverse and includes a unique identifying tag.

This project offers a simpler method of control utilizing the Arduino Uno, which is linked to the mobile device via Bluetooth and WiFi. The discussion on the metaverse value chain by Jon Radoff (2021) offers another justification for how the metaverse came to be. The convergence of the Internet, entertainment, and social communities is the emphasis of Radoff's work as a metaverse pioneer. Similar to Ball's (2021) comments, Radoff described the seven strata of the metaverse, which offered a theory for how the metaverse came to be.

The first layer of Radoff's (2021) concept relates to the activities that users can take part in within the metaverse. The metaverse virtual spaces provide consumers with a huge variety of experiences. The second layer, known as the discovery layer, is concerned with how users find unique experiences within the metaverse. Examples include clicking on advertisements, search engine results, or community-driven material that is passed about by word of mouth. The third layer, or creator economy, emphasizes the metaverse growing capacity for ideas to materialize. Spatial computing, the fourth layer, will redraw the lines separating the real and virtual worlds as the creator economy in the metaverse develops.

Three-dimensional (3D) engines that display geometry and animation, data integration from devices and biometrics from individuals, and next-generation user interfaces to allow concurrent information streams are some of the main components of spatial computing. By utilizing blockchain, edge computing, and artificial intelligence (AI) technologies, interoperability fosters experimentation and evolution within the metaverse, which is the fifth layer. Blockchain-based metaverses differ from centralized offers, such the metaverse created by Meta, mostly through their decentralization layer.

Idealistically, the MeTAI metaverse should make it easier to enhance and incorporate disparate, standalone systems into a cohesive healthcare infrastructure. The metaverse new features will reshape society and biomedicine as the technologies supporting it develop. You may converse with the chatbot in a number of human-like ways using Chat GPT, a powered by artificial intelligence natural language processing tool. The model of language may assist you in composing letters, articles, and code, as well as providing answers to your questions.

One potential use of IoT in the metaverse is to create smart homes and smart cities within the virtual environment. IoT devices such as sensors, cameras, and smart appliances could be integrated into virtual homes and buildings, allowing users to interact with these devices as they would in the physical world. For example, users could control virtual thermostats, lights, and security systems using their virtual reality headsets or other devices. IoT could also be used to create more personalized and targeted advertising within the metaverse. By using data from sensors and other IoT devices, advertisers could create more relevant and personalized ads that are tailored to the interests and preferences of individual users

2.2 RESEARCH GAP

The papers on metaverse have been published on various websites, but the best papers were referenced to and the project was continued based on that. Since metaverse is the least explored topic, a lot of research had to be done for certain scientific facts. Throughout the process, metaverse was vastly explored and studied in basis of garment or textile industry wise. Garments for creating new avatar forms is a very unique concept and this project has established new avatars

CHAPTER 3

METAVERSE AND ITS FUTURE CHALLENGES

3.1 GENERAL INTRODUCTION

The metaverse is a virtual universe that is composed of a collective shared space of interconnected virtual worlds. It is a three-dimensional space that exists within a computer-generated environment and is accessed by users through a virtual reality headset or other means of digital access. The metaverse is not just a game or a social network; it is a new kind of platform that allows for immersive and interactive experiences that blur the line between physical and digital reality. The metaverse is considered as the internet's eventual development. Web 3.0, or Web3, refers to a new blockchain-based form of the internet.

The concept of the metaverse has been around for several decades, but recent advancements in virtual reality, augmented reality, and blockchain technology have brought it closer to reality. It has the potential to revolutionize the way we interact with each other, consume entertainment and media, conduct business, and even live our lives. The metaverse is a vast and complex system that will require collaboration between different industries, including gaming, entertainment, technology, and finance. It is still in its early stages, and its potential and implications are still being explored and debated by experts and enthusiasts alike.

- Privacy: The World Wide Web is no longer safe since most corporations are exploiting their users' information to target them with deceptive advertisements. As a result, it is a major fear that these firms would utilise the Metaverse to make more money since they will have access to information about users that was previously unavailable.

- Discrimination: Because only a few individuals will be able to enter the Metaverse owing to a shortage of resources and money, it will increase prejudice and bias in society.

- Women and Child Safety: In the past, the Metaverse has wreaked havoc on women's and children's safety concerns. In the Metaverse 3D virtual environment, awful acts against women and children have been documented. It constitutes one of the more vexing issues in the Metaverse.

- User Addiction: Individuals are becoming increasingly addicted to their social media lives. No one wants to live in the actual world and appreciate the individuals in teir personal connections, but many prefer interacting with one another remotely. The Metaverse will worsen this and lead to increased user addiction in a society with an irresponsible lifestyle.

- Law and Jurisdiction: The Metaverse presently has no laws, regulations, or jurisdictions enforcing them. Because so many individuals will utilise the Metaverse, there is a high likelihood that criminal activity is going to occur in the Metaverse, and thus there are currently no laws dealing with justice and the rule of law in the Metaverse.

3.2 APPLICATIONS OF METAVERSE

The metaverse has a wide range of potential applications in various fields. Some of the most notable applications of the metaverse include:

- Gaming: The metaverse is often associated with gaming as it provides an immersive and interactive gaming experience. Virtual reality and augmented reality games can be created and played within the metaverse, providing gamers with a more realistic and engaging experience.

- Social Networking: The metaverse can be used as a social network platform, where people can interact and connect with each other in a virtual world. Users can create their avatars, chat, attend events, and even attend virtual concerts within the metaverse.

- Education: The metaverse can be used as an educational platform, providing students with an immersive and interactive learning experience. Virtual classrooms and labs can be created, where students can learn and experiment in a safe and controlled environment.

- Business: The metaverse can be used for business purposes, allowing companies to conduct meetings, presentations, and even sell their products and services in a virtual environment. It can also be used for virtual trade shows, providing a more cost-effective and environmentally friendly alternative to physical trade shows.

- The metaverse can be used in healthcare to provide virtual medical consultations, training, and simulations. It can also be used to create virtual hospitals and clinics, providing patients with a more comfortable and safer environment.

3.3 CHALLAU – METAVERSE PLATFORM

Challau is a metaverse platform which provides immersive 3D settings available on all internet-connected devices without the need to download software. More than 20,000 Metaverse user interactions have already occurred since the beta's introduction, and most recently, the platform's user base has grown by 28% week over week. On the Challau platform, people have already produced more than 3800 different virtual 3D spaces.

Using the platform, users may simply construct their own 3D virtual world. Each 3D environment supports full body avatars, spatial audio, real-time high quality web images, avatar audio lip-sync, and micro-expressions, and up to 25 people can interact there at once. On Challau, there are now about 3000 residential properties, 400 workplaces, and over 200 academic campuses. People using the platform to establish their initial presence on virtual assets in the Metaverse are receiving enormous value from it

3.4 LOGIN AND SELECTING AVATARS

Challau Avatars were specifically created with human aesthetics, real-life movement, and behavior in mind. They are racially and culturally varied. Through our avatars, we project our emotions, feelings, and thoughts into the Metaverse. Challau Avatars were created with this in mind, and they can easily convey a lifelike projection of your digital identity thanks to their ability to convey realistic facial expressions and body language. Try a fresh attire as shown in Fig 3.4.1 and Fig 3.4.2 or perhaps even an entirely different personality for your avatar the next time you connect into your virtual world. You may be anybody you want to be on Challau.com; the options are unlimited. We look forward to seeing you in 3D and hope you enjoy the experience!

Each user of a Metaverse requires an avatar, a digital representation of themselves in virtual reality, in order to traverse it. We are represented in the Metaverse by an avatar, and other users communicate with others via our avatar. While some individuals want to pick fresh looks and some want to entirely reinvent themselves, others prefer that their avatars seem as they do in real life. The best part is that you get to pick your Metaverse identity, and unlike in real life, we can instantly modify how we appear, how we dress, and who we are.

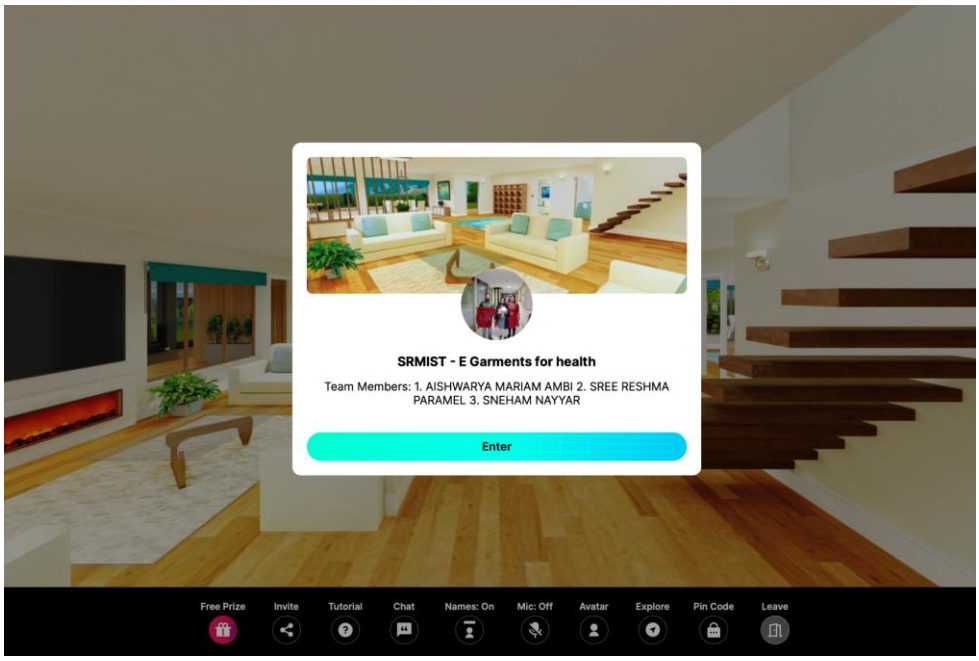

Fig 3.4.1: SRM IST E-Garments for Health Home Screen

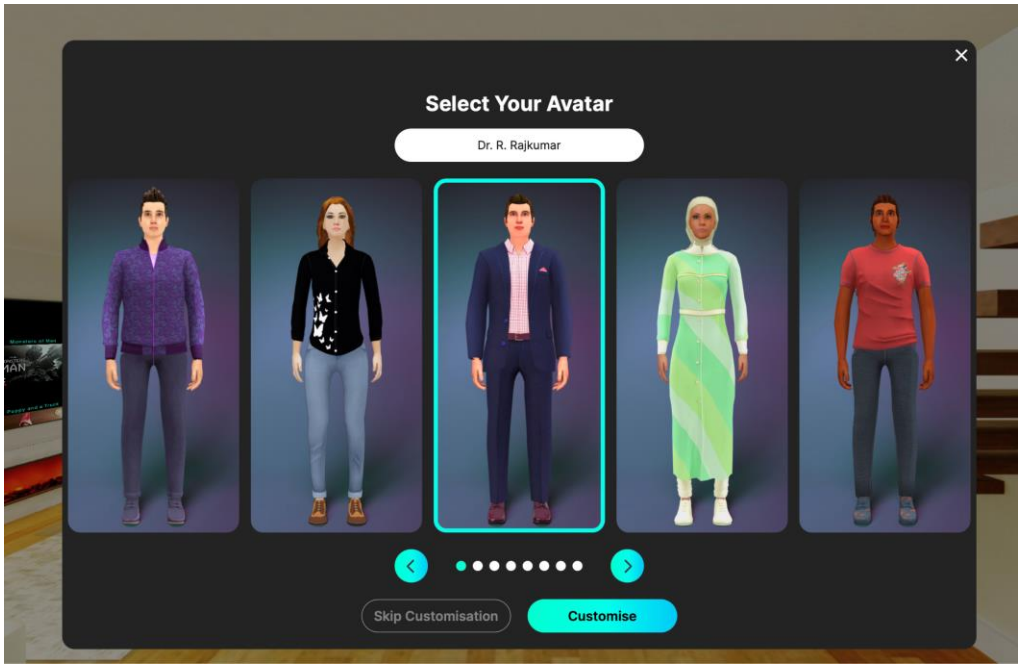

Fig 3.4.2: Selecting Customized E-Garment

3.5 IoT WITH METAVERSE

The combination of the Internet of Things (IoT) and the Metaverse presents a fascinating opportunity for innovation and new experiences. The IoT refers to the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, and connectivity that enables these objects to connect and exchange data. The Metaverse, on the other hand, is a virtual space or universe that is shared by many users and is created by the convergence of physical and virtual reality.

One potential application of IoT and the Metaverse is to create immersive environments where users can interact with smart devices and other IoT-enabled objects in a virtual world. For

example, a user could control their smart home appliances, lighting, and temperature through a virtual interface in the Metaverse, while also seeing a representation of their physical environment. Another use case is to use IoT sensors and devices to collect data from the physical world and integrate it into the Metaverse. This could include information on weather, traffic, pollution, or energy usage, which could then be visualized and analyzed in a virtual environment. For instance, users could monitor air quality in their local area or observe traffic patterns in a city through the Metaverse.

CHAPTER 4

4.1 IMPLEMENTATION AND DIGITAL TWIN

A virtual version of a real thing or system is known as a digital twin, and it has several uses in healthcare. In healthcare, as shown in Fig 4.1. a digital twin can represent a patient's body or a specific medical device or system. By creating a digital twin, healthcare providers can simulate various scenarios and test different treatments without putting the patient at risk. One application of digital twin technology in healthcare is predictive modeling. By using data from sensors and other IoT devices, healthcare providers can create a digital twin of a patient's body and use it to simulate various scenarios. A digital replica is a virtual representation of a physical thing or building.

The phrase was coined in David Gelernter's 1991 book Mirror Worlds, and NASA employed digital twin technology for the first time in 2010 to perform simulations of space capsules. Microsoft, in specific, has emphasized the importance of digital twin technology in the creation of the metaverse.

For example, a doctor could use a digital twin to test different treatments for a particular condition and predict how the patient would respond. This could enable more personalized and effective treatments for patients. Another application of digital twin technology in healthcare is medical device development. By creating a digital twin of a medical device, manufacturers can test and refine the device before it is put into production.

This can help to reduce costs and improve the safety and effectiveness of medical devices. The education of healthcare workers can be enhanced with the help of digital twins. Healthcare professionals can practice and improve their skills in a secure and controlled setting by developing virtual simulations of medical procedures. This can lessen the possibility of medical errors and enhance patient results.

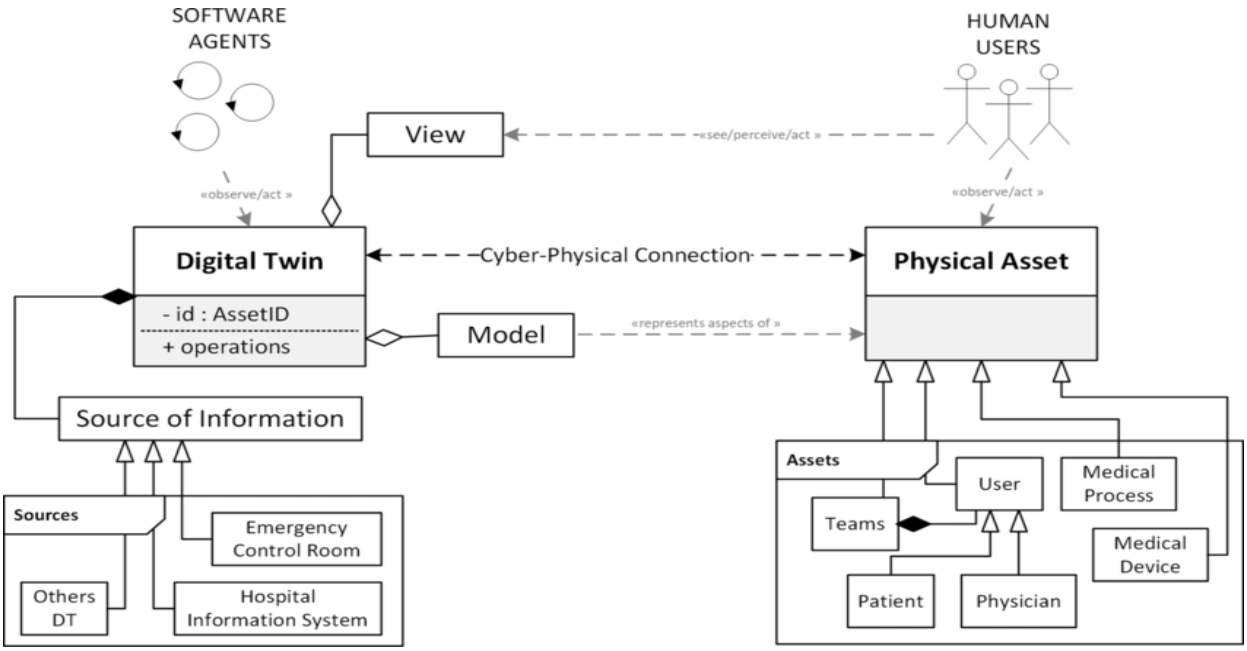

Fig. 4.1.1 Metaverse block diagram in healthcare settings

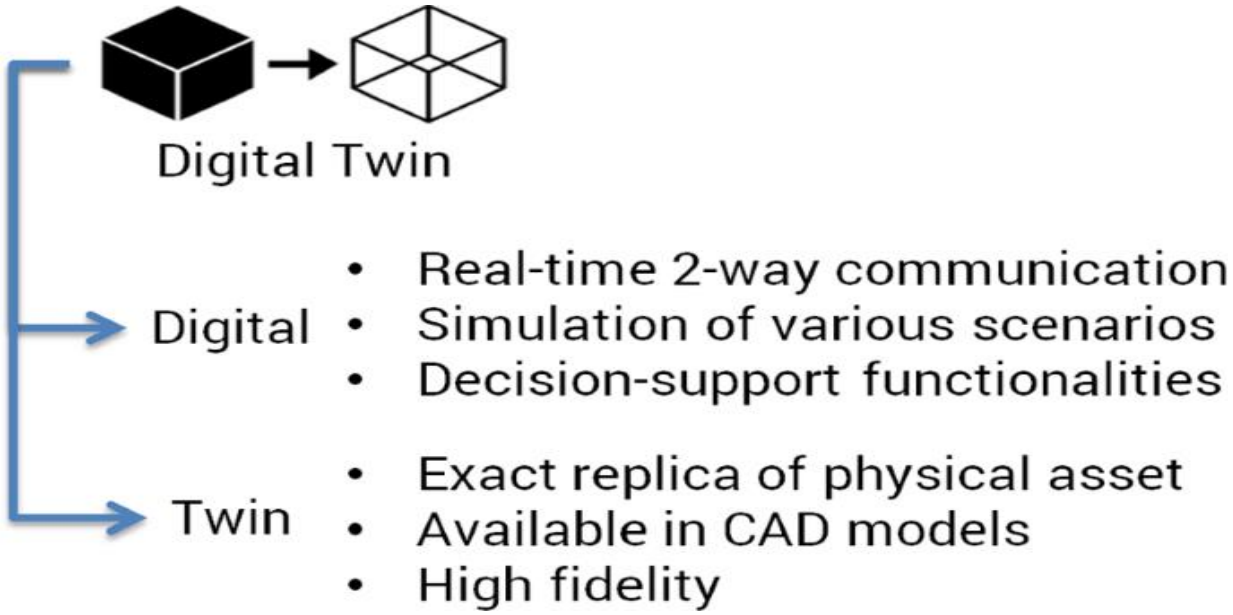

Fig 4.1.2 Digital Twin Diagram

Immersive experiences offered by enhanced (AR) and virtual reality (VR) will allow employees to get practical product design training and experience while sitting at their workstations by manipulating 3-D digital reproductions of equipment. Mass simulation and artificial intelligence (AI) will harness data streams from within and outside the organization to assist top executives forecast what will happen next with incredible accuracy and prescribe the most effective plan for proceeding in even the most chaotic of times.

One telecom and tech company, for example, cut its capital and operational expenditures by 10% as a result of an electronic replica of its network assets. Based on distinct network data, the twin can optimise capital investment, control use patterns, identify problem areas, and automatically conduct digital solutions. The firm believes that its virtual twins will generate millions of dollars in total economic effect over the next decade as they allow further AI use cases and expand the scope of data-driven choices made across the organization.

Our cloud platform Thinkspeaks as a pictorial representation in Fig 4.1.3

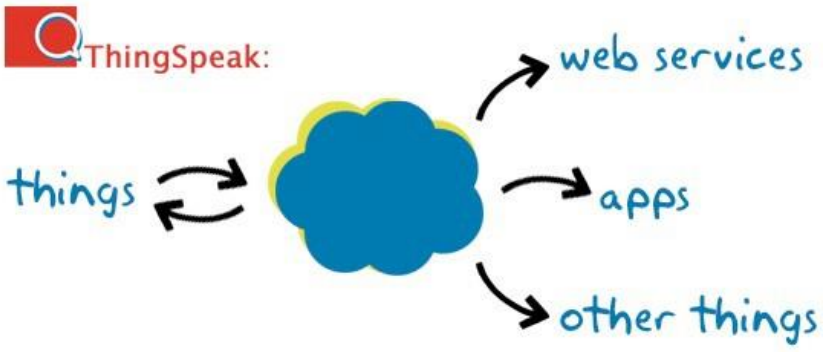

Fig 4.1.3 Thinkspeak representing itself as a cloud interface

CHAPTER 5

5. HARDWARE AND SOFTWARE REQUIREMENTS

The e-garment which is designed is basically cotton material and the sensors are embedded in them. Different types of sensors are used and it will be used to calculate the medical parameters. Different materials were bought and are used for the design of our garment which is prototype.

5.1 Arduino Uno hardware

5.2 Different sensors : -

- Temperature Sensor
- Pulse Sensor
- Gyroscopic Sensor
- Oximeter

5.3 Bread board

5.4 Connector wires

5.5 Jumper wires.

5.1 TEMPERATURE SENSOR

The medical parameters like temperature, heart rate, and pulse rate, we employ a garment embedded with the proper sensors, such as temperature sensors and pulse sensors. We discovered the sensors for the garment—a heart rate sensor and a pulse sensor—to track the patient's pulse and heart rate. We used jumper wires to attach sensors to the Arduino board, upload the necessary code, and get the sensors up and running. Following that, we took the operational sensors' readings. A temperature sensor is a device that measures the temperature

of an object or environment and converts that temperature into an electrical signal that can be measured and analyzed. There are various types of temperature sensors, but the most common type is a thermocouple. A diagrammatic representation is shown in Fig 5.1.1 and Fig 5.

A thermocouple is a device that is a sensor made up of two different metals joined at one end. When the connected end of the two metal is heated or cooled, a voltage corresponding to a temperature differential that exists between the connected end and the other end is created. The voltage generated by the thermocouple can be measured and used to calculate the temperature of the object being measured. The temperature is calculated using a formula that takes into account the properties of the two metals used in the thermocouple, as well as the voltage generated.

Regardless of the type of temperature sensor used, the principle is the same: the sensor detects a change in temperature and turns the variation into an electrical impulse that can be monitored and utilised to calculate temperature of the object or environment being measured

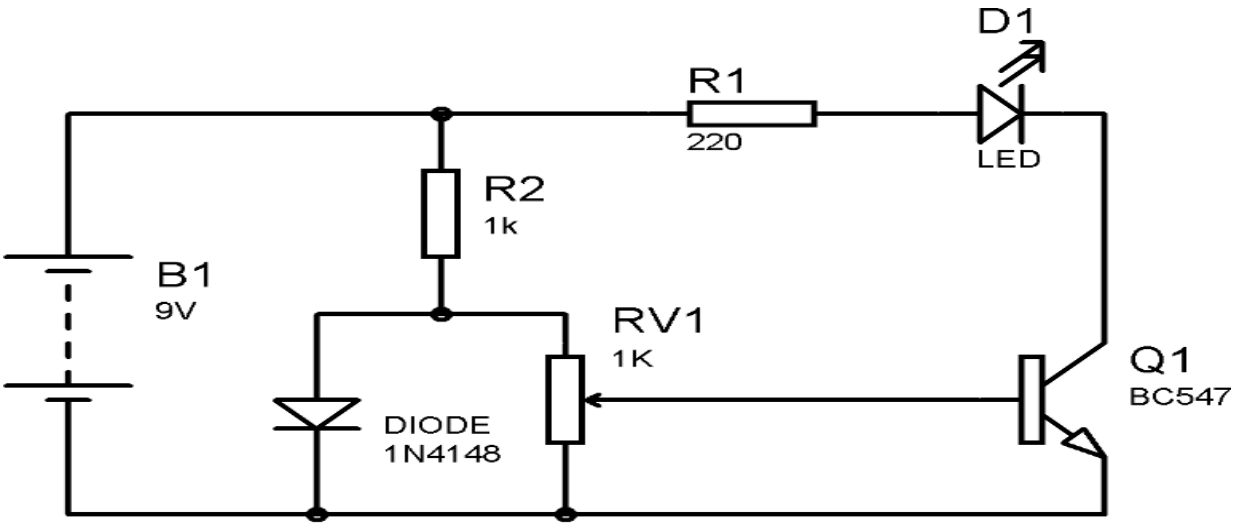

Fig 5.1.1 Circuit diagram for temperature sensor

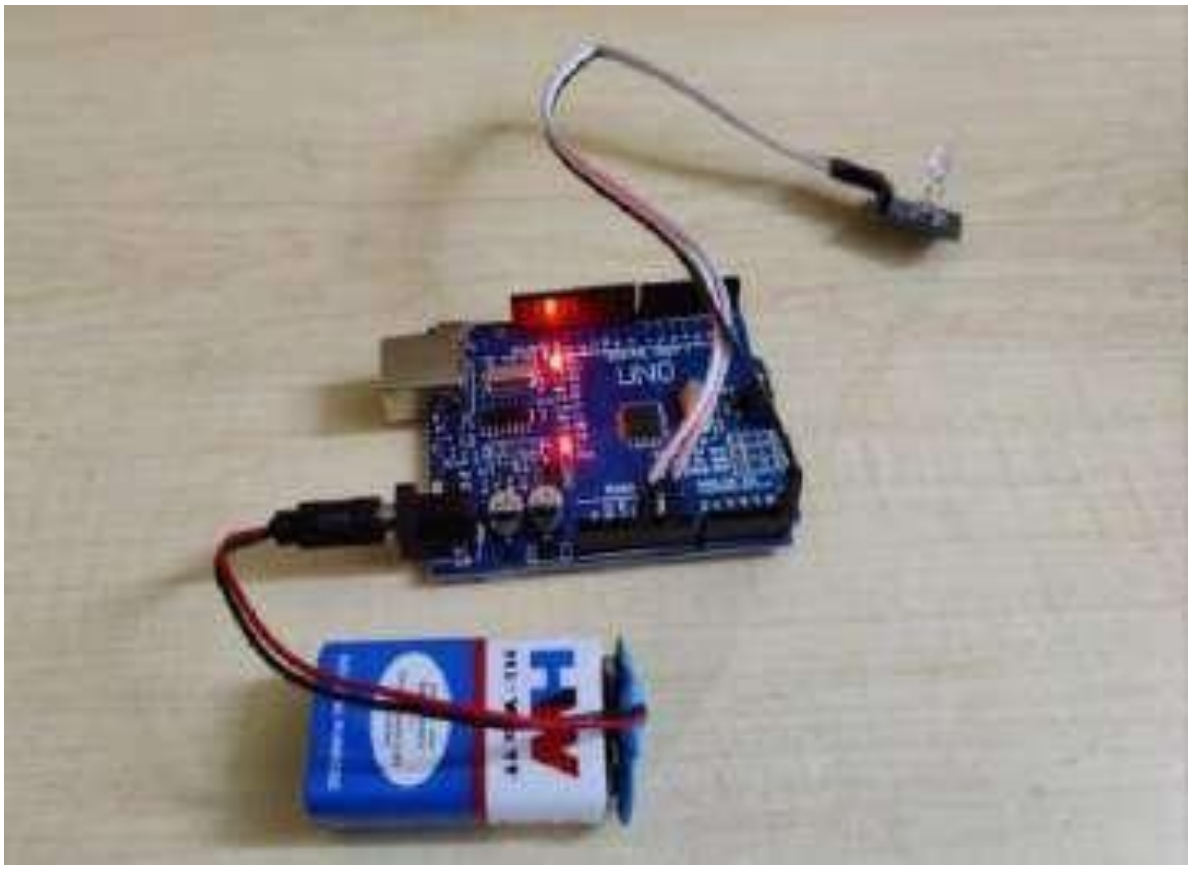

Fig 5.1.2 Temperature sensor

5.1.2. PULSE SENSOR - An optical pulse sensor works by shining a light onto the skin and detecting the changes in blood volume that occur as blood is pumped through the arteries. When the heart beats, there is an increase in blood volume in the arteries, which causes more light to be absorbed by the skin. The sensor detects this change in light absorption and uses it to determine the heart rate as shown in Fig 5.1.2.1 Another type of pulse sensor is an electrocardiogram (ECG) sensor. Through electrodes affixed to the skin, an ECG monitor measures the electrical activity of the heart. As the heart beats, it produces electrical signals that can be detected by the ECG sensor and used to determine the heart rate

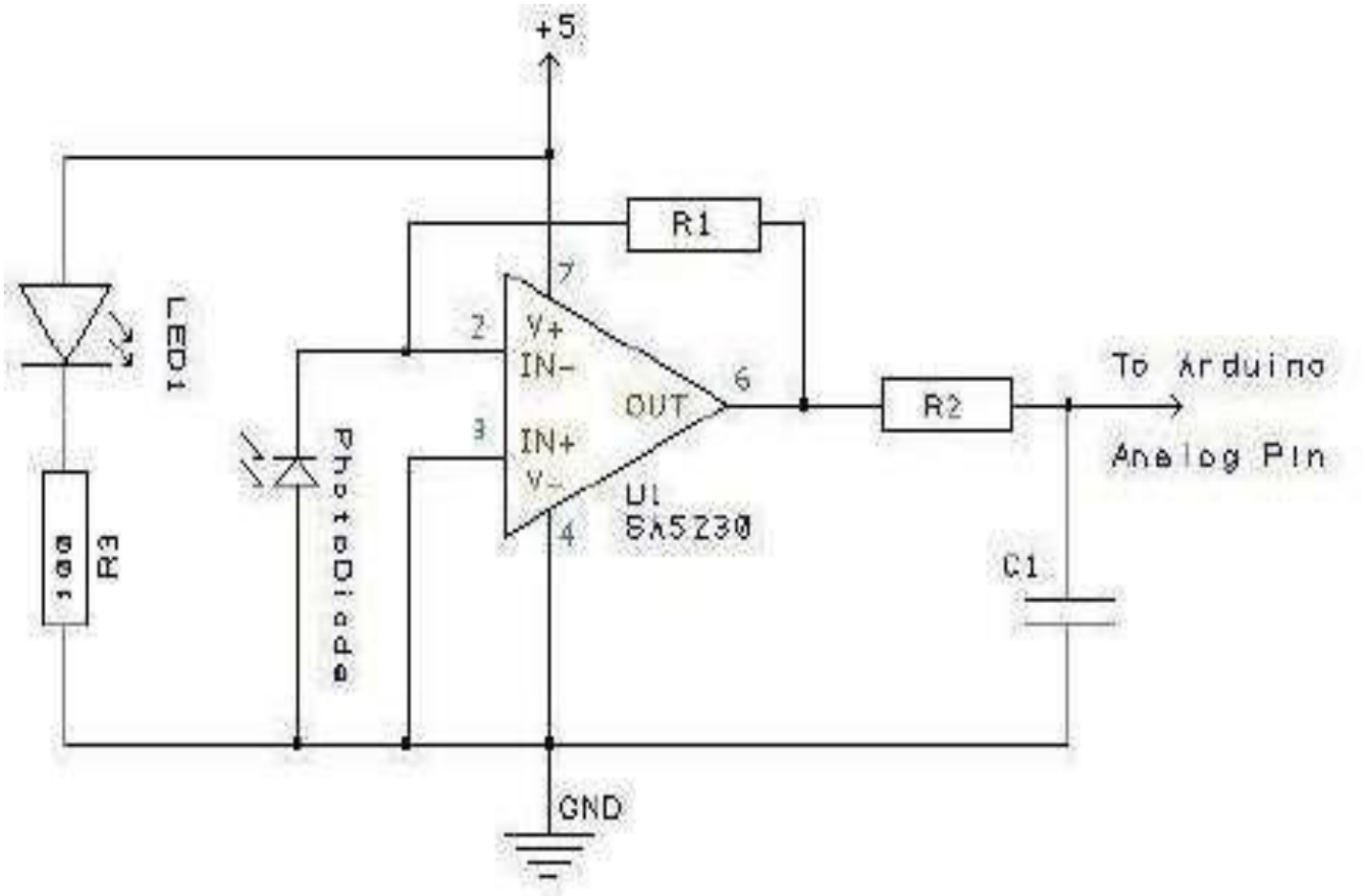

Fig 5.1.2.2.1 Circuit Diagram of Pulse sensor

These devices use the pulse sensor to continuously monitor the wearer's heart rate and provide real-time feedback on their level of activity and overall health. Some pulse sensors also include additional features such as sleep tracking and stress monitoring. Overall, pulse sensors are a useful tool for monitoring heart rate and overall health, especially during physical activity. With the rise of wearable technology, pulse sensors have become more accessible and widely. It used, making it easier for people to track their heart rate and improve their overall health and fitness

In our garment, we have embedded two pulse sensors into the garment for measuring the pulse rate and heart rate of the patient who is wearing it. The health parameters and vitalities will then get recorded and saved as real-time data into the cloud which we are using. Using our 2D experience virtual reality universe - Challau, a doctor can treat and diagnose the patients and check their data by clicking on their avatars, irrespective of geographical locations or boundaries. Fig 5.1.2.2.2 shows working of a pulse sensor.

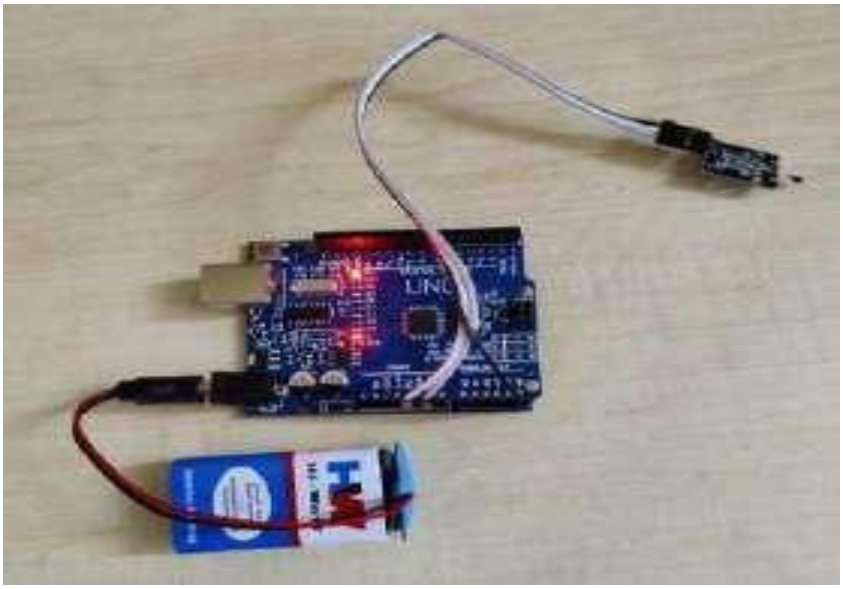

Fig 5.1.2.2.2 Working of a pulse sensor.

5.1.3 GYROSCOPIC SENSOR

A gyroscope is the gadget that detects and records direction and angular velocity. A gyroscope sensor measures an object's angular speed, tilt, or lateral orientation. There are multiple axes of gyroscope sensors available. These sensors are used in situations where the orientation of an item is difficult for humans to detect. With the incorporation of the Gyroscope sensor, more accurate measurements of orientation and movement in 3D space were feasible.

Many consumer gadgets now have accelerometers, which provide new techniques to measure gait, mobility, and fall risk. A number of sensors in devices that are worn can aid in the recording of walking and running data; spatiotemporal and kinematic factors may then be computed in gait analysis. The gyroscopic sensor is one such sensor that we have included in our garment.

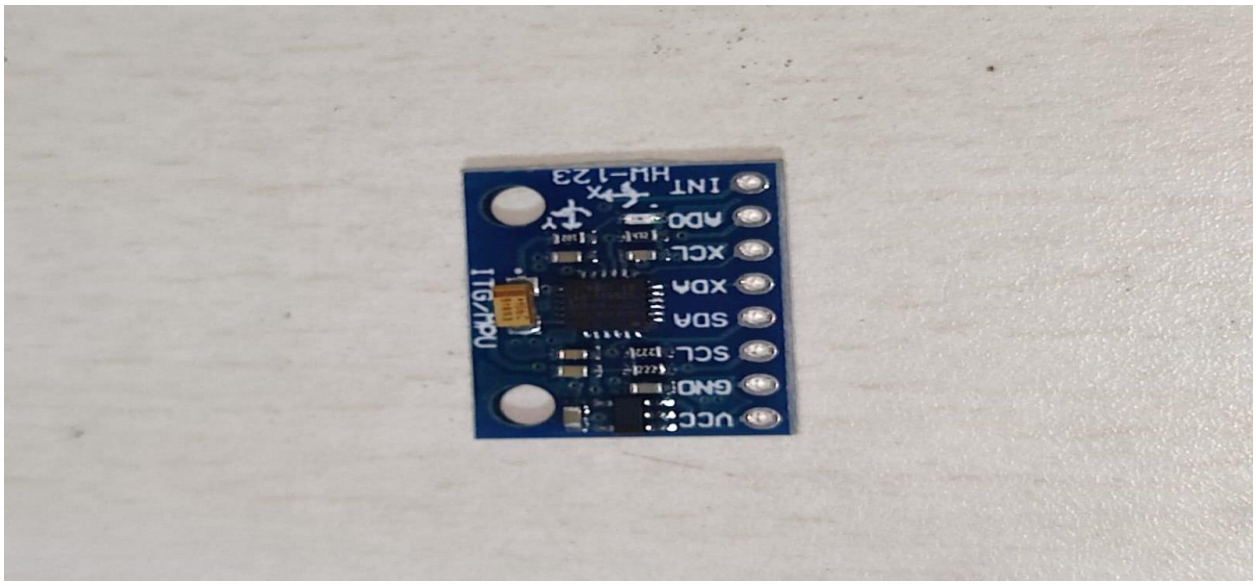

Fig 5.1.3.1 Gyroscopic sensor

5.1.4 OXIMETER

A pulse oximeter measures both the blood oxygen levels and your pulse rate. Low oxygen saturation may occur if you have certain medical conditions. The use of pulse oximetry is a noninvasive test that evaluates the level of saturation of oxygen in your blood. It is capable of detecting even little differences in levels of oxygen in actual time. These levels show how well your blood distributes oxygen to your extremities farthest away from the heart, such as your limbs and arms.

The hemoglobin in our blood is essential for effectively monitoring blood oxygen saturation. The amount of oxygen in hemoglobin influences our blood's ability to absorb red and infrared light rays. Sensors on devices that are worn can detect pulse data by producing light at both of these frequencies. Optical SpO2 sensors monitor oxygen levels using red and infrared light sensors, detecting changes in those levels by observing the color of the blood. The sensor monitors the volume of oxygen in your blood depending on how light travels through your finger and sends the information to the device's screen, which displays the percentage of oxygen in your blood. Fig 5.1.2.4.1 shows an oximeter sensor.

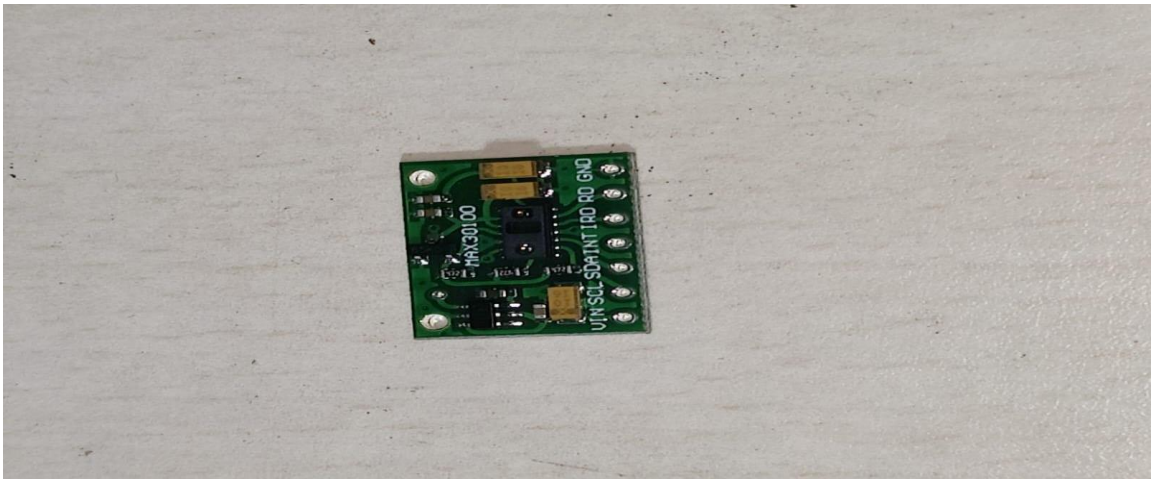

Fig5.1.4.1 shows an oximeter sensor.

5. NUMERICAL ANALYSIS AND DATA VISUALIZATION\

The provided code is an Arduino sketch that reads data from a body temperature sensor and a heart rate sensor, converts the raw data to meaningful values, and displays them on the serial monitor.

bodyTempSensorPin and heartRateSensorPin are constants that represent the analog input pins connected to the body temperature sensor (A3) and the heart rate sensor (A0) respectively

setup() Function:

Initializes the serial communication at a baud rate of 9600. This enables communication between the Arduino board and the computer via the USB cable

Converts the raw data to degrees Celsius using the formula: bodyTempCelsius = ((float)bodyTempReading * 5.0 / 1023.0) * 12;

Converts the raw data to beats per minute (BPM) using the formula: heartRateBPM = ((float)heartRateReading - 400.0) * 0.75;

Prints the converted values of body temperature and heart rate to the serial monitor using the Serial.print() function.

The readings are displayed as "Body temperature: <value> degrees Celsius, Heart rate: <value> BPM".

The loop then repeats, continuously reading the sensors, converting the values, and displaying them on the serial monitor at regular intervals.

5.2.1. Implementation of IoT Sensor in Garments

5.2.1.1 Pulse Sensor to Arduino -

Signal(+) to Analog pin A0

Negative to GND

Voltage to 5V

5.2.1.2 Temperature to Arduino -

Signal(+) to Analog pin A3

Negative to GND

Voltage to 5V

5.2.1.3 ESP8266 WIFi Module to Arduino -

3V3 , RST , EN to 3.3 V

GND , GPIO2 , GPIO0 to GND

TX to RX of Arduino .

RX to TX of Arduino

5.2.2 CODE FOR ARDUINO SENSORS

```
const int bodyTempSensorPin = A3; // Analog input pin for body temperature sensor
const int heartRateSensorPin = A0; // Analog input pin for heart rate sensor


int bodyTempReading = 0; // Raw reading from body temperature sensor
int heartRateReading = 0; // Raw reading from heart rate sensor


float bodyTempCelsius = 0; // Body temperature in degrees Celsius
float heartRateBPM = 0; // Heart rate in beats per minute
```

```
void setup() {
  // Initialize serial communication
  Serial.begin(9600);
}


void loop() {
  // Read raw data from body temperature sensor
  bodyTempReading = analogRead(bodyTempSensorPin);



  // Convert raw data to degrees Celsius
  bodyTempCelsius = ((float)bodyTempReading * 5.0 / 1023.0)*12;
;

  // Read raw data from heart rate sensor
  heartRateReading = analogRead(heartRateSensorPin);


  // Convert raw data to beats per minute
  // This conversion formula may need to be adjusted depending on your heart rate sensor
  heartRateBPM = ((float)heartRateReading - 400.0) * 0.75;


  // Print the readings to the serial monitor
```

```
  Serial.print("Body temperature: ");
  Serial.print(bodyTempCelsius);
  Serial.print(" degrees Celsius, ");


  Serial.print("Heart rate: ");
  Serial.print(heartRateBPM);
  Serial.println(" BPM")

  // Wait for a short period before taking another reading
  delay(1000);
}
```

5.2.3 CODE FOR WIFI MODULE

```
void setup() {
  Serial.begin(9600);
  delay(1000);


  // Reset ESP8266 module
  Serial.println("AT+RST");
  delay(1000);


  // Configure ESP8266 as a Wi-Fi client
  Serial.println("AT+CWMODE=1");
```

```
  delay(1000);


  // Connect to Wi-Fi network
  Serial.println("AT+CWJAP=\"snabc\",\"123456789\"");
  delay(5000);


  // Check if Wi-Fi connection is successful
  Serial.println("AT+CIFSR");
  delay(1000);
}


void loop() {
```

5.4 NUMERICAL ANALYSIS AND EXPERIMENTAL WORK

- We found the sensors for the garment to monitor the pulse and heart rate of the patient i.e. heart rate sensor, pulse sensor. Here we used KY-103 as the temperature sensor, which measures analog signals data and converts it into a digital signal. The pulse sensor we used is KY-039, and these are embedded into the garment, which will then be worn by the patient to measure health vitalities.

- We connected the sensors with the Arduino board Sensors and uploaded the codes on the Arduino sensor using jumper wires and made the sensors working.

- Took the readings of the sensors and the real-time data is stored in a cloud platform Think Speaks, which will be seen in the cloud and can be viewed by doctors or physicians and they will be able to treat patients accordingly.

5.4. DATA VISUALIZATION

The virtual representation of a patient's body or medical condition, healthcare providers can help patients to better understand their condition and treatment options. This can help to improve patient outcomes and satisfaction. Overall, digital twin technology has numerous applications in healthcare, from predictive modeling to medical device development, to healthcare professional training and patient education. Data Visualization diagram is shown in Fig 5.4.1

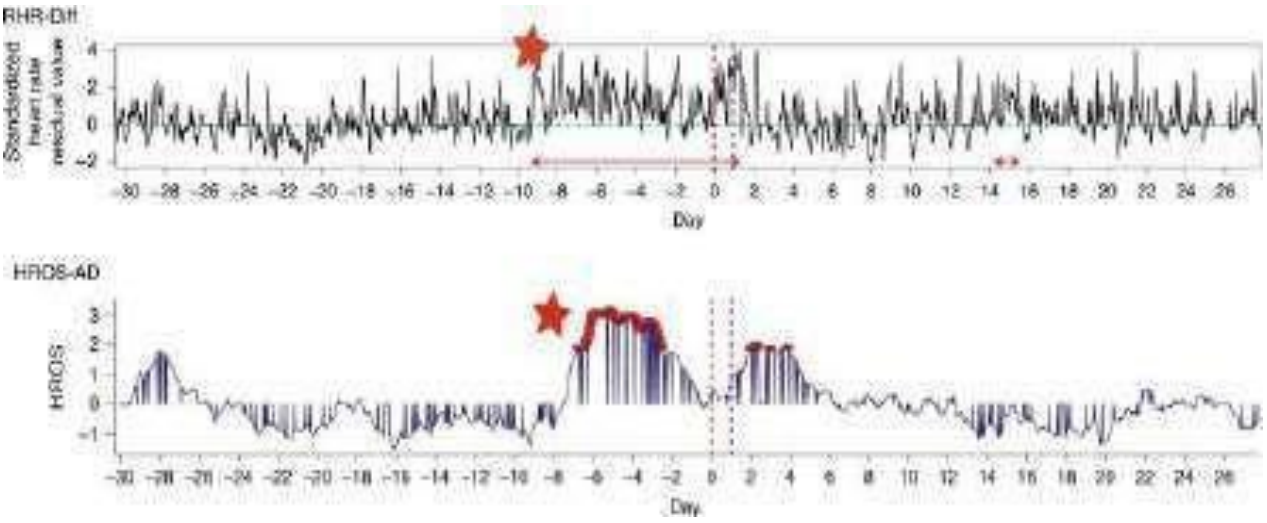

Fig. 5.4.1. Data Visualization of Temperature and Pulse

CONCLUSION

The convergence of the metaverse and IoT has a chance to change the way we interact with clothes and other wearables. By incorporating sensors and other IoT devices into garments, it is possible to create more immersive and interactive experiences that are closely tied to the physical world. The use of temperature sensors and pulse sensors in garments can enable a range of applications, from tracking fitness and wellness to improving safety in hazardous environments. Similarly, the use of motion sensors and gesture recognition technology can enable more natural and intuitive interactions with virtual environments and objects. In addition to the potential applications in the fashion industry, the integration of IoT with the metaverse has the potential to revolutionize healthcare by enabling remote patient monitoring, immersive health education experiences, and improved medical research. Digital twin technology can also be used to create virtual simulations of medical procedures and test different treatments before putting patients at risk. Overall, the integration of IoT with the metaverse has the potential to create more personalized, engaging, and effective experiences in a range of industries, from fashion to healthcare. As technology advances, we may anticipate new and novel applications of the Internet of Things and the alternate universe in clothing. As technology advances, we should expect to witness new and novel applications for digital twins for medical purposes and other wearables develop. In today's corporate sector, there is much talk about the metaverse, notably concerning Industry 4.0, which is credited with embracing automation, data interchange, and manufacturing technology. Digital twins are at the heart of this new industrial revolution, bringing with them boundless potential for the development of the digital and virtual corporate worlds. In the industrial realm, it has transformed the old traditional strategy of "first build, then tweaks." Metaverse, a more simulator-based system design approach with technological improvement, can be provided by digital twins, resulting in far more dynamic hardware or systems.

LIST OF FIGURES

Fig 6 Garment – cotton material

Fig 7 Garment with sensors embedded

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E Garments Metaverse

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