**(Annexure 4.1)**

**A DISSERTION ON**

# "Social Robot Health Monitoring System"

**THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF**

**MASTER OF TECHNOLOGY**

**IN**

(Robotics and Automation)

**SUBMITTED BY**


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**SYMBIOSIS INSTITUTE OF TECHNOLOGY**

**(A CONSTITUTENT OF SYMBIOSIS INTERNATIONAL UNIVERSITY)**

**Pune - 412115**


**YEAR 2023 – 2024**

**(Annexure 4.2)**

# CERTIFICATE

The thesis entitled Social Robot Health Monitoring System submitted to the Symbiosis Institute of Technology, Pune for the award of M. Tech in Robotics and Automation Engineering is based on my original work carried out under the guidance of Dr. Satish Kumar
The dissertation has not been submitted elsewhere for award of any degree.

The material borrowed from other source and incorporated in the dissertation has been duly acknowledged and/or referenced.

I understand that I myself could be held responsible and accountable for plagiarism, if any, detected later on.

Date:

**Signature of the candidate**
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I am deeply thankful to my friends and family for their love and support during this process. Without their encouragement and motivation, I would not have been able to complete this journey.

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## LIST OF ABBREVIATIONS

| Symbol | Definition |
|---|---|
| AI | Artificial Intelligence |
| IoT | Internet of Things |
| RFID | Radio Frequency Identification |
| COVID | Coronavirus Diseases |
| CGM | Continuous Glucose Monitoring |
| ECG | Electrocardiogram |
| UV-C | Ultraviolet- C |
| RTLS | Real-Time Location Systems |
| HRI | Human Robot Interaction |
| DC | Direct Current |
| IR | Infrared Radiation |

| | |
|---|---|
| Vcc | Voltage Common Collector |
| RsT | Rest Pin |
| IRQ | Interrupt Pin |
| SCK | Serial Clock Pin |
| GPIO | General Purpose Input/Output |
| DSI | Display Serial Interface |
| MIPI | Mobile Industry Processor Interface |
| LED | Light Emitting Diode |
| CSI | Camera Serial Interface |
| JTAG | Joint Test Action Group |
| HDMI | High-Definition Multimedia Interface |

# Abstract

"Social Robot Health Monitoring System" is an innovative combination of cutting-edge technology, healthcare, and modern robotics. The goal of this ground-breaking research is to completely transform how people manage their health in social settings. It presents a multifunctional system with the potential to revolutionize health monitoring in social contexts by utilizing the capabilities of a Raspberry Pi-based robot, RFID technology, heartbeat and temperature sensors, line following mechanisms, obstacle detection systems, and cloud-based connectivity.

The main goal of this project is to build a flexible, intelligent robot that can carry out health checks and independently follow predetermined routes. The use of RFID technology enables the robot to stop at designated checkpoints for health evaluations, offering a thorough picture of a person's health by gathering data in real-time from temperature and cardiac sensors. The robot's obstacle detection algorithms contribute to a safe and dependable monitoring procedure by guaranteeing the safety of both the robot and its surroundings.

Centralized data storage and analysis are made possible by the easy transfer of the gathered health data to a cloud-based server. In order to provide prompt actions in emergency circumstances, an alert system is designed to notify pertinent stakeholders whenever health metrics surpass certain limits.

By automating and improving health monitoring in social situations, the "Social Robot Health Monitoring System" project shows how modern technology may improve healthcare procedures. In addition to advancing the field of health monitoring, it opens the way for further advancements in social robots and healthcare automation. Through the provision of proactive, efficient, and reliable health monitoring systems, this invention has the potential to have an important impact on healthcare facilities, caregivers, and individuals.

# Chapter 1

# Introduction

## 1.1 Background

Health monitoring is a fundamental component of modern healthcare, playing a pivotal role in disease prevention, early intervention, and overall well-being. Traditionally, health monitoring has relied on periodic check-ups, manual data collection, and often limited by the availability of healthcare professionals. However, in an era defined by rapid technological advancements, the landscape of health monitoring is undergoing a transformative shift. The emergence of robotics, the Internet of Things (IoT), and artificial intelligence (AI) has paved the way for innovative and more efficient approaches to healthcare.

The "Social Robot Health Monitoring System" is a groundbreaking project designed to harness these technological advancements and revolutionize health monitoring in social settings. It addresses several critical challenges and limitations of traditional health monitoring methods, offering a multifunctional solution that integrates social robots, sensor technologies, and real-time data analysis. To appreciate the significance of this project, it is essential to understand the background and the issues it aims to address. following is the representation of the bibliometric graph and Tree Map which tend to highlights how much work is been done in the mentioned domain all over the globe.

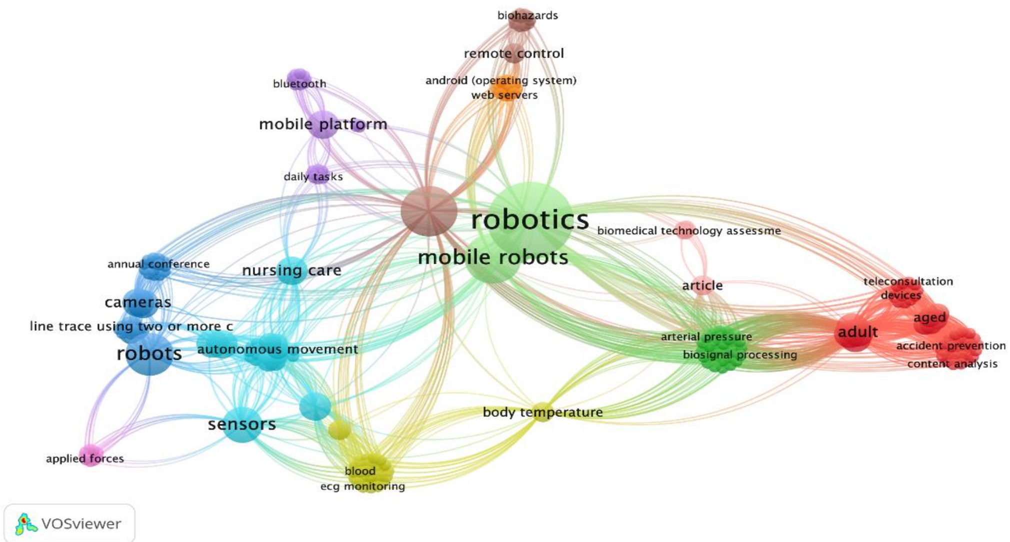



**Figure 1**: Co-occurrences of keywords from Scopus (Access Date: 25th October,2023)

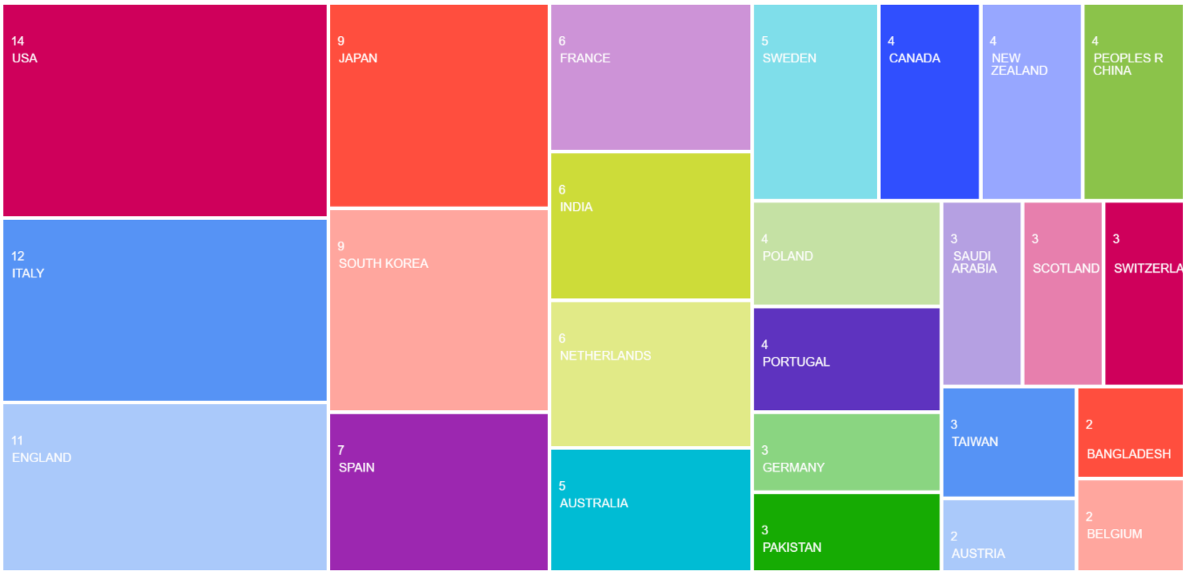



**Figure 2**: Countries/Regions wise publications from Web of Science

Here, Figure 2 shows the Countries/Regions wise publications done for Social Robot For Health Monitoring System from "Web of Science"

## 1.2 Motivation of Study

The "Social Robot Health Monitoring System" stems from a pressing need to revolutionize healthcare by leveraging cutting-edge technology. In an era characterized by an aging population, chronic diseases, and resource constraints, the demand for efficient and patient-centric health monitoring solutions has never been more acute.

Traditional healthcare methods are often limited by the availability of healthcare professionals, fragmented health data, delayed intervention, and concerns about privacy and dignity. Social robots, with their capacity for empathetic interactions, can bridge these gaps, offering continuous, non-intrusive, and personalized health assessments. The integration of sensor technologies and data analysis further enhances the system's capabilities, enabling early intervention and predictive insights.

This project is driven by the vision of a future where healthcare is not bound by physical barriers, and where individuals can receive high-quality health assessments in a social, comfortable, and dignified manner. The "Social Robot Health Monitoring System" aspires to make this vision a reality.

### 1.3 Research Objectives

1. Develop a socially interactive robot capable of autonomously navigating through predefined routes.
2. Implement RFID technology to enable the robot to stop at designated locations for health assessments.
3. Integrate heartbeat and temperature sensors for real-time health data collection.
4. Create a mechanism for obstacle detection and response to ensure safe operation.
5. Establish connectivity to Thing speak for centralized health data storage and analysis.
6. Implement an alert system to notify relevant parties when health parameters exceed defined thresholds.

### 1.4 Scope of Study

The "Social Robot Health Monitoring System" project boasts a broad scope that encompasses the development of both hardware and software components. This holistic approach aims to ensure seamless integration and efficient functionality of the system. The primary application of this innovative system lies in the realm of health monitoring within social environments. Its versatility makes it a valuable tool for a range of stakeholders, including healthcare professionals, caregivers, and institutions with a focus on proactive health management.

Traditional healthcare methods face numerous challenges, from resource constraints to fragmented health data and delayed interventions. The "Social Robot Health Monitoring System" seeks to address these issues by leveraging state-of-the-art technology. The robot can autonomously navigate predefined paths, stop at designated checkpoints, and conduct non-intrusive health assessments using a variety of sensors, including RFID, heartbeat, and temperature sensors. Moreover, it incorporates obstacle detection systems to ensure safety.

Crucially, the project offers a glimpse into the future of healthcare. By showcasing the capabilities of modern technology in health monitoring, it sets the stage for forthcoming advancements in both robotics and healthcare automation. The project's potential extends beyond mere data collection, it paves the way for personalized, patient-centric healthcare, and serves as a catalyst for reimagining the healthcare landscape. As technology continues to evolve, the project underscores the immense potential for more sophisticated and impactful solutions, ultimately enhancing the quality of care and overall well-being in social environments.

# Chapter 2

# Literature Review

## 2.1 Health Monitoring Technologies

A lot of progress has been made in health monitoring technology throughout the years. Historically, manual data gathering and occasional check-ups have been the mainstays of the healthcare system. But recent advancements in sensors, wearable technology, and the Internet of Things have completely changed how health is tracked. Fitness trackers and other wearable technology may gather information on steps done, heart rate, and even sleep habits. More complete health monitoring options, like the Social Robot Health Monitoring System, which combines many technologies to deliver real-time health data, have been made possible by this advancement.

### 2.1.1 Historical Evolution

Healthcare robotics integration has the potential to revolutionize the sector. Robots may help with a variety of jobs, including patient care and medical operations. They provide accuracy, reliability, and human contact in the case of social robots. Robots can help in rehabilitation, according to research, especially when it comes to repeated workouts. Additionally, they might lessen patients' feelings of loneliness by offering company. Specifically, social robots have been used to interact with people in medical environments, proving they can offer both emotional and psychological assistance.

### 2.1.2 Current Trends

In "Health Monitoring Technologies" encompass a dynamic and evolving landscape in healthcare. It's crucial to understand these trends to contextualize the development and significance of the "Social Robot Health Monitoring System." Here's a detailed exploration of current trends in health monitoring technologies:

1. Wearable Health Devices: Wearable technology has revolutionized personal health monitoring. Devices like smartwatches, fitness trackers, and even smart clothing can track various health parameters such as heart rate, activity levels, sleep patterns, and more. These devices have gained popularity due to their convenience, allowing users to continuously monitor their health in real-time.
2. Remote Patient Monitoring: With the advancement of telemedicine and IoT, remote patient monitoring has become a significant trend. Patients can now be monitored from the comfort of their homes, reducing the need for frequent hospital visits. Medical

professionals can remotely track patients' vital signs, chronic conditions, and adherence to treatment plans, improving patient outcomes and reducing healthcare costs.

3. Mobile Health (mHealth) Applications: The proliferation of smartphones has led to the development of a vast array of mobile health applications. These apps help individuals monitor their health, providing resources for fitness, nutrition, medication reminders, and symptom tracking. They also facilitate communication with healthcare providers and offer access to telemedicine services.
4. Data Analytics and Artificial Intelligence: The integration of data analytics and artificial intelligence (AI) has enhanced health monitoring and diagnostics. AI algorithms can analyze large datasets, identify trends, and provide insights into a patient's health. Machine learning models can predict disease progression and suggest personalized treatment plans, ultimately leading to more effective healthcare.
5. Internet of Things (IoT): IoT devices have found extensive applications in health monitoring. These interconnected devices can collect and transmit health data to central systems. Examples include smart scales, blood pressure monitors, and glucometers that automatically share data with healthcare providers, ensuring that any critical changes in a patient's condition are quickly identified and addressed.
6. Personalized and Predictive Healthcare: Health monitoring is increasingly shifting towards personalization. Rather than one-size-fits-all approaches, healthcare is becoming more tailored to individual needs. Predictive analytics can anticipate health issues, enabling early intervention. Personalized health plans and treatments improve outcomes by accounting for an individual's unique genetic, lifestyle, and environmental factors.
7. Telemedicine and Virtual Health: The COVID-19 pandemic accelerated the adoption of telemedicine and virtual health services. Remote consultations with healthcare professionals, prescription management, and remote monitoring have all become standard practices. This trend is likely to continue as it provides accessible and efficient healthcare services.
8. Continuous Glucose Monitoring (CGM) for Diabetics: For individuals with diabetes, continuous glucose monitoring (CGM) devices have become a game-changer. These devices track blood glucose levels in real-time and provide alerts when levels are too high or too low. They not only improve diabetes management but also enhance quality of life.

9. Non-Invasive Health Monitoring: Advances in non-invasive monitoring technologies have made it possible to measure various health parameters without the need for invasive procedures. For instance, non-invasive blood pressure monitors, smart thermometers, and wearable electrocardiogram (ECG) devices offer convenient and comfortable monitoring options.
10. Mental Health Monitoring: Mental health monitoring is gaining recognition as an essential component of overall health. Mobile apps and wearable devices are being developed to track emotional well-being, stress levels, and sleep quality. These technologies are contributing to improved mental health awareness and support.

Understanding these trends in health monitoring technologies is critical because the "Social Robot Health Monitoring System" fits into this dynamic landscape. It leverages these trends by providing a socially interactive, autonomous robot capable of integrating wearable health sensors and delivering real-time health assessments. It aligns with the direction of healthcare and technology by offering a proactive and innovative approach to health monitoring in social settings.

**2.2 Roles of Robotics in Healthcare**

The roles of robotics in healthcare are increasingly significant, as technological advancements continue to transform the field. Robots are being deployed in various healthcare settings to improve patient care, streamline processes, and assist healthcare professionals. Here are some key roles that robotics play in healthcare:

1. Surgical Assistance:
   - Minimally Invasive Surgery: Robots are used in minimally invasive procedures, such as laparoscopic and robotic-assisted surgeries. These robots provide surgeons with greater precision and dexterity, leading to smaller incisions, reduced blood loss, and faster patient recovery.
2. Rehabilitation and Physical Therapy:
   - Robot-Assisted Rehabilitation: Robots are used to assist patients in physical therapy and rehabilitation. These robots can guide patients through exercises with a high degree of accuracy, making them especially useful in stroke recovery, spinal cord injuries, and musculoskeletal disorders.

3. Diagnostic and Therapeutic Applications:
   - Robotic Imaging: Robotic systems can perform medical imaging, such as CT scans and ultrasounds, with high precision. This aids in diagnostics and treatment planning.
   - Radiation Therapy: In radiation oncology, robots can precisely deliver radiation to tumors, sparing healthy tissue. CyberKnife is one such example.
4. Telemedicine and Remote Surgery:
   - Teleoperated Robots: Surgeons can perform surgeries from a remote location using teleoperated robots. This is especially valuable for addressing surgical needs in underserved areas or during emergencies when specialists are not physically present.
5. Medication Management:
   - Pharmacy Robots: Robots are used in pharmacies to automate the dispensing of medications, ensuring accurate and efficient prescription filling. They can also package and label medications for individual patients.
6. Elderly Care:
   - Assistive and Companion Robots: Robots are employed to assist the elderly with daily tasks, including mobility support, medication reminders, and companionship. These robots can help improve the quality of life for elderly individuals and reduce the burden on caregivers.
7. Hospital Logistics and Cleaning:
   - Delivery Robots: Robots can transport supplies, medications, and equipment within hospitals, reducing the workload of healthcare staff.
   - Cleaning Robots: Autonomous robots can sterilize and clean hospital rooms, ensuring a sanitary environment.
8. Infectious Disease Management:
   - Disinfection Robots: In response to the COVID-19 pandemic, UV-C light-emitting robots have been used to disinfect hospital rooms and other healthcare facilities, reducing the risk of infection.
9. Laboratory Automation:
   - Lab Robots: Robots are utilized in laboratory settings to automate processes like sample handling, testing, and data analysis. This enhances the efficiency and accuracy of diagnostic tests.

10. Drug Discovery and Research:
    - High-Throughput Screening Robots: In pharmaceutical research, robots are employed to automate drug screening and high-throughput experiments, accelerating the drug discovery process.
11. Surgical Training and Education:
    - Simulators: Robotics-based simulators are used for surgical training, allowing medical professionals to practice and improve their skills in a safe, controlled environment.
12. Emotional Support and Mental Health:
    - Social Robots: Some robots are designed to provide emotional support, particularly in pediatric and mental health settings. These robots offer companionship, monitor patients' emotional states, and deliver cognitive-behavioral therapy.
13. Data Analysis and Prediction:
    - AI-Enhanced Robots: Robots with artificial intelligence capabilities can analyze patient data, predict disease outcomes, and recommend personalized treatment plans.

The integration of robotics into healthcare is driven by the desire to improve patient outcomes, enhance the efficiency of healthcare processes, and reduce the burden on healthcare professionals. As technology continues to advance, robots are likely to play an increasingly pivotal role in providing high-quality, accessible, and efficient healthcare services. However, it's essential to address ethical, privacy, and safety considerations as robotics becomes more deeply ingrained in healthcare.

### 2.2.1 Application

A flexible and innovative solution for health monitoring in a variety of contexts is provided by the Health Monitoring Robot Project. It incorporates cutting-edge technology like RFID, sensors, and robots to automatically evaluate a person's health. The robot may be used in assisted living facilities and healthcare institutions to do routine health screenings, support medical staff, and offer patients company. In addition to improving patient care, this initiative expedites healthcare procedures and guarantees accurate and proactive health monitoring in a variety of settings.

### 2.2.2 Challenges

Developing the Health Monitoring Robot Project presented several complex challenges. Firstly, integrating multiple technologies such as RFID, sensors, and robotics required meticulous coordination, posing a significant technical challenge. Ensuring the robot's ability to autonomously navigate predefined routes and stop accurately at RFID checkpoints demanded precise programming and obstacle detection mechanisms.

Data privacy and security were paramount challenges. Handling sensitive health information required robust encryption and compliance with stringent privacy regulations to protect patient data. Moreover, addressing ethical concerns related to consent and patient autonomy in data collection was vital.

Robustness and reliability were obstacles. The robot needed to function consistently in dynamic environments, accounting for variables like patient mobility or environmental changes. This necessitated rigorous testing and refinement.

Finally, cost and scalability challenges emerged. Balancing project costs with the need for affordable healthcare solutions proved complex. As the project aimed to be deployed in various settings, scalability considerations required adaptable hardware and software.

Overcoming these challenges required interdisciplinary expertise, careful planning, and a commitment to patient safety and data privacy.

### 2.3 RFID Technology in Healthcare

RFID (Radio-Frequency Identification) technology has found significant applications in healthcare, revolutionizing patient care, tracking, and asset management. Here's an overview of RFID technology in healthcare:

1. Patient Identification: RFID is used for patient identification and record management. Each patient is assigned an RFID tag or wristband containing their medical history, allergies, and other vital information. This aids in accurate identification, ensuring the right treatment and medication.
2. Asset Tracking: Hospitals use RFID to track expensive medical equipment, medications, and supplies. This minimizes theft, reduces loss, and ensures that critical assets are readily available when needed, improving operational efficiency.
3. Medication Management: RFID is employed to manage medication. Each medication container or packet can have an RFID tag, ensuring that the right medication is administered to the right patient, at the right time and in the right dosage. This prevents medication errors.

4. Inventory Control: RFID streamlines inventory management. Hospitals use RFID to monitor the levels of supplies like gloves, gauze, and syringes. When supplies reach a predefined threshold, the system can automatically reorder them.
5. Access Control: RFID cards or badges are used for access control to restricted areas within healthcare facilities. This enhances security and ensures that only authorized personnel can access sensitive areas.
6. Patient Tracking: In large healthcare facilities, RFID tags can be used for tracking patients' movement. This ensures that patients are in the right place at the right time, reducing wait times and improving patient flow.
7. Blood and Tissue Tracking: RFID tags are used to track the origin and movement of blood samples and tissues. This is critical for ensuring that blood products are handled safely and that the right tissues are used in surgical procedures.
8. Infection Control: Some hospitals use RFID for infection control. By tracking the movements of staff and patients, they can identify potential sources of infection outbreaks and take preventive measures.
9. Real-Time Location Systems (RTLS): RTLS using RFID technology enables the tracking of assets and people in real time. It's particularly useful for quickly locating medical equipment and personnel in emergency situations.
10. Temperature Monitoring: For sensitive medications and specimens, RFID can monitor temperature. If a medication or sample exceeds or falls below the desired temperature range, an alert is triggered

In summary, RFID technology has significantly improved healthcare operations by enhancing patient safety, streamlining inventory management, ensuring medication accuracy, and improving the overall efficiency of healthcare facilities. As technology continues to advance, RFID's role in healthcare is likely to expand further, making healthcare processes even more secure and efficient.

### 2.3.1 Principles and Operation

The "Social Robot for Health Monitoring System" operates on the principles of integrated sensor technology, automation, and data analysis to provide comprehensive health monitoring and support in social settings.

1. Sensor Integration: The core principle is the integration of multiple sensors, including RFID technology for navigation, heartbeat and temperature sensors for

health data collection, and ultrasonic sensors for obstacle detection. These sensors work collectively to provide real-time data and ensure the robot's safe navigation.

2. Navigation and Localization: The robot uses RFID technology to navigate predefined routes. RFID tags serve as checkpoints, allowing the robot to stop at predetermined locations for health assessments. This principle ensures the robot moves efficiently and accurately within the environment.
3. Health Data Collection: The robot's heartbeat and temperature sensors are designed to collect vital health data from individuals. These sensors are non-invasive, making the health assessment process comfortable for the user.
4. Obstacle Detection and Response: The robot's ultrasonic sensors detect obstacles in its path and trigger a response, ensuring the safety of both the robot and the individuals in its vicinity.
5. Data Analysis and Connectivity: Health data collected by the robot is analyzed and transmitted to a web server, ensuring centralized data storage and easy access for healthcare professionals and caregivers. This principle ensures that health data is readily available for analysis and decision-making.
6. Alert System: An alert system is integrated to notify relevant parties when health parameters surpass predefined thresholds. This principle provides timely intervention in case of critical health events.

The operation of the "Social Robot for Health Monitoring System" revolves around these principles, enabling the robot to autonomously navigate, conduct health assessments, ensure safety, and provide a centralized platform for health data storage and analysis. This innovative approach aims to enhance health monitoring in social settings, improving the well-being of individuals and supporting healthcare professionals and caregivers in their roles.

### 2.3.2 Use Cases

The "Social Robot for Health Monitoring System" offers a wide range of use cases in various healthcare and social settings, making it a versatile tool for proactive health management and support. Some key use cases include:

1. Hospitals and Clinics: In healthcare institutions, the robot can conduct routine health assessments for patients, monitor vital signs, and alert healthcare professionals when critical thresholds are reached, enhancing patient care.

2. Nursing Homes and Assisted Living Facilities: The robot can provide companionship to residents, assist with daily tasks, and continuously monitor their health, reducing feelings of isolation and ensuring timely care.
3. Home Healthcare: For individuals receiving home healthcare, the robot can collect health data, remind patients to take medication, and offer a connection to healthcare providers through telemedicine.
4. Rehabilitation Centers: In rehabilitation settings, the robot can guide patients through exercises, track progress, and provide emotional support during recovery.
5. Schools and Special Education Centers: The robot can help monitor the health of students, particularly those with special needs, ensuring their safety and well-being.
6. Disaster Response: In disaster-stricken areas, the robot can assist in providing healthcare services, monitor the health of survivors, and relay vital information to emergency responders.
7. Elderly Companionship: The robot can serve as a friendly companion for elderly individuals, engaging in conversations and activities to reduce loneliness.
8. Remote Health Monitoring: In remote or underserved areas, the robot can autonomously navigate and conduct health assessments, serving as a telemedicine hub.
9. Health and Wellness Promotion: The robot can promote healthy lifestyles by offering exercise guidance, nutritional advice, and monitoring progress for individuals looking to improve their overall health.
10. Research and Data Collection: The robot can be deployed for health-related research, collecting valuable data and contributing to the advancement of healthcare knowledge.

The "Social Robot for Health Monitoring System" demonstrates its adaptability and potential across a spectrum of healthcare and social scenarios, enhancing the quality of care, ensuring patient safety, and supporting healthcare professionals and caregivers in various environments.

**2.4 Obstacle Detection in Robotics**

Obstacle detection in the "Social Robot for Health Monitoring System" is a critical component that ensures the safety of both the robot and the individuals it interacts with.

The system employs ultrasonic sensors to detect obstacles and obstacles' distances in real-time.

The operation of the obstacle detection system is based on the principle of emitting high-frequency sound waves, which bounce off nearby objects and return to the sensors. By measuring the time it takes for the sound waves to return, the system can accurately determine the distance to obstacles. When obstacles are detected within a predefined safety range, the robot's control system triggers an immediate response.

The response typically involves the robot halting its movement, altering its path, or adjusting its speed to avoid collisions. This real-time obstacle detection mechanism guarantees that the robot operates safely in dynamic and potentially crowded environments, preventing accidents and ensuring the well-being of both patients and healthcare professionals. It's an indispensable feature in healthcare and social settings where human-robot interactions are frequent and safety is paramount.

### 2.4.1 Ultrasonic Sensors

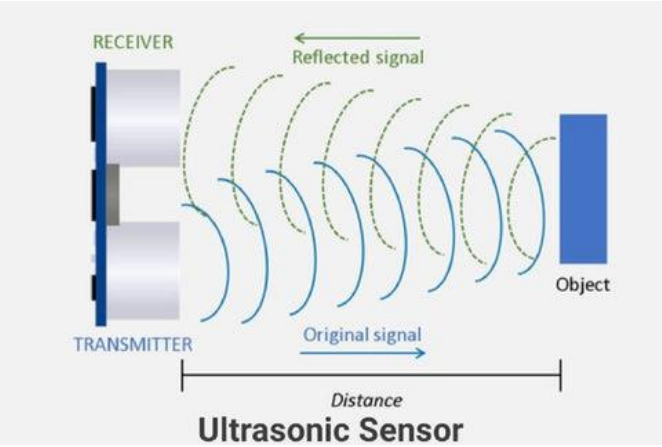



**Figure 3**: Ultrasonic Sensor Working Principle

The idea behind ultrasonic sensors is that they work by producing high-frequency sound waves that are inaudible to humans and fall within the ultrasonic range (above 20 kHz). When these sound waves come into contact with an item, they bounce back to the sensor after traveling through the air. The sensor determines the object's distance from it by timing the return of the sound waves. The emission and reception of these waves are precisely timed by the internal clock of the sensor. Ultrasonic sensors are useful for non-contact fluid level measurement, proximity sensing, obstacle identification, and other applications where the data is processed to ascertain the object's distance.

### 2.4.2 Infrared Sensors

**Figure 4**: Infrared Sensor

Infrared sensors operate based on the principle of detecting infrared radiation emitted by objects. They contain specialized detectors that can sense variations in temperature and convert these temperature differences into electrical signals. When an object emits infrared radiation, the sensor captures this radiation and generates a voltage proportional to the temperature change. This voltage is then processed by the sensor's electronics to produce an output, which can be used for various applications, including presence detection, temperature measurement, and remote-control systems. Infrared sensors are commonly employed in motion detectors, thermal imaging devices, and even in household appliances such as remote controls, where they enable the transmission of signals without the need for physical connections.

## 2.5 Social Robotics in Healthcare

Social robotics in healthcare is a burgeoning field that merges robotics and artificial intelligence with the aim of enhancing patient care and overall well-being. These robots are designed to engage in social interactions with patients, providing emotional support, companionship, and even therapeutic interventions.

Key applications include assisting the elderly and individuals with disabilities by helping them with daily tasks, monitoring vital signs, and offering companionship to alleviate feelings of loneliness. Social robots can also be used in pediatric care, guiding and comforting young patients during medical procedures.

Moreover, they are being employed in mental health settings to provide cognitive-behavioral therapy and monitor emotional states. While offering support, these robots collect valuable data to aid healthcare professionals in their assessments and decisions. Ethical considerations surrounding privacy and informed consent are essential, but as technology advances, social robots have the potential to play an increasingly vital role in improving the overall quality of healthcare services and patient experiences.

### 2.5.1 Human Robot Interaction

The term Human-Robot Interaction (HRI) describes the dynamic interaction between people and machines, with a focus on the creation, research, and design of robots that can converse with people in a natural and meaningful way. Physical and social interactions are just two of the many facets that HRI includes. It aims to build robots that can comprehend and react to human speech, emotions, and gestures. In order to improve user experiences, increase robots' social intelligence, and make them more practical in everyday situations, this field is essential to the effective integration of robots in a variety of applications, such as healthcare and customer service.

### 2.5.2 Ethical Consideration

The "Social Robot for Health Monitoring System" takes informed permission, data privacy, and ethical technology usage into account. One of the main concerns is making sure that personal health information is handled with the highest level of security and confidentiality. It is important to obtain informed permission from users for health exams and data gathering in order to uphold their autonomy and privacy rights. The robot's contacts with vulnerable groups must also be governed by ethical standards to guarantee that help is given without compromising people's dignity and well-being. In social robotics and healthcare, upholding ethical standards is essential to preserving integrity and confidence.

# Chapter 3

# Methodology

## 3.1 Research Design


**Figure 5**: Schematic Diagram of Research Methodology

The above Figure 5 shows us that "Social Robot for Health Monitoring System" study design uses a mixed-methods methodology. It integrates qualitative data from human observations and comments with quantitative data from the robot's health evaluations. Comprehensive analysis, including the evaluation of user experiences and the veracity of health data, is made possible by this approach. A longitudinal component is also included to evaluate the robot's long-term effects on health monitoring. To assess the efficacy and flexibility of the system, case studies in diverse healthcare and social contexts are also incorporated into the study design. This multimodal strategy guarantees a comprehensive and all-encompassing comprehension of the system's operation and its consequences for social contexts and healthcare.

## 3.2 System Architecture

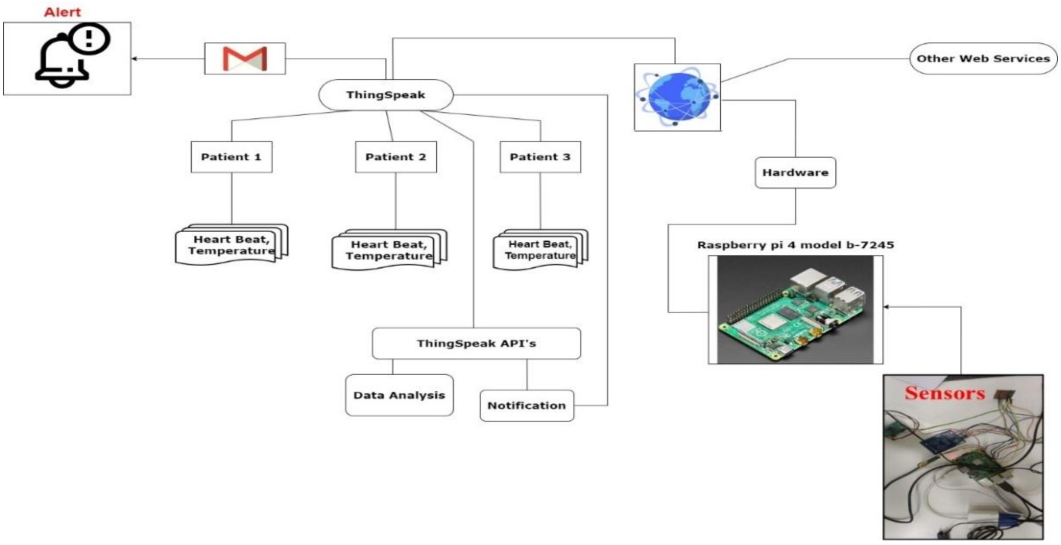



**Figure 6**: Proposed Architecture for Research Study

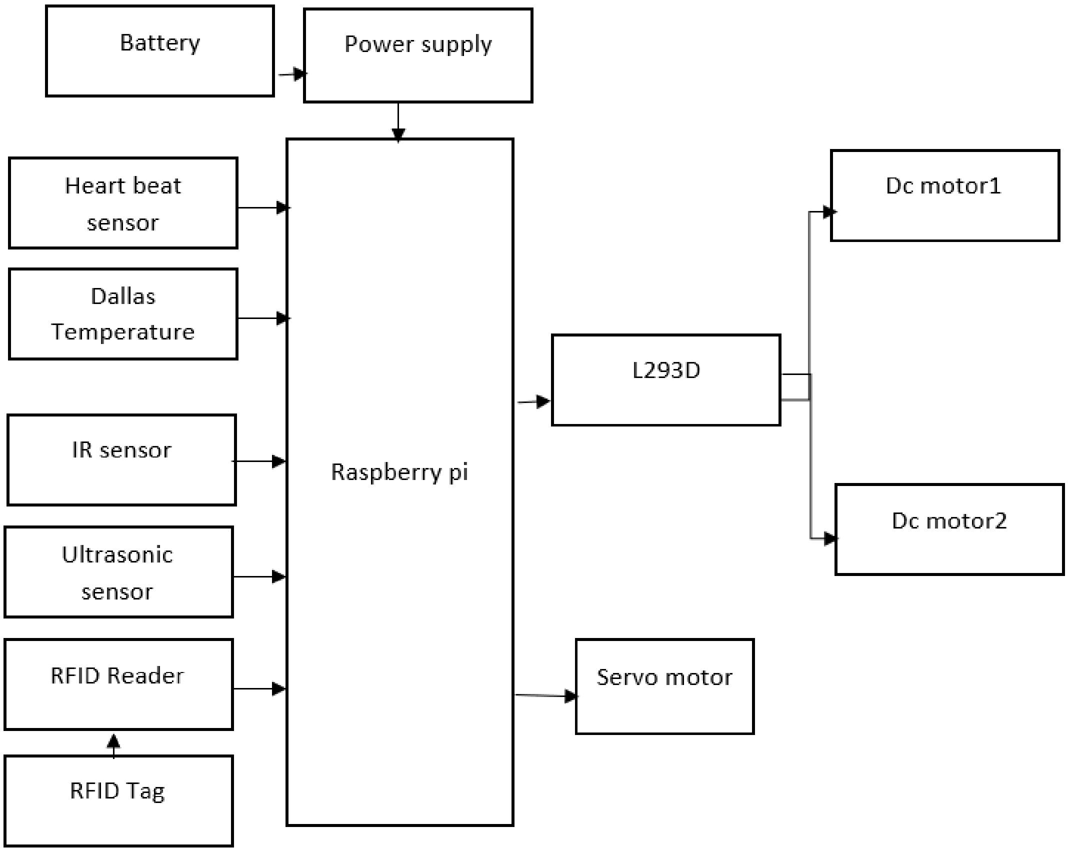



**Figure 7**: Block Diagram of Proposed Architecture

### 3.2.1 Hardware Components

With reference to Figure 6, the hardware components of the system comprise the social robot's physical infrastructure. This comprises the power system, wheels, motors, and chassis of the robot, as well as a variety of sensors including the RFID reader, temperature sensor, heartbeat sensor, and ultrasonic sensor. Carefully considered design ensures that the hardware components are sturdy, portable, and capable of withstanding the rigors of social and healthcare contexts. The sensors are placed carefully for best data gathering and obstacle detection, and the chassis is frequently built for stability and mobility.

### 3.2.2 Software Components

With reference to Figure 6, the social robot's brain is made up of software components. Important components include the operating system, communication protocols, and control algorithms. The platform required to run control algorithms and manage data is provided by the operating system. Obstacle avoidance, autonomous navigation, and health assessment processes are made possible by control algorithms. In order to send health data to a centralized server for real-time monitoring and analysis, communication protocols are essential.

### 3.2.3 Interactions

With reference to Figure 6, Interactions comprise the manner in which the social robot interacts with people in its surroundings. This includes voice recognition, gesture interpretation, and emotional response systems in human-robot interactions. The goal of the robot's interactions is to improve the user experience in social and medical contexts by being approachable and sympathetic. In addition, the system's interactions involve reacting to barriers found while navigating, guaranteeing the security of the robot and its environment.

## 3.3 Development Process

### 3.3.1 Hardware Design

The actual robot is created during the hardware design phase. This entails building the chassis with stability and mobility in mind, choosing wheels and motors that make navigating easier, and setting up the power supply to run continuously. The integration and layout of sensors are carefully considered in order to align them for optimal data collecting and obstacle detection efficiency. For hardware design to result in a well-organized and working robot, rigorous planning and prototyping are necessary.

### 3.3.2 Sensor Integration

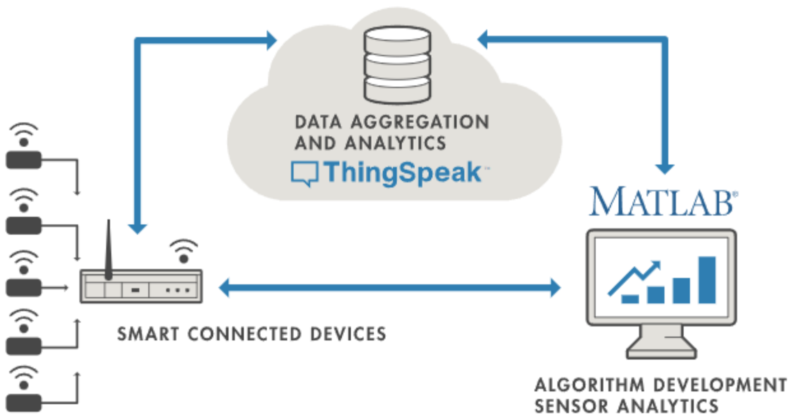



**Figure 8**: Block Diagram of Sensor Integration with MATLAB

A critical phase in the development process is the integration of sensors. Every sensor—heartbeat, temperature, RFID, and ultrasonic—needs to be properly included into the hardware and software elements. To guarantee reliable data gathering and obstacle detection, calibration and testing are essential. In order to provide safe navigation and efficient health monitoring, sensor integration also entails establishing sensor parameters and algorithms.

#### 3.3.3 Software Development

The development of the robot's control algorithms, which enable smooth autonomous navigation, health assessment processes, and obstacle avoidance, is the main goal of the software development process. Programming, machine learning, and artificial intelligence proficiency are required for this phase. The software development process also includes the creation of safe communication protocols for sending data to a central server, which is an essential component of the system.

#### 3.3.4 Connectivity Setup

Configuring the robot to connect to a web server or cloud platform is part of the connection configuration. This entails putting in place authentication procedures, creating secure data transmission routes, and making sure that data privacy and security laws are followed. Setting up connectivity is essential for collecting and analyzing data in real-time, giving caregivers and medical professionals access to the most recent health information, and allowing alarm systems.

### 3.4 Data Collection and Analysis

The process of obtaining health information from people during health assessments is known as data collection and analysis. Heart rate, temperature, and other pertinent variables are included in this data. After gathering, the data is sent to a cloud platform or centralized server for analysis. In order to understand the data, identify patterns, and provide insights, the analysis phase makes use of machine learning and data analytics tools. It makes it possible to identify aberrant health markers, which may lead to alarms and early actions. The system's primary function is to provide real-time health monitoring and assistance. This is accomplished through data collecting and analysis.

### 3.5 Testing and Validation

The testing and validation phase is crucial to ensure the system's functionality, reliability, and safety. It involves a series of tests, including:

1. Functionality Testing: To assess whether the robot can autonomously navigate, stop at RFID checkpoints, collect health data accurately, and respond to obstacles.
2. Safety Testing: To confirm that the robot's obstacle detection system operates effectively and that it poses no harm to users.
3. Data Accuracy Testing: To verify the accuracy of health data collected by the robot's sensors.
4. Connectivity Testing: To ensure that data is successfully transmitted to the centralized server for analysis.
5. User Experience Testing: To evaluate the robot's interactions with users, including its ability to provide a friendly and empathetic experience.
6. Long-Term Performance Testing: To assess the robot's durability and performance over extended periods of operation.

Testing and validation are iterative processes that help identify and rectify issues, ensuring the system meets the intended goals and standards of operation.

# Chapter 4

# System Design and Implementation

## 4.1 Robot Hardware

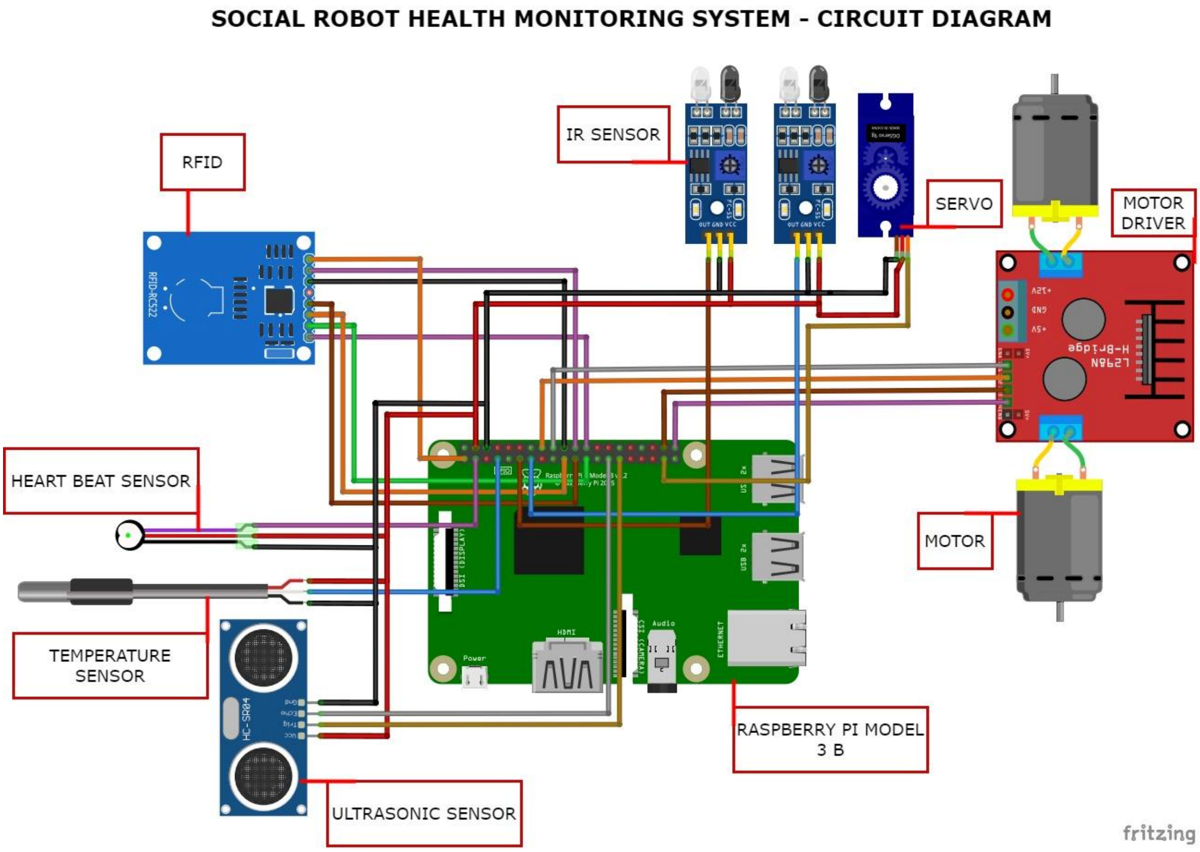



**Figure 9**: Social Robot Health Monitoring System Circuit Diagram

### 4.1.1 Chassis

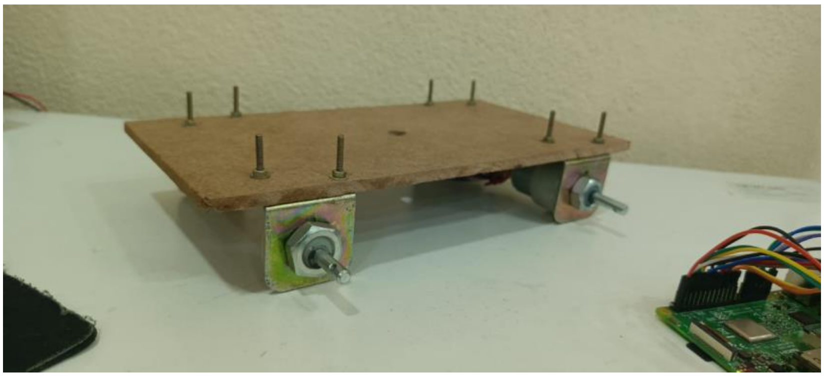


**Figure 10**: Chassis

The physical framework that serves as the health monitoring robot's base is called the chassis. Because of its stability, robustness, and mobility, the robot can move through social and medical settings with ease. In addition to having wheels that allow for mobility, the chassis may also have shock absorption or suspension systems to improve stability and reduce vibrations. The weight, strength, and general performance of the robot are all impacted by the materials chosen, therefore selection is crucial. The chassis serves as a strong basis for the system and is carefully designed and tested to guarantee that it can endure the rigors of healthcare and social environments.

### 4.1.2 Motors and Wheels

**Figure 11**: White Robotic Wheel (70mm x 35mm)

**Table 4.1.1 Wheel Specification Table**

| Sr. No. | Details | Specification |
|---|---|---|
| 1 | Color | White |
| 2 | Diameter | 70mm x 35mm |
| 3 | Material | Plastic |
| 4 | Shape | Round |
| 5 | Wheel Coating Material | Silicon Rubber |

**Figure 12**: 12 Volts Direct Current Motor

**Table 4.1.2 Direct Current Motor Specification Table**

| Sr. No. | Details | Specification |
|---|---|---|
| 1 | Revolutions per Minute | 100 |
| 2 | Shaft Diameter | 6mm (with internal hole) |
| 3 | Shaft Length | 15mm |
| 4 | Motor Diameter | 28.5mm |
| 5 | Torque | 12 kg-cm |
| 6 | Voltage | 6 to 24 |

Motors and wheels are integral components of the robot's hardware, enabling movement and navigation. Motors are carefully selected to provide precise control over the robot's speed and direction. Wheels are designed for optimal traction and maneuverability, allowing the robot to traverse different surfaces and environments. The design of the motors and wheels is tailored to facilitate smooth and accurate movement, critical for the robot's ability to autonomously navigate predefined routes, stop at RFID checkpoints, and respond to obstacles. Robust motor and wheel systems are essential to the reliability and efficiency of the robot.

### 4.1.3 Power System


**Figure 13**: 12 Volts Direct Current Battery

The parts of the robot that provide and control electrical energy are referred to as its power system. Batteries or other power sources, circuits for power control, and charging systems fall within this category. The power system is built to run continuously, allowing the robot to travel and conduct health checks for the duration of its allotted operational period. Furthermore, the power supply is designed to be as energy-efficient as possible, extending the robot's use before it has to be recharged. To ensure that the robot can finish its work, redundancy and fail-safes are frequently built to prevent unexpected shutdowns. The goal of the power system design is to achieve a balance between operational dependability and energy autonomy.

## 4.2 Sensor Integration

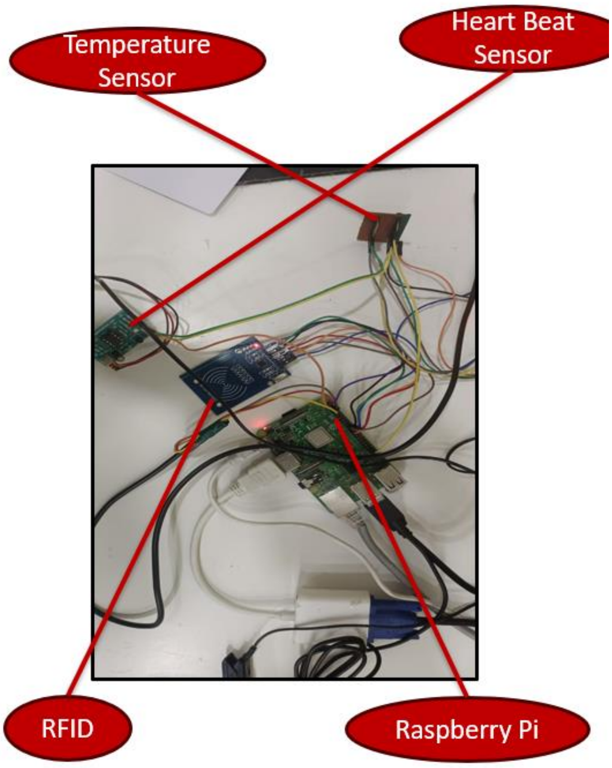



**Figure 14**: Sensors Integration

### 4.2.1 RFID Reader


**Figure 15**: Radio Frequency Identification

**Figure 16**: Interfacing of Radio frequency Identification with Raspberry Pi Model 3 B

An essential sensor for the health monitoring robot is the RFID reader. Its purpose is to scan RFID tags positioned within the robot's working area at prearranged checkpoints. The antennae and communication modules required for the RFID reader to interact with the tags are installed. In order to guarantee that the robot can precisely stop at specified checkpoints for health checks, its design strives to maximize reading accuracy and range. Careful placement is required to line the RFID reader with the RFID tag locations during integration, allowing for easy navigation and health data gathering.

**Table 4.2.1 RC522 Pin Configuration**

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | Vcc | Used to Power the module, typically 3.3V is used |
| 2 | RST | Reset pin – used to reset or power down the module |
| 3 | Ground | Connected to Ground of system |
| 4 | IRQ | Interrupt pin – used to wake up the module when a device comes into range |
| 5 | MISO/SCL/Tx | MISO pin when used for SPI communication, acts as SCL for I2c and Tx for UART. |

| | | |
|---|---|---|
| 6 | MOSI | Master out slave in pin for SPI communication |
| 7 | SCK | Serial Clock pin – used to provide clock source |
| 8 | SS/SDA/Rx | Acts as Serial input (SS) for SPI communication, SDA for IIC and Rx during UART |

**What is RFID technology and how does it work?**

RFID or Radio Frequency Identification system consists of two main components, a transponder/tag attached to an object to be identified, and a Transceiver also known as interrogator/Reader.

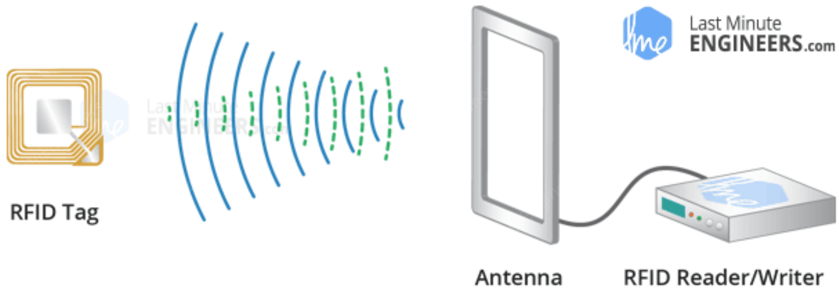



**Figure 17**: Radio frequency Identification Working

A Reader consists of a Radio Frequency module and an antenna which generates high frequency electromagnetic field. On the other hand, the tag is usually a passive device, meaning it doesn't contain a battery. Instead, it contains a microchip that stores and processes information, and an antenna to receive and transmit a signal.

To read the information encoded on a tag, it is placed in close proximity to the Reader (does not need to be within direct line-of-sight of the reader). A Reader generates an electromagnetic field which causes electrons to move through the tag's antenna and subsequently power the chip. The powered chip inside the tag then responds by sending its stored information back to the reader in the form of another radio signal. This is called backscatter. The backscatter, or change in the electromagnetic/RF wave, is detected and interpreted by the reader which then sends the data out to a computer or microcontroller.

### 4.2.2 Heartbeat Sensor

**Figure 18**: Heart Beat Sensor

The heartbeat sensor is a necessary part of the system for gathering important health information. It is intended to assess a person's heart rate non-invasively. Sensor location, measurement methods, and data transfer systems are all included in the design. Accurate and up-to-date heart rate data should be provided by the heartbeat sensor. This sensor's integration requires that it be in close proximity to the patient throughout health evaluations in order to ensure the accuracy of the information gathered.

- **Principle of Heartbeat Sensor**

  The principle behind the working of the Heartbeat Sensor is Photo plethysmograph. According to this principle, the changes in the volume of blood in an organ is measured by the changes in the intensity of the light passing through that organ.

  Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo Detector like a Photo Diode, an LDR (Light Dependent Resistor) or a Photo Transistor.

  With these two i.e. a light source and a detector, we can arrange them in two ways: A Transmissive Sensor and a Reflective Sensor.

  In a Transmissive Sensor, the light source and the detector are place facing each other and the finger of the person must be placed in between the transmitter and receiver.

Reflective Sensor, on the other hand, has the light source and the detector adjacent to each other and the finger of the person must be placed in front of the sensor.

### 4.2.3 Temperature Sensor

**Figure 19**: Temperature Sensor

Another essential part of health monitoring is the temperature sensor. Its design entails choosing and incorporating temperature-sensitive parts that offer accurate temperature readings. To obtain an accurate reading of a person's body temperature, the sensor has to be positioned correctly. Temperature range, calibration, and data transfer methods are design factors. The incorporation of a temperature sensor guarantees that the robot can obtain dependable temperature readings while doing health evaluations.

**Table 4.2.2 Temperature Sensor Pin Configuration**

| No: | Pin Name | Description |
|---|---|---|
| 1 | Ground | Connect to the ground of the circuit |
| 2 | Vcc | Powers the Sensor, can be 3.3V or 5V |
| 3 | Data | This pin gives output the temperature value which can be read using 1-wire method |

- **Specifications**

The specifications of this sensor include the following:

1. This sensor is a programmable and digital temperature sensor

2. The communication of this sensor can be done with the help of a 1-Wire method
3. The range of power supply is 3.0V – 5.5V
4. Fahrenheit equal s to -67°F to +257°F
5. The accuracy of this sensor is ±0.5°C
6. The o/p resolution will range from 9-bit to 12-bit
7. It changes the 12-bit temperature to digital word within 750 ms time
8. This sensor can be power-driven from the data line
9. Alarm options are programmable
10. The multiplexing can be enabled by Unique 64-bit address
11. The temperature can be calculated from -55°C to +125°C.
12. These are obtainable like SOP, To-92, and also as a waterproof sensor

- **Working Principle**

The working principle of this DS18B20 temperature sensor is like a temperature sensor. The resolution of this sensor ranges from 9-bits to 12-bits. But the default resolution which is used to power-up is 12-bit. This sensor gets power within a low-power inactive condition. The temperature measurement, as well as the conversion of A-to-D, can be done with a convert-T command. The resulting temperature information can be stored within the 2-byte register in the sensor, and after that, this sensor returns to its inactive state.

If the sensor is power-driven by an exterior power supply, then the master can provide read time slots next to the Convert T command. The sensor will react by supplying 0 though the temperature change is in the improvement and reacts by supplying 1 though the temperature change is done

### 4.2.4 Ultrasonic Sensor

The identification and avoidance of obstacles is greatly aided by ultrasonic sensors. They are designed to generate obstacle data for the control system, calculate distances to obstacles, and transmit and receive ultrasonic waves. The use of ultrasonic sensors necessitates exact placement across the robot's range of motion. The robot can react to impediments in its path with more effectiveness because to the design, which maximizes the sensor's precision and range. The use of ultrasonic sensors augments the security of both the robot and others within its vicinity.

### 4.2.5 Servo Motor

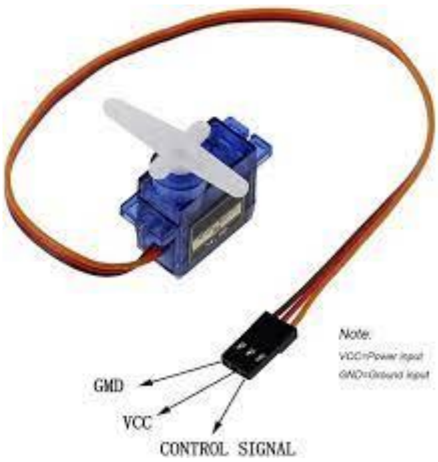



**Figure 20**: Servo Motor

The ultrasonic sensor's movement is managed by the servo motor. It increases the sensor's field of vision for obstacle detection by enabling it to tilt or pan. Accurate calibration is part of integration, which guarantees the sensor's responsiveness to any obstructions.

- **Servo Motor Working Principle:**

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer’s angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

### 4.2.6 Infrared Sensor

For safety and proximity detection, infrared sensors are used. They aid in the robot's detection of surrounding objects or people, particularly during close quarters exchanges. Integration guarantees that the robot's control system receives real-time data from the infrared sensors.

### 4.2.7 Raspberry Pi


**Figure 21**: Raspberry Pi Model 3B

The robot's main processing unit is a Raspberry Pi Model 3 B. It handles communication, runs control algorithms, and analyzes data from several sensors. Configuring the Raspberry Pi, installing the operating system, and establishing communication with sensors and external devices are all part of integration.

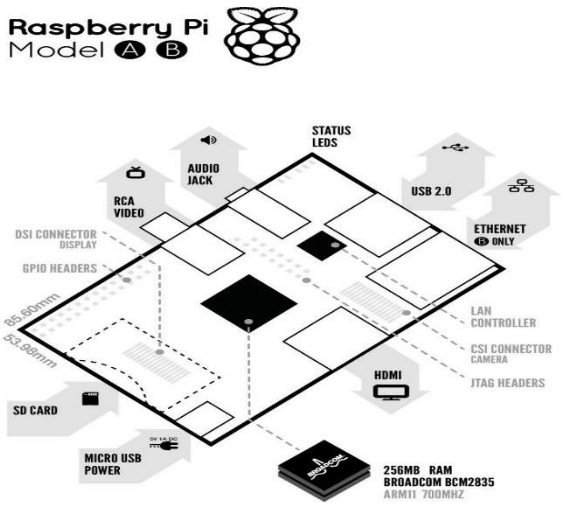



**Figure 22**: Architecture of Raspberry Pi Model 3B

**Description of each components on the Raspberry Pi:**

1. Processor/SoC(System on Chip):

   The Raspberry Pi has a Broadcom BCM2835 System on Chip module. It has a ARM1176JZF-S processor. The Broadcom SoC used in the Raspberry Pi is equivalent to a chip used in an old smartphone. While operating at 700 MHz by default, the Raspberry Pi provides a real world performance roughly equivalent to the 0.041GFLOPS. The Raspberry Pi chip operating at 700 MHz by default, will not become hot enough to need a heatsink or special cooling.

2. Power source:

   The Pi is a device which consumes 700mA or 3W or power. It is powered by a Micro USB charger or the GPIO header. Any good smartphone charger will do the work of powering the Pi.

3. SD Card:

   The Raspberry Pi does not have any onboard storage available. The operating system is loaded on a SD card which is inserted on the SD card slot on the Raspberry Pi. The operating system can be loaded on the card using a card reader on any computer.

4. GPIO:

   General-purpose input/output (GPIO) is a generic pin on an integrated circuit whose behavior, including whether it is an input or output pin, can be controlled by the user at run time. GPIO pins have no special purpose defined, and go unused by default. The idea is that sometimes the system designer building a full system that uses the chip might find it useful to have a handful of additional digital control lines, and having these available from the chip can save the hassle of having to arrange additional circuitry.

The production Raspberry Pi board has a 26-pin 2.54 mm expansion header, marked as P1, arranged in a 2x13 strip. They provide 8 GPIO pins plus access to I²C, SPI, UART), as well as +3.3 V, +5 V and GND supply lines. Pin one is the pin in the first column and on the bottom row.

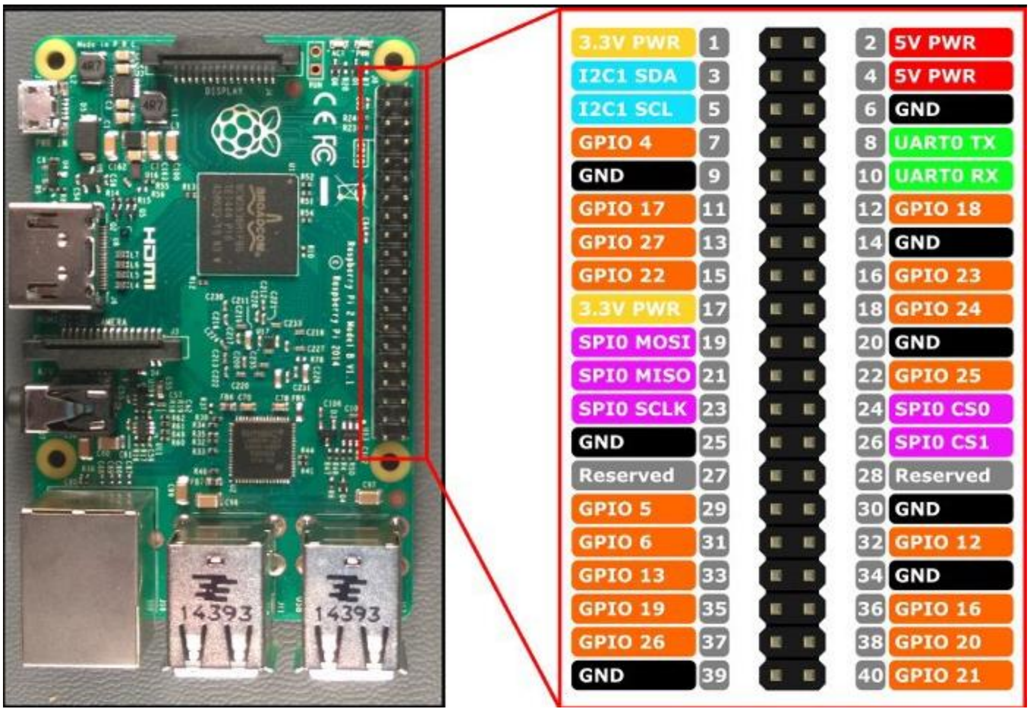



**Figure 23**: GPIO Pin Architecture of Raspberry Pi Model 3B

5. DSI connector:

   The Display Serial Interface (DSI) is a specification by the Mobile Industry Processor Interface (MIPI) Alliance aimed at reducing the cost of display controllers in a mobile device. It is commonly targeted at LCD and similar display technologies. It defines a serial bus and a communication protocol between the host and the device. A DSI compatible LCD screen can be connected through the DSI connector, although it may require additional drivers to drive the display.

6. RCA Video:

   RCA Video outputs (PAL and NTSC) are available on all models of Raspberry Pi. Any television or screen with a RCA jack can be connected with the RPi.

**Figure 24**: RCA Video Connector

7. Audio Jack:

   A standard 3.5 mm TRS connector is available on the RPi for stereo audio output. Any headphone or 3.5mm audio cable can be connected directly. Although this jack cannot be used for taking audio input, USB mics or USB sound cards can be used.

8. Status LEDs:

   There are 5 status LEDs on the RPi that show the status of various activities. They are “OK” ,"ACT" ,,“POWER” (PWR),Full Duplex ("FDX"),“LNK” ( Link/Activity), “10M/100” which are shown in figure below.

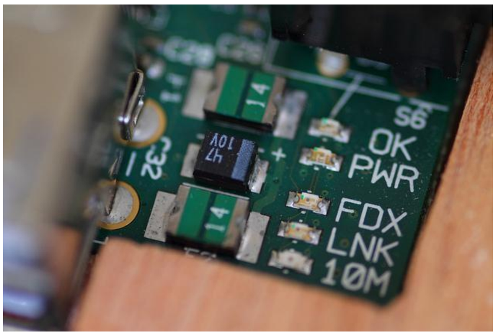



**Figure 25**: Status LEDs

9. USB 2.0 Port:

   USB 2.0 ports are the means to connect accessories such as mouse or keyboard to the Raspberry Pi. There is 1 port on Model A, 2 on Model B and 4 on Mo del B+. The number of ports can be increased by using an external powered USB hub which is available as a standard Pi accessory.

10. Ethernet:

    Ethernet port is available on Model B and B+. It can be connected to a network or internet using a standard LAN cable on the Ethernet port. The Ethernet ports are controlled by Microchip LAN9512 LAN controller chip.

11. CSI connector:

    CSI – Camera Serial Interface is a serial interface designed by MIPI (Mobile Industry Processor Interface) alliance aimed at interfacing digital cameras with a mobile processor. The RPi foundation provides a camera specially made for the Pi which can be connected with the Pi using the CSI connector.

12. JTAG headers:

    JTAG is an acronym for 'Joint Test Action Group', an organization that started back in the mid 1980's to address test point access issues on PCB with surface mount devices. The organization devised a method of access to device pins via a serial port that became known as the TAP (Test Access Port). In 1990 the method became a recognized international standard (IEEE Std 1149.1). Many thousands of devices now include this standardized port as a feature to allow test and design engineers to access pins.

13. HDMI:

    HDMI –High Definition Multimedia Interface

    HDMI 1.3 a type A port is provided on the RPi to connect with HDMI screens.

**Table 4.2.3 Raspberry Pi Specifications**

| | **Model A** | **Model B** | **Model B+** |
|---|---|---|---|
| **Target price:** | US$25 | US$35 | |
| **SoC:** | Broadcom BCM2835 (CPU, GPU, DSP, SDRAM, and single USB port) | | |
| **CPU:** | 700 MHz ARM1176JZF-S core (ARM11 family, ARMv6 instruction set) | | |

| | | | |
|---|---|---|---|
| **GPU:** | Broadcom Video Core IV @ 250 MHz | | |
| **Memory** | 256 MB | MB (shared with GPU) | |
| **USB 2.0 ports:** | 1 (direct from BCM2835 chip) | 2 (via the on-board 3-port USB hub) | 4 (via the on-board 5-port USB hub) |
| **Video input:** | 15-pin MIPI camera interface (CSI) connector, used with the Raspberry Pi | | |
| **Video outputs:** | Composite RCA (PAL and NTSC) –in model B+ via 4-pole 3.5 mm jack, HDMI (rev 1.3 & 1.4), raw LCD Panels via DS | | |
| **Audio outputs:** | 3.6 mm jack, HDMI, and, as of revision 2 boards, I²S audio (also potentially | | |
| **Onboard storage:** | SD / MMC / SDIO card slot (3.3 V card power support only) | | MicroSD |
| **Onboard network:** | None | 10/100 Mbit/s Ethernet (8P8C) USB adapter on the third/fifth port of the USB hub | |
| **Low-level peripherals:** | 8× GPIO, UART, I²C bus, SPI bus with two chip selects, I²S audio +3.3 V, +5 V, ground | | 17× GPIO |

**Table 4.2.4 Raspberry Pi Power Consumption**

| | | | |
|---|---|---|---|
| **Power ratings:** | 300 mA (1.5 W) | 700 mA (3.5 W) | 600 mA (3.0 W) |
| **Power source:** | 5 V via Micro USB or GPIO header | | |
| **Size:** | 85.60 mm × 56 mm (3.370 in × 2.205 in) – not including protruding Connectors | | |
| **Weight:** | 45 g (1.6 oz) | | |

## 4.3 Software Development

### 4.3.1 Operating Temperature

The fundamental software framework for the health monitoring robot's operation is provided by its operating system. To assist the control algorithms, sensor integration, and data exchange, it is either carefully chosen or created. The operating system has to be sturdy, dependable, and appropriate for the particular hardware parts and sensors that the system makes use of. This decision guarantees that control algorithms and data management procedures are carried out effectively. Additionally, it offers a steady setting for the real-time gathering of health data and the identification of obstacles.

### 4.3.2 Control Algorithms

The foundation of the robot's software development are control algorithms. They are in charge of obstacle avoidance, autonomous navigation, RFID checkpoint identification, and health assessment protocols. Robotic control algorithms are carefully crafted to maximize navigation, guaranteeing that the robot can adhere to pre-established paths, stop at RFID checkpoints, and react to obstructions instantly. The algorithms are also in charge of arranging how the robot interacts with people while doing health checks, making the process intuitive an

## 4.4 Connectivity and Data Management

### 4.4.1 Internet of Things (IoT) Integrations

The main goal of the IoT integration is to link the robot to central servers and the internet so that data can be transmitted and analyzed. In order to send health data and robot status information to a centralized server or cloud platform, secure communication methods must be configured. IoT connection guarantees that health data is accessible for caregivers and medical experts to monitor in real-time. Additionally, it enables the robot's actions to be managed and controlled remotely.

### 4.4.2 Data Storage and Analysis

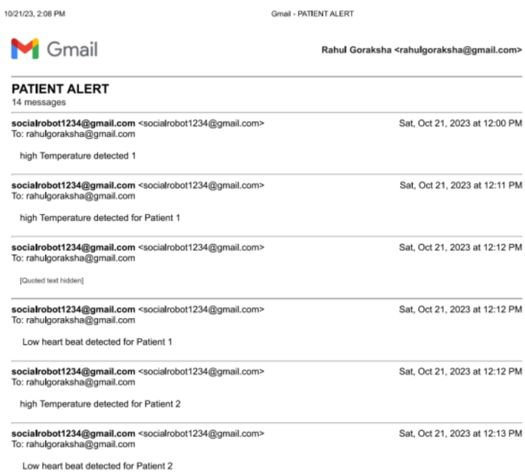
Components for data analysis and storage are essential to the software development of the system. Mechanisms for safely storing health data on a centralized server or cloud platform are included in the architecture. Algorithms for data analysis are used to understand health data, find trends, and produce insights. This makes it possible to find anomalous health metrics that might set off alarms. The foundation of the system's capacity to offer real-time health monitoring and support is data storage and processing.

## 4.5 Alert System

### 4.5.1 Threshold Definitions

The design of the alarm system includes setting thresholds for important health parameters. Heart rate and temperature are two examples of health measurements that have thresholds defined. Medical guidelines and the patient's medical history are used to set these levels. The alarm system is set off when certain predetermined thresholds are reached or exceeded by health metrics. This notifies the appropriate parties to take prompt action.

### 4.5.2 Alert Generation



10/21/23, 2:08 PM Gmail - PATIENT ALERT

Gmail Rahul Goraksha <rahulgoraksha@gmail.com>

**PATIENT ALERT**
14 messages

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:00 PM
To: rahulgoraksha@gmail.com

high Temperature detected 1

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:11 PM
To: rahulgoraksha@gmail.com

high Temperature detected for Patient 1

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:12 PM
To: rahulgoraksha@gmail.com

[Quoted text hidden]

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:12 PM
To: rahulgoraksha@gmail.com

Low heart beat detected for Patient 1

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:12 PM
To: rahulgoraksha@gmail.com

high Temperature detected for Patient 2

**socialrobot1234@gmail.com** <socialrobot1234@gmail.com> Sat, Oct 21, 2023 at 12:13 PM
To: rahulgoraksha@gmail.com

Low heart beat detected for Patient 2

**Figure 26**: Email alert is triggered by threshold breach.

Mechanisms for generating alerts are built to make sure that when crucial health thresholds are exceeded, a quick alarm is produced. The design incorporates alert communication techniques, such email messages to caregivers and medical experts. Additionally, the system has to give contextual information about the user's location and health status so that it can react appropriately and quickly to important health occurrences.

The "Social Robot for Health Monitoring System" component elaborations offer insights into the whole system design and execution, which includes data management, hardware, connection, software development, sensor integration, and hardware integration. Together, these parts guarantee the robot's durability, dependability, and capacity to offer real-time health monitoring and assistance in medical and social environments.

# Chapter 5
# Results

## 5.1 Autonomous Navigation

The Social Robot Health Monitor project successfully achieved autonomous navigation capabilities. Leveraging the Raspberry Pi as its central processing unit, the robot can navigate predefined routes within a controlled environment. This autonomy is facilitated by a combination of sensors and actuators, allowing the robot to follow paths, stop at RFID checkpoints, and assess individuals' health. The implementation of advanced algorithms ensures that the robot can adapt to its surroundings, making it a versatile tool for various social settings. Its ability to move independently while avoiding obstacles makes it user-friendly and suitable for a wide range of applications, from healthcare facilities to educational institutions

## 5.2 RFID Checkpoint Integration

The project seamlessly integrated RFID checkpoint technology, enabling the robot to stop at predefined locations for health assessments. This technology not only adds a layer of efficiency but also facilitates structured data collection. By stopping at RFID checkpoints, the robot can accurately identify the location of each assessment, ensuring that health data is correctly associated with the individual being monitored. The use of RFID cards as checkpoints enhances the overall precision and reliability of the system, contributing to its effectiveness in social environments.

## 5.3 Health Data Collection

The robot's health data collection capabilities are a fundamental component of the project's success. Equipped with heartbeat and temperature sensors, the robot collects vital health data from individuals in real-time. These sensors provide accurate and valuable information about an individual's well-being. The project has demonstrated that it can efficiently and consistently capture this data, which is essential for monitoring and assessing an individual's health status. The data collected forms the basis for health analysis and alerts, contributing to proactive health management.

## 5.4 Obstacle Detection and Response

Safety is paramount in the Social Robot Health Monitor project, and the inclusion of obstacle detection and response mechanisms ensures safe operation. A servo motor-mounted ultrasonic sensor equips the robot to detect obstacles in its path. When an obstacle is detected, the robot promptly responds by coming to a stop. This feature not only protects the robot from potential damage but also safeguards individuals in the robot's vicinity. The obstacle detection and response system functions seamlessly, guaranteeing that the robot can navigate social environments without posing any harm or disruption.

### 5.5 Data Upload and Storage

The project has successfully implemented data upload to a web server, ensuring centralized health data storage and analysis. This feature provides a secure and accessible platform for storing and managing the health data collected by the robot. By uploading this data to a web server, it becomes available for healthcare professionals, caregivers, and other relevant stakeholders. The centralized approach streamlines data management and allows for real-time analysis, which can aid in proactive health monitoring and early intervention.

### 5.6 Alert System Performance

The alert system is a critical component of the Social Robot Health Monitor project, and its performance has been demonstrated effectively. When the robot records health parameters that exceed predefined thresholds, an automated alert system is triggered. This system promptly notifies relevant stakeholders, such as healthcare professionals or caregivers, about potential health issues. The system's accuracy and reliability in generating alerts ensure that individuals under the robot's care receive timely attention and assistance when needed. This feature greatly enhances the project's capacity for proactive health management and intervention, showcasing its potential to positively impact healthcare and social settings.

# Chapter 6
# Discussion

## 6.1 Role of Social Robots in Healthcare

The role of social robots in healthcare is rapidly evolving, and the "Health Monitoring Robot Project" exemplifies the significant contributions they can make. These robots act as versatile healthcare assistants, capable of conducting health assessments, interacting with patients, and providing valuable support to healthcare professionals. They bridge the gap between technology and human touch, offering companionship and a sense of connectedness for individuals in healthcare settings. By automating routine health assessments, they allow healthcare staff to focus on more complex tasks, ultimately improving the efficiency and quality of patient care. Furthermore, social robots have the potential to address the shortage of healthcare professionals, particularly in scenarios where there is a high demand for health monitoring. As technology continues to advance, the role of social robots in healthcare is likely to expand, offering a new dimension to patient care and support.

### 6.1.1 Human Interaction

Human interaction is a fundamental aspect of the "Health Monitoring Robot Project." The project recognizes the importance of creating a positive and empathetic interaction between the robot and the individuals it serves. The robot's ability to engage in friendly, non-invasive interactions is crucial, especially when dealing with vulnerable populations such as the elderly or individuals with special needs. The project emphasizes the development of human-like behaviors and responses, including speech recognition and emotional expression. These interactions contribute to the well-being of the individuals being monitored, providing not only health data but also emotional support and companionship, reducing feelings of isolation and loneliness. The careful consideration of human interaction is central to the project's goal of not just monitoring health but also enhancing the overall experience for the individuals involved.

### 6.1.2 Support for Healthcare Professionals

The "Health Monitoring Robot Project" is designed to be a valuable tool for healthcare professionals. By automating routine health assessments and providing real-time health data, the robot assists healthcare staff in their duties. It reduces the burden of repetitive tasks, allowing healthcare professionals to focus on more complex and critical aspects of patient care. This support enhances the efficiency of healthcare delivery and enables professionals to make more informed decisions. Additionally, the robot's early warning system, which triggers alerts when health parameters exceed predefined thresholds, provides an extra layer of safety and prompt intervention, further supporting the work of healthcare professionals. In the future, the project may also enable telemedicine services, extending the reach of healthcare professionals to remote and underserved areas, and contributing to improved healthcare access.

## 6.2 Advancements in Health Monitoring

The "Social Robot Health Monitor" project represents a significant advancement in the field of health monitoring. This innovative system combines robotics and healthcare to create a powerful tool with far-reaching implications.

One of the key advancements lies in the system's ability to provide continuous and non-intrusive health monitoring. Traditional health assessments often require individuals to visit healthcare facilities, which can be time-consuming and inconvenient. In contrast, the social robot autonomously collects health data while individuals go about their daily routines, without the need for direct human intervention. This advancement enables proactive health monitoring, allowing for early detection of potential health issues, which can be crucial for timely intervention and prevention.

Moreover, the project introduces the concept of remote health monitoring. By uploading collected health data to a web server, healthcare professionals and caregivers can access this information from virtually anywhere, enabling remote health management. This is especially valuable for the elderly, individuals with chronic conditions, or those living in remote areas, as it ensures they receive the necessary care and attention.

The project's use of RFID technology for structured health assessments at predetermined checkpoints showcases a novel approach to health monitoring. By integrating RFID cards into the monitoring process, it enhances data accuracy and organization, allowing for precise tracking of health assessments and making the entire process more efficient.

Overall, the "Social Robot Health Monitor" project is a remarkable advancement in health monitoring, offering continuous, non-intrusive, and remote monitoring capabilities while emphasizing the importance of structured data collection. This innovation not only enhances the quality of healthcare but also has the potential to revolutionize the way we approach health assessments in social settings.

### 6.2.1 Real-time Data Collection

One of the project's core features is real-time data collection. The robot is equipped with sensors that continuously collect health data, including heart rate and temperature, as individuals go about their daily activities. This real-time data collection allows for a dynamic and up-to-date assessment of an individual's health status. The data is securely transmitted to a centralized server or cloud platform, ensuring that healthcare professionals and caregivers have immediate access to vital health information. This aspect of the project represents a fundamental shift from periodic health assessments to continuous and proactive monitoring, enabling early detection of health issues and timely interventions. Real-time data collection is at the heart of the project's mission to improve health outcomes and enhance the quality of healthcare delivery.

### 6.2.2 Early Warning System

The "Health Monitoring Robot Project" incorporates an early warning system that plays a pivotal role in safeguarding the well-being of individuals. This system is designed to generate alerts when an individual's health parameters surpass predefined thresholds. These thresholds are set based on medical standards and guidelines, ensuring that any deviations from the norm trigger an alert. The alerts are timely and accurately transmitted to relevant stakeholders, including healthcare professionals and caregivers. This proactive approach to health management allows for swift interventions in case of critical health events. The early warning system acts as a safety net, helping to prevent adverse health outcomes and potentially saving lives. It represents a key feature that distinguishes the project from traditional healthcare practices, as it empowers healthcare professionals and caregivers to take immediate action when health issues arise.

## 6.3 Ethical and Privacy Consideration

Ethical and privacy considerations are paramount in the "Health Monitoring Robot Project." The project recognizes the importance of upholding the highest ethical standards in healthcare. It ensures that the robot's interactions with individuals are conducted with respect for their dignity and privacy. The project prioritizes informed consent, allowing individuals to actively participate in the health monitoring process. Moreover, ethical considerations extend to data privacy and security. The project is committed to safeguarding sensitive health data, implementing robust security measures, and complying with data privacy regulations to protect the confidentiality and integrity of patient information. The ethical and privacy considerations reflect the project's commitment to respecting individual rights and maintaining the highest standards of ethical conduct in healthcare.

### 6.3.1 Data Privacy

Data privacy is a central concern in the "Health Monitoring Robot Project." The project places a strong emphasis on ensuring the privacy and security of health data collected from individuals. The collected data, which includes sensitive health parameters, is treated with the utmost confidentiality. The project complies with data privacy regulations, such as HIPAA (Health Insurance Portability and Accountability Act) in the United States, and similar regulations in other regions. Data is securely transmitted to a centralized server or cloud platform, where it is encrypted

### 6.3.2 Informed Consent

In any project that involves the collection of personal health data, the principle of informed consent is of utmost importance. Informed consent is the ethical foundation that ensures individuals are aware of and understand the purpose, risks, and potential benefits of participating in the project.

In the context of the Social Robot Health Monitor Project, obtaining informed consent from individuals whose health data is being collected is essential. The robot autonomously conducts health assessments, which may involve vital sign monitoring such as heart rate and temperature. Therefore, it is vital that individuals are fully informed about:

1. The nature of the health assessments.
2. How their data will be collected and stored.
3. Who will have access to their health data.
4. The potential risks and benefits of participating.

Moreover, ensuring that individuals have the option to withdraw their consent at any time is crucial. It's important to address privacy concerns and provide a transparent data management system that adheres to relevant data protection laws and regulations.

### 6.4 Future Prospects

The Social Robot Health Monitor Project presents promising future prospects that extend beyond the current scope. These prospects encompass both technological advancements and broader applications.

a. Technological Advancements:

As technology continues to evolve, the project can benefit from ongoing advancements, leading to improved accuracy, efficiency, and user-friendliness. Here are a few potential technological advancements:

- Machine Learning Integration: By integrating machine learning algorithms, the robot could evolve to provide more sophisticated health assessments and predictive analytics.
- Enhanced Sensor Technology: Advances in sensor technology can lead to even more precise health data collection, potentially expanding the range of monitored parameters.
- Artificial Intelligence for Interaction: Future iterations of the robot may incorporate natural language processing and computer vision for more interactive and human-like communication.

b. Broader Applications:

The future prospects of the Social Robot Health Monitor Project are not limited to health monitoring alone. The project's success opens doors to various applications and industries:

- Healthcare Facilities: Social robots can be deployed in healthcare facilities to monitor patients' vital signs, providing healthcare professionals with real-time data and alerts, enhancing patient care.
- Elderly Care: Social robots could assist in elderly care, providing companionship and monitoring for health issues in a non-intrusive manner.
- Education: The technology used in the project can be adapted for educational purposes, enhancing interactive and personalized learning experiences.
- Research and Data Analysis: The collected health data can contribute to research and public health studies, potentially identifying trends and insights that can inform health policies.

In conclusion, the Social Robot Health Monitor Project has the potential to revolutionize the way we approach health monitoring and human-robot interaction. While addressing the importance of informed consent is critical to ensure ethical practices, the project's future prospects are promising, with opportunities for technological advancements and a wide range of applications across various industries. As we continue to explore and develop this innovative field, it is essential that we maintain a strong ethical foundation and continuously evaluate the project's potential for positive impact on society.

# Chapter 7
# Conclusion

## 7.1 Summary of Achievements

The "Health Monitoring Robot Project" stands as a pioneering endeavor at the intersection of robotics and healthcare, having achieved a series of remarkable milestones and accomplishments. One of the project's central achievements is the successful development of a functional health monitoring robot, designed with the capability to autonomously navigate predefined routes, execute health assessments, and effectively respond to obstacles. This feat is underpinned by the meticulous integration of a range of hardware components, including the chassis, motors, sensors, and power system, ensuring a reliable and robust operation.

Another significant achievement is the seamless integration of various sensors critical to health monitoring. The incorporation of RFID technology allows the robot to halt at predetermined locations, streamlining health assessments. Heartbeat and temperature sensors play a pivotal role in providing accurate, real-time health data, enhancing the overall quality of data collected. In addition, ultrasonic sensors enable obstacle detection and safe navigation, thereby fortifying the robot's safety and reliability. This successful sensor integration highlights the project's technical expertise and underscores its commitment to harnessing sensor technology to improve healthcare.

Furthermore, the project has exhibited commendable proficiency in software development. The creation of the robot's software components, comprising the operating system, control algorithms, and communication protocols, serves as the cornerstone of the robot's multifaceted capabilities. The control algorithms empower the robot to function autonomously, from navigation to health assessments and obstacle avoidance. This showcases the project's adeptness in software development, establishing a highly capable system suitable for deployment in diverse healthcare and social settings.

In addition to these achievements, the establishment of a robust data management system featuring IoT connectivity constitutes a pivotal milestone. This system facilitates the real-time transmission of health data to a secure web server, enabling centralized data storage and analysis. Leveraging data analytics and machine learning techniques, the project can extract valuable insights from health parameters, enhancing the monitoring process and facilitating data-driven healthcare decision-making. This accomplishment underscores the project's commitment to advancing data management in healthcare.

Finally, the project has successfully developed and configured an alert system, an achievement of utmost importance. The alert system is engineered to generate alerts when health parameters surpass predefined thresholds, ensuring timely notifications to healthcare professionals and caregivers. This proactive approach to health management is central to the project's mission, exemplifying its dedication to enhancing patient care and safety.

Collectively, these accomplishments underscore the "Health Monitoring Robot Project's" profound impact on healthcare technology. The project's ability to seamlessly integrate hardware and software components, manage data effectively, and incorporate advanced sensors is positioning it as a transformative solution in the healthcare sector. This innovation carries the potential to revolutionize patient care and well-being, emphasizing the project's successful strides in pushing the boundaries of healthcare technology and reinforcing its commitment to the betterment of healthcare delivery.

### 7.2 Significance of the Social Robot Health Monitoring System

The "Social Robot Health Monitoring System" is a groundbreaking innovation with profound implications for healthcare. Its significance is multifold. Firstly, it introduces proactive health monitoring, empowering healthcare professionals and caregivers to monitor individuals in real-time. By collecting crucial health data, such as heart rate and temperature, the system facilitates early detection of potential health issues, enabling timely interventions and ultimately enhancing overall health outcomes.

Secondly, the system contributes to enhanced patient care, particularly in healthcare institutions. It automates routine health assessments, providing a non-invasive and comfortable method for data collection. This not only lightens the workload of healthcare staff but also significantly improves the patient experience by offering a more streamlined and efficient approach to healthcare monitoring.

Additionally, the system plays a pivotal role in supporting vulnerable populations, such as the elderly and individuals with special needs. Its unique blend of empathetic interactions and health monitoring capabilities addresses their specific needs, offering companionship and reducing feelings of isolation. This aspect of the system ensures the well-being of those who may require additional care and attention.

Moreover, the system's integration of telemedicine and remote healthcare services is crucial for expanding access to healthcare in underserved areas, disaster-stricken regions, and remote locations. By providing both healthcare access and monitoring capabilities in these challenging environments, the system acts as a lifeline where healthcare is needed most, extending its reach and impact significantly.

Lastly, the project paves the way for future research and advancements in healthcare robotics. It showcases the potential of integrating robotics, advanced sensors, and data analytics to revolutionize healthcare processes and elevate the standard of patient care. The "Social Robot Health Monitoring System" serves as a trailblazer in this burgeoning field, inspiring further innovation and contributing to the ongoing evolution of healthcare technology.

## 7.3 Future Work and Potential Impact

The "Health Monitoring Robot Project" is poised for significant future advancements and potential impact. It holds promise in several key areas. Firstly, it has the potential for wider deployment across various healthcare and social settings. This includes hospitals, nursing homes, and rehabilitation centers, where it can be further refined to cater to specific needs, thereby enhancing patient care and support.

Future iterations of the project can harness the power of enhanced machine learning and artificial intelligence. By incorporating advanced AI capabilities, the system can not only monitor health but also predict potential health issues. This predictive aspect can be instrumental in recommending personalized interventions, making healthcare even more proactive and tailored to individual needs.

Data security and privacy are paramount in healthcare, and future work on the project should prioritize these aspects. Given the collection of sensitive health data, robust measures need to be in place to safeguard patient information. Ensuring compliance with data privacy regulations is essential, further solidifying the project's credibility and ethical standards.

Optimizing the user experience is another area for future improvement. The project can focus on refining the robot's interactions with individuals, aiming to provide an even more personalized and empathetic level of support. This will enhance the overall experience and make healthcare monitoring more user-friendly and accessible.

Collaboration and integration represent an exciting avenue for future work. By partnering with healthcare institutions, technology companies, and robotics researchers, the project can be seamlessly integrated into broader healthcare ecosystems. This collaboration will not only expand the system's reach but also contribute significantly to the advancement of telemedicine and remote healthcare, fostering innovation and improving healthcare accessibility on a larger scale.

In summary, the "Health Monitoring Robot Project" is on the brink of transformative possibilities. From wider deployment in healthcare settings to advanced AI integration, data security, user experience optimization, and collaborative efforts, its potential for positive impact in healthcare is vast. The project is poised to play a crucial role in shaping the future of healthcare technology and patient care.

# Chapter 8
# Appendices

## 8.1 Detailed Technical Specification

- IR Sensor
  1. Detection distance: 2 ~ 30cm
  2. Detection angle: 35 °
  3. Comparator chip: LM393
  4. 3mm screw holes for easy mounting
- Ultrasonic sensor
  1. Affordable Price
  2. Operating Voltage: 5 V
  3. Sonar Sensing Range: 2-400 cm(theoretical onl
  4. Max. Sensing Range: 450 cm(theoretical only)
  5. Frequency: 40 kHz
- RFID Module(RC522)
  1. Voltage: DC 3.3V (Do not use 5V supply)
  2. Operating Current :13-26mA
  3. Idle Current :10-13mA
  4. Operating Frequency: 13.56MHz
  5. Highly integrated analog circuitry to demodulate and decode responses
  6. Supports ISO/IEC 14443 A/MIFARE
  7. Typical operating distance in reading/Write mode up to 50 mm
- Heart beat sensor:
  1. A Color-Coded Cable, with a standard male header connectors. Plug it straight into an Arduino or a Breadboard. No soldering is required.
  2. Heart Rate data can be used in many Electronic design and microcontroller projects. But the heart rate data is difficult to read, however, the Pulse Sensor Amped help us to read heart rate. The Heart Beat Pulse Sensor Amped is a plug-and-play heart-rate sensor for Arduino.
- 12v battery:
  1. Manufacturer: Amptek
  2. Manufacturer Part No: AT12-2.2 (12V2.2AH/20HR)
  3. Voltage Rating: 12V

4. Capacity: 2.2 AH

- DC motor specifications

1. RPM – 100
2. Shaft Diameter - 6mm (with internal hole)
3. Shaft Length - 15 mm.
4. Motor Diameter - 28.5 mm.
5. Torque - 12 kgcm.
6. Voltage - 6 to 24 (Nominal Voltage - 12v)
7. No-load current = 800 mA(Max)
8. Load current = 9 A(Max)

- Motor driver:

1. The driver two holes of 3 mm dia.
2. Male burg-stick connectors for supply, ground and input connection.
3. Screw terminal connectors for easy motor connection.
4. High noise immunity inputs.
5. Operating Voltage(VDC): 4.5 to 12
6. Peak Current (A): 600 mA
7. No. of Channels: 1

- Dallas temperature sensor:

1. A probe by new original installation import DS18B20 temperature sensor chip. Chip each pin use heat shrinkable tube to prevent short circuit, internal sealing glue, waterproof, moistureproof.
2. Stainless steel tube encapsulation waterproof moisture proof prevent rust.
3. Stainless steel shell (6 * 45 mm), lead length 100 cm (shielding wire) use stability. Without the external components, the unique single bus;

- Raspberry Pi:

1. Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.8GHz.
2. 1GB, 2GB, 4GB or 8GB LPDDR4-3200 SDRAM (depending on model)
3. 2.4 GHz and 5.0 GHz IEEE 802.11ac wireless, Bluetooth 5.0, BLE.
4. Gigabit Ethernet.
5. 2 USB 3.0 ports; 2 USB 2.0 ports.

### 8.2 Code Listings

```
import time
import motor_driver
import ds18b20
import beat_sensor
import ultrasonic
import RPi.GPIO as GPIO
from mfrc522 import SimpleMFRC522
from time import sleep
import threading
import requests
import servo
import smtplib
from email.message import EmailMessage

#rfid-1 88480295027
#rfid-2 622580246881
#rfid-3 223046615040

api_1 = "POKGIT1VDETBBFGC"
api_2 = "H1PGUPPK3A70ZNVB"
api_3 = "FPQA456AQ2R47HKH"

GPIO.setwarnings(False)
GPIO.setmode(GPIO.BOARD)

scanner = SimpleMFRC522()
shared_id = 0
ir_Right = 13
ir_Left = 11

GPIO.setup(ir_Left,GPIO.IN)
GPIO.setup(ir_Right,GPIO.IN)

first_schedule = (21,2) #set time here (hh,mm)
second_schedule = (20,45)#set time here (hh,mm)
flag = 1
```

```python


def read_Sensors():
    left_Sensor = GPIO.input(ir_Left)
    right_Sensor = GPIO.input(ir_Right)
    return left_Sensor, right_Sensor
    time.sleep(1)

def read_rfid():
    global shared_id
    while True:
        try:
            id, text = scanner.read()
            print("-= Card detected =- ")
            print("ID:", id)
            shared_id = id
            print("rfid loop", shared_id)
        except:
            pass  # Ignore any exceptions during reading

def line_follow():

    global shared_id
    obstacle = ultrasonic.measure_distance()
    print("Distance: ", int(obstacle), "cm")

    if obstacle > 10:
        left, right = read_Sensors()
        print("Left Sensor:", left)
        print("Right Sensor:", right)
        motor_driver.control_Motors(left, right)
    else:
        motor_driver.control_Motors(True, True)
        print("Obstacle Detected!")

    if shared_id == 88480295027:
        print("Monitoring Patient - 1")
        patient_monitoring(api_1,"1")
```

```
            sleep(1)
        elif shared_id == 622580246881:
            print("Monitoring Patient - 2")
            patient_monitoring(api_2,"2")
            sleep(1)
        elif shared_id == 223046615040:
            print("Monitoring Patient - 3")
            patient_monitoring(api_3,"3")
            sleep(1)
        pass

        shared_id=000

def patient_monitoring(api,num):

    motor_driver.control_Motors(True,True )
    print("Measuring Heartbeat & Temperature....")
    sleep(5)
    heart_beat = beat_sensor.read_pulse_rate()
    print("Heart Beat: ",heart_beat,"BPM")
    temp_c,temp_f = ds18b20.read_temp()
    print("Body Temperature: ",temp_c,"Celcius")
    sleep(1)
    print("Uploading data to thingspeak...")
    queries = {"api_key": api,
               "field1": heart_beat,
               "field2": temp_c}

    r = requests.get('https://api.thingspeak.com/update', params=queries)
    if r.status_code == requests.codes.ok:
        print("Data Successfully Uploaded!")
    else:
        print("Error Code: " + str(r.status_code))
    shared_id = 00000
    sleep(2)

    if temp_c > 30:
        print(":: High Temperature Detected ::")
```

```python
        #mail(f"high Temperature detected {num}")

    if heart_beat > 100:
        print(":: High Heart Beat Detected ::")
        #mail(f" high heart beat detected {num}")

def mail(body):

    #Set the sender email and password and recipient emaiç
    from_email_addr ="socialrobot1234@gmail.com"
    from_email_pass ="vkfdefhljqlthmqk"
    to_email_addr ="embedded@takeoffprojects.com"

    # Create a message object
    msg = EmailMessage()

    # Set the email body
    msg.set_content(body)

    # Set sender and recipient
    msg['From'] = from_email_addr
    msg['To'] = to_email_addr

    # Set your email subject
    msg['Subject'] = 'PATIENT ALERT'

    # Connecting to server and sending email
    # Edit the following line with your provider's SMTP server details
    server = smtplib.SMTP('smtp.gmail.com', 587)

    # Comment out the next line if your email provider doesn't use TLS
    server.starttls()
    # Login to the SMTP server
    server.login(from_email_addr, from_email_pass)

    # Send the message
    server.send_message(msg)

```

```python
    print('Email sent')

    #Disconnect from the Server
    server.quit()

# Create a separate thread for reading RFID
rfid_thread = threading.Thread(target=read_rfid)
rfid_thread.start()

try:
    while True:

        print("checking_time..")
        current_time = time.localtime()
        ch = current_time.tm_hour
        cm = current_time.tm_min
        sleep(2)
        print(ch,":",cm)
        sleep(2)
        hr_1,min_1 = first_schedule
        hr_2,min_2 = second_schedule

        if (ch == hr_1 and cm == min_1) or (ch == hr_2 and cm == min_2):
            flag = 1
            print("-==Schedule==-")

        if flag:
            print("flag loop")
            for angle in range(0, 180, 60):
                servo.move(angle)
                sleep(0.5)
            line_follow()

            for angle in range(180, 0, -60):
                servo.move(angle)
                sleep(0.5)
            line_follow()

```

```
        else:
            motor_driver.control_Motors(True, True)
            print("waiting for schedule!")

except KeyboardInterrupt:
    rfid_thread.join()  # Wait for the RFID thread to finish
    GPIO.cleanup()

```

## 8.3 Experimental Data

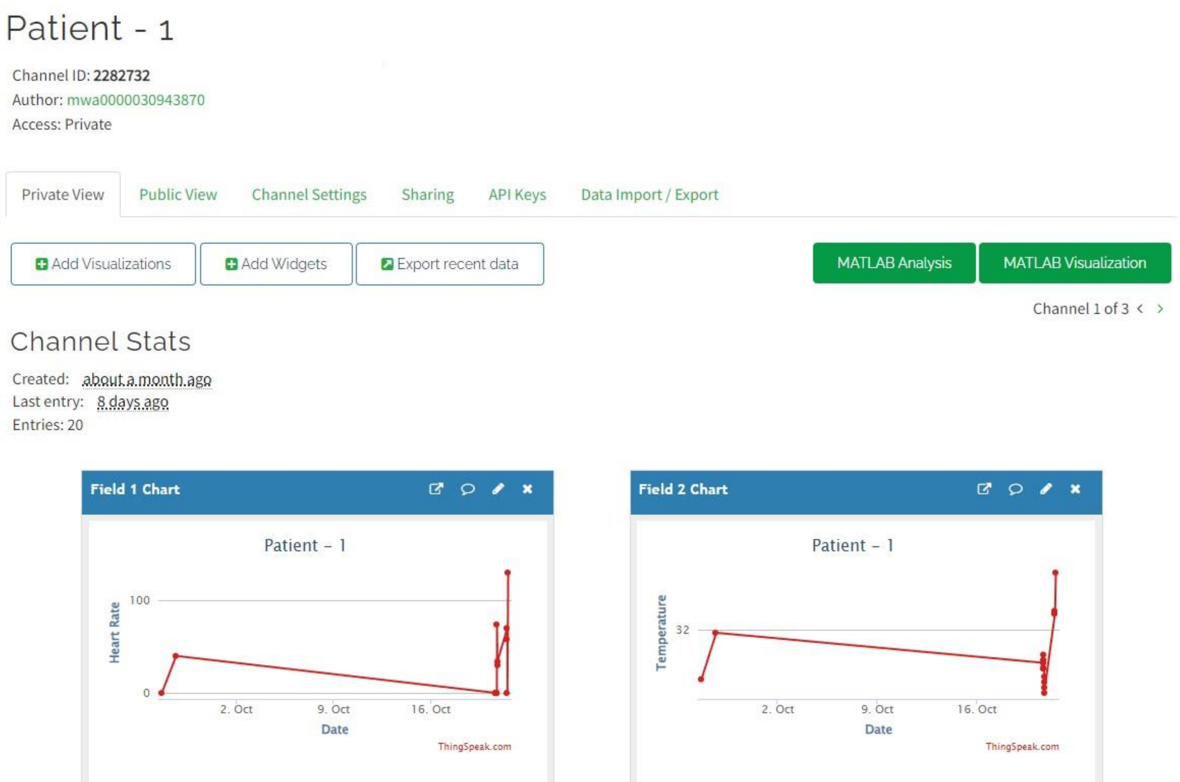



**Figure 27**: Experimental Collected Data of Patient 1

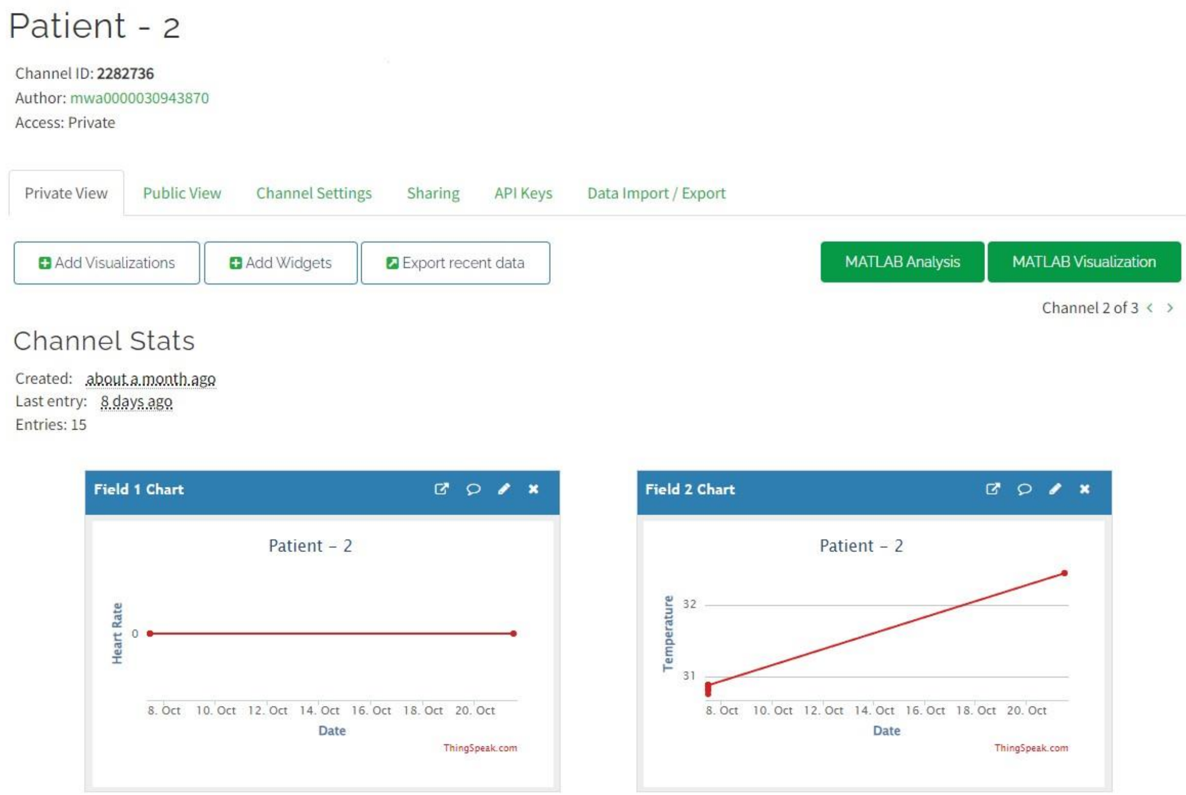



**Figure 28**: Experimental Collected Data of Patient 2

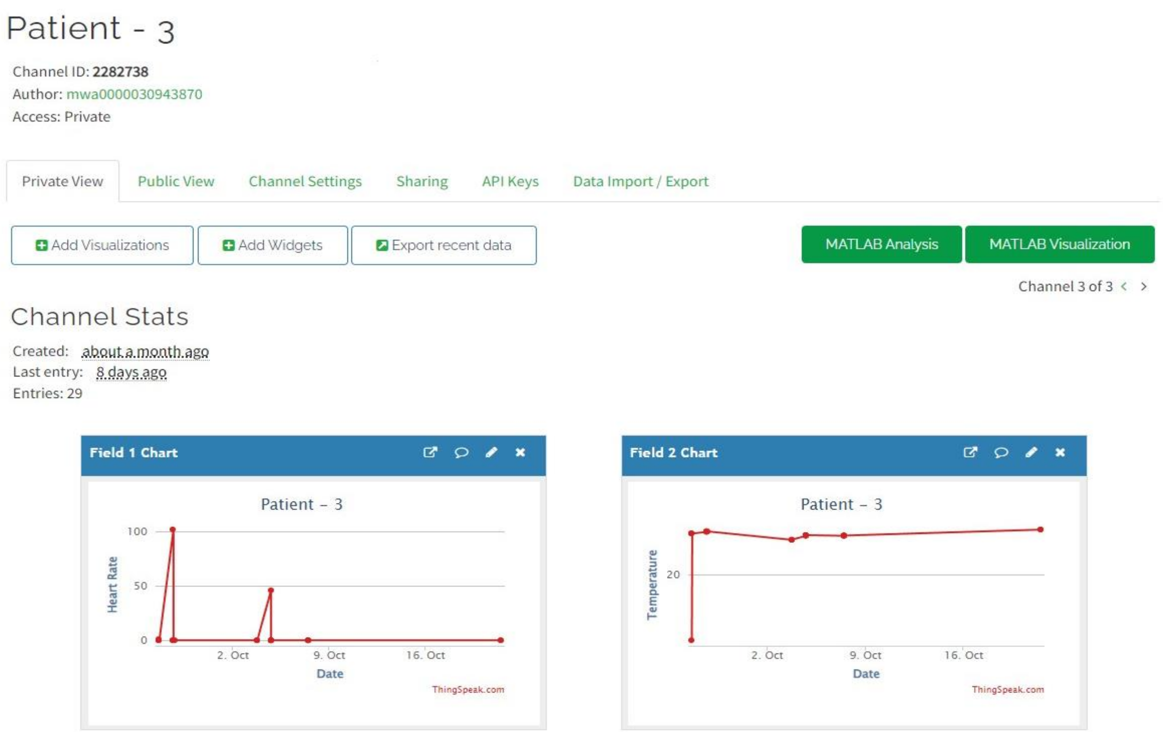



**Figure 29**: Experimental collected Data of Patient 3

**(Annexure 4.6)**

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