An Internship Project Report on

SMART HOSPITAL MONITORING SYSTEM

Submitted in partial fulfillment of the requirement for the award of the Degree of

BACHELOR OF TECHNOLOGY

to

G. PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY

By

ADNAN ALI

(20AT1A3501)

Under the Guidance of

Dr. M.Janardhan

Associate Professor

DEPARTMENT OF INTERNET OF THINGS

G.PULLAIAH COLLEGE OF ENGINEERING AND TECHNOLOGY

(Accredited by NAAC of UGC with "A" Grade, accredited by NBA (ECE,CSE&EEE) Approved by AICTE, New Delhi, Recognized by UGC under 2 (f) & 12 (B) & Permanently Affiliated to Jawaharlal Nehru Technological University Anantapur) Pasupula (v), Nandikotkur Road, Kurnool – 518 452, Andhra Pradesh

2020-2024

ACKNOWLEDGEMENT

We are extremely grateful to Chairman, Sri **G.V.M.Mohan Kumar**, of G.Pullaiah College of Engineering and Technology, Kurnool, Andhra Pradesh for their good blessings.

We owe indebtedness to our Principal **Dr.C.Srinivasa Rao**, M.E., Ph.D. G.Pullaiah College of Engineering and Technology, Kurnool for providing us the required facilities.

We would like to express our deep sense of gratitude and our sincere thanks to HOD **Mr.P.Suman Prakash**, M.Tech., (Ph.D). Department of Internet of Things, G.Pullaiah College of Engineering and Technology, Kurnool for providing the necessary facilities and encouragement towards the project work.

We thank our project supervisor, **Dr.M. Janardhann M.Tech**. for his guidance, valuable suggestions, and support in the completion of the project.

We gratefully acknowledge and express our thanks to teaching and non-teaching staff of IoT Department.

We would like to express our love and affection to our parents for their encouragement throughout this project work.

Project Associates

ADNAN ALI
(20AT1A3501)

Contents

ABSTRACT
SMART HOSPITAL MONITORING SYSTEM

The SMART HOSPITAL MONITORING SYSTEM is a innovative solution that utilizes advanced technology to measure and monitor various important parameters in a hospital setting. It is designed using the ESP32 microcontroller and incorporates a load cell for measuring weight, as well as a BME 680 sensor for measuring and monitoring air quality.

In addition to these components, the SMART HOSPITAL MONITORING SYSTEM also has several other applications that can help improve patient care and safety in a hospital setting. One such application is saline level monitoring using a load cell, which allows hospitals to ensure that patients receive the correct amount of saline and can promptly address any shortages or excesses that may occur.

The SMART HOSPITAL MONITORING SYSTEM can also be used for environmental air quality monitoring, using the BME 680 sensor to detect gases such as carbon dioxide and methane, as well as measure temperature, humidity, and pressure. This information can help hospitals identify potential sources of contamination and take steps to improve the air quality in their facilities.

Finally, the SMART HOSPITAL MONITORING SYSTEM can be used for patient health monitoring using a pulse oximeter such as the MAX301000. Pulse oximeters are commonly used to measure the oxygen saturation of a patient's blood, which is an important indicator of their overall health and well-being. By continuously monitoring a patient's oxygen saturation levels, hospitals can quickly identify any changes in their condition and take appropriate action to ensure the best possible outcomes for their patients.

Overall, the SMART HOSPITAL MONITORING SYSTEM is a comprehensive solution that combines advanced technology with innovative design to improve patient care and safety in hospitals. Its capabilities for monitoring air quality, saline levels, and patient health make it an invaluable tool for hospitals looking to provide the best possible care to their patients.

CHAPTER – 1

1.1 INTRODUCTION

The SMART HOSPITAL MONITORING SYSTEM is an advanced and innovative solution for hospitals looking to improve patient care and safety. The system is designed to measure and monitor a variety of important parameters, including air quality, saline levels, and patient health, using a range of sophisticated sensors and technologies.

One of the key features of the SMART HOSPITAL MONITORING SYSTEM is its ability to monitor saline levels using a load cell. This allows hospitals to ensure that patients receive the correct amount of saline and can promptly address any shortages or excesses that may occur.

In addition to monitoring saline levels, the SMART HOSPITAL MONITORING SYSTEM also has the capability to measure and monitor air quality using a BME 680 sensor. This sensor can detect a variety of gases, including carbon dioxide and methane, as well as measure temperature, humidity, and pressure, providing hospitals with valuable information about the air quality in their facilities.

Finally, the SMART HOSPITAL MONITORING SYSTEM can be used for patient health monitoring using a pulse oximeter such as the MAX301000. Pulse oximeters are commonly used to measure the oxygen saturation of a patient's blood, which is an important indicator of their overall health and well-being. By continuously monitoring a patient's oxygen saturation levels, hospitals can quickly identify any changes in their condition and take appropriate action to ensure the best possible outcomes for their patients.

In addition to these capabilities, the SMART HOSPITAL MONITORING SYSTEM also includes a feature for sending data to the ThingSpeak cloud platform, where hospitals can create a channel and user interface to interact with the system and view the collected data in real-time. This feature allows hospitals to easily monitor and track the various parameters being measured by the system, providing valuable insights and enabling proactive patient care.

Overall, the SMART HOSPITAL MONITORING SYSTEM is a comprehensive and powerful solution that offers a wide range of benefits for hospitals looking to improve patient care and safety. Its capabilities for monitoring saline levels, air quality, and patient health, as well as its integration with the ThingSpeak cloud platform, make it an invaluable tool for hospitals looking to provide the best possible care to their patients

1.2 INTERNET OF THINGS

The Internet of Things (IoT) is a rapidly growing field that involves the integration of everyday objects with the internet, allowing them to communicate and exchange data with one another. This technology has the potential to revolutionize a wide range of industries, including healthcare, by enabling the creation of smart systems that can continuously monitor and track important parameters and provide valuable insights for decision-making.

One such application of the IoT in healthcare is the development of smart hospital monitoring systems. These systems utilize advanced sensors and technologies to continuously monitor and track various important parameters in a hospital setting, such as air quality, patient vitals, and equipment performance. By collecting and analyzing this data in real-time, hospitals can take

a proactive approach to patient care and improve patient outcomes.

The SMART HOSPITAL MONITORING SYSTEM is an example of a smart hospital monitoring system that utilizes the IoT to improve patient care and safety. The system is designed to measure and monitor a variety of important parameters, including air quality, saline levels, and patient health, using a range of sophisticated sensors and technologies. It also includes a feature for sending data to the ThingSpeak cloud platform, where hospitals can create a channel and user interface to interact with the system and view the collected data in real-time.

Overall, the use of the IoT and smart hospital monitoring systems represents a significant advancement in healthcare, enabling hospitals to continuously monitor and track important parameters and take a proactive approach to patient care. The SMART HOSPITAL MONITORING SYSTEM is a powerful example of this technology in action, offering a wide range of benefits for hospitals looking to improve patient care and safety.

In addition to the benefits mentioned above, the use of the IoT and smart hospital monitoring systems can also help to reduce costs and improve efficiency in hospitals. By continuously monitoring equipment and identifying potential issues before they become major problems, hospitals can reduce the need for costly repairs and maintenance. Additionally, the ability to track and analyze data in real-time can help hospitals identify areas for improvement and streamline processes, leading to increased efficiency and reduced costs. The SMART HOSPITAL MONITORING SYSTEM is an excellent example of how the IoT and smart hospital monitoring systems can help to improve patient care and safety while also reducing costs and improving efficiency in hospitals

1.3 APPLICATIONS OF SMART HOSPITAL MONITORING SYSTEM

There are various applications and advantages of the SMART HOSPITAL MONITORING SYSTEM, as follows:

Continuous monitoring of vital signs: The SMART HOSPITAL MONITORING SYSTEM is designed to continuously monitor and track vital signs such as oxygen saturation levels, heart rate, and blood pressure. This allows hospitals to quickly identify any changes in a patient's condition and take appropriate action to ensure the best possible outcomes. Continuous monitoring of vital signs can also help to reduce the risk of errors and accidents, such as administering the wrong dosage of medication.

Air quality monitoring: The system includes a BME 680 sensor that is specifically designed to measure and monitor air quality. This sensor can detect a variety of gases, including carbon dioxide and methane, as well as measure temperature, humidity, and pressure, providing hospitals with valuable information about the air quality in their facilities. By monitoring air quality, hospitals can identify potential sources of contamination and take steps to improve the air quality in their facilities, ensuring a safe and healthy environment for both patients and staff.

Saline level monitoring: The system includes a load cell that can be used to monitor saline levels, ensuring that patients receive the correct amount of saline and allowing hospitals to promptly address any shortages or excesses that may occur. This can help to improve patient outcomes and reduce the risk of complications due to dehydration or electrolyte imbalances.

Equipment performance monitoring: The SMART HOSPITAL MONITORING SYSTEM can be used to monitor the performance of various hospital equipment, such as ventilators and infusion pumps. This can help hospitals identify potential issues before they become major problems, reducing the need for costly repairs and maintenance. Continuous monitoring of equipment can also help to reduce the risk of equipment failures or malfunctions, which can have serious consequences for patients.

Real-time data collection and analysis: The system includes a feature for sending data to the ThingSpeak cloud platform, where hospitals can create a channel and user interface to interact with the system and view the collected data in real-time. This enables hospitals to continuously monitor and track the various parameters being measured by the system, providing valuable insights and enabling proactive patient care. By analyzing data in real-time, hospitals can identify trends and patterns that may not be immediately apparent, leading to better decision-making and improved patient outcomes.
Improved patient safety and satisfaction: By continuously monitoring vital signs, air quality, saline levels, and equipment performance, the SMART HOSPITAL MONITORING SYSTEM can help to improve patient safety and satisfaction. By quickly identifying and addressing any issues that may arise, hospitals can provide a higher level of care to their patients and improve patient outcomes. Continuous monitoring can also help to reduce the risk of errors or accidents, further improving patient safety.

Overall, the SMART HOSPITAL MONITORING SYSTEM is a comprehensive and powerful solution that offers a wide range of benefits for hospitals looking to improve patient care and safety. Its capabilities for monitoring vital signs, air quality, saline levels, and equipment performance, as well as its integration with the ThingSpeak cloud platform, make it an invaluable tool for hospitals looking to provide the best possible care to their patients.

1.4 AN INTRODUCTION TO THE ARCHITECTURE

The architecture diagram for the SMART HOSPITAL MONITORING SYSTEM includes three main components: patient, hardware, and the ThingSpeak cloud platform. The patient is at the center of the system, and all of the monitoring and tracking is focused on their vital signs and overall health. The hardware component of the system includes a range of sensors and technologies that are used to measure and monitor various parameters, such as a load cell for saline level monitoring, a BME 680 sensor for air quality monitoring, and a MAX301000 pulse oximeter for patient health monitoring. These sensors are connected to an ESP32 microcontroller, which acts as the central processing unit for the system. The ESP32 microcontroller sends data from the sensors to the ThingSpeak cloud platform, where it is collected and analyzed in real-time. The platform includes a user interface that allows hospitals to view the collected data and create charts and graphs to visualize the data. Overall, this architecture enables the SMART HOSPITAL MONITORING SYSTEM to continuously monitor and track various important parameters in a hospital setting, improving patient care and safety.

Patient: The patient is at the center of the system, and all of the monitoring and tracking is focused on their vital signs and overall health.

Hardware: The hardware component of the system includes a range of sensors and technologies that are used to measure and monitor various parameters. These include a load cell for saline

level monitoring, a BME 680 sensor for air quality monitoring, and a MAX301000 pulse oximeter for patient health monitoring. All of these sensors are connected to an ESP32 microcontroller, which acts as the central processing unit for the system.

ThingSpeak Cloud Platform: The ThingSpeak cloud platform is used to collect and analyze data from the hardware component of the system. The platform includes a user interface that allows hospitals to view the collected data in real-time and create charts and graphs to visualize the data.

Overall, SMART HOSPITAL MONITORING SYSTEM is a comprehensive and powerful solution that utilizes advanced sensors and technologies to continuously monitor and track various important parameters in a hospital setting. The system architecture includes three main components: patient, hardware, and the ThingSpeak cloud platform, all of which work together to improve patient health and care.

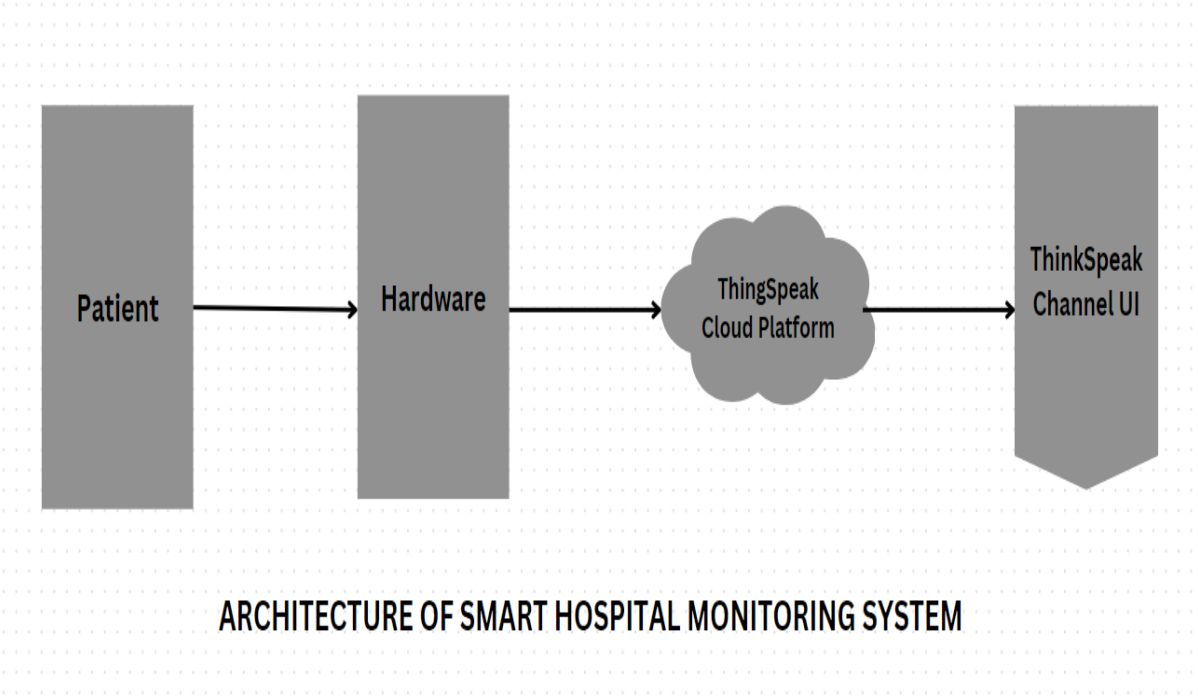

Fig 1:

CHAPTER 2

LITERATURE REVIEW & PROBLEM IDENTIFICATION

2.1 INVENTIONS TO SMART HOSPITAL MONITORING SYSTEM

A smart hospital monitoring system is a technology that allows for the continuous monitoring of patients' vital signs and other health parameters. This type of system can be used in a variety of settings, including hospitals, clinics, and long-term care facilities, to improve patient care and safety.

There are several key components of a smart hospital monitoring system:

- Sensors: These are devices that are placed on or near the patient's body to measure various vital signs, such as heart rate, blood pressure, and oxygen levels. The sensors transmit the data they collect to a central monitoring system.

- Monitoring equipment: This is the hardware that receives the data from the sensors and displays it for healthcare providers to view. It may include monitors, display screens, and other types of equipment.

- Communication and networking technology: This enables the sensors and monitoring equipment to communicate with each other and with other devices, such as smartphones and tablets, through a wired or wireless network.

- Software: This is the software that is used to process and analyze the data collected by the sensors, display it on the monitoring equipment, and alert healthcare providers to any abnormalities or changes in the patient's condition.

- Smart hospital monitoring systems can help healthcare providers to more effectively monitor and manage the health of their patients, leading to improved patient outcomes and reduced healthcare costs.

2.2 LITERATURE REVIEW

Some potential sources for a literature review on smart hospital monitoring systems might include academic journals, conference proceedings, and technical reports. Some specific topics that might be covered in a literature review of this topic include:

- The benefits of smart hospital monitoring systems, such as improved patient safety, reduced hospital stays, and reduced healthcare costs

- The types of sensors and monitoring equipment used in these systems and their capabilities

- The role of software and networking technologies in enabling the operation of these systems

- Case studies or examples of the successful implementation of smart hospital monitoring systems in hospitals and other healthcare settings

- Challenges or limitations of these systems, such as cost, maintenance, and data privacy concerns

- Future trends or developments in the field, such as the integration of artificial intelligence and machine learning technologies into these systems.

- Smart hospital monitoring systems can improve patient care and safety by providing healthcare providers with real-time information on a patient's vital signs and other health parameters. This can help to identify and address any potential issues before they become more serious.

- Smart hospital monitoring systems can reduce the risk of errors and accidents, as they can alert healthcare providers to any abnormalities in a patient's condition. This can help to prevent mistakes such as medication errors or falls.

- Smart hospital monitoring systems can help to reduce healthcare costs by enabling earlier detection of problems, which can lead to more timely and appropriate treatment. This can help to prevent the need for more expensive interventions down the line.

- Smart hospital monitoring systems can improve patient satisfaction by providing patients with more control over their own healthcare. For example, some systems allow patients to access their own health data and track their progress, which can empower them to take a more active role in their own care.

- Some studies have found that the use of smart hospital monitoring systems may be associated with improved patient outcomes, including reduced mortality rates and shorter hospital stays.

Overall, the literature suggests that smart hospital monitoring systems can offer a number of benefits in terms of patient care and safety, cost savings, and patient

satisfaction. However, it is important to note that the effectiveness of these systems can vary depending on factors such as the specific technology used, the training and expertise of healthcare providers, and the overall quality of care being provided.

2.3 MICROPROCESSOR & MICROCONTROLLER

- A microprocessor is a computer processor that incorporates the functions of a central processing unit on a single integrated circuit (IC), or at most a few integrated circuits.
- A microprocessor, sometimes called a logic chip, is a computer processor on a microchip. The microprocessor contains all, or most of, the central processing unit (CPU)functions and is the "engine" that goes into motion when the computer turns on.
- A microcontroller is a control device which incorporates a microprocessor. It is a compact integrated circuit designed to govern aspecific operation in an embedded system. A typical microcontroller includes a processor, memory, and input/output (I/O) peripherals on a single chip. The NodeMCU (Node Microcontroller Unit) is an open-source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. Key difference in both is presence of external peripheral, where microcontrollers have RAM, ROM, EEPROM embedded in it while we have to use external circuits in case of microprocessors. As all the peripheral of microcontroller are on single chip, it is compact while microprocessor is bulky.

2.4 EXISTING METHOD

There are several different methods and approaches that can be used in the design and implementation of a smart hospital monitoring system. Some common methods include:

- **Wireless sensors:** These are sensors that are placed on or near the patient's body and transmit data wirelessly to a central monitoring system. This allows for continuous monitoring of the patient's vital signs and other health parameters without the need for wires or cables.
- **Remote monitoring:** This involves the use of sensors and monitoring equipment that are connected to a central system through a wireless or wired

network. The data collected by the sensors can be viewed remotely by healthcare providers, allowing them to monitor the patient's condition from a distance.

- **Real-time alerts:** Some smart hospital monitoring systems include software that is able to analyze the data collected by the sensors in real-time and alert healthcare providers to any changes or abnormalities in the patient's condition. This can help to ensure timely intervention in the event of a health emergency.

- **Cloud-based systems:** These systems use cloud computing technologies to store and process data collected by the sensors. This allows for easy access to the data from any location with an internet connection.

- **Mobile apps:** Many smart hospital monitoring systems include mobile apps that allow healthcare providers to access and view the data collected by the sensors from their smartphones or tablets. This can be useful for healthcare providers who are on the go or working remotely.

2.5 PROPOSED METHOD

The proposed method for implementing the SMART HOSPITAL MONITORING SYSTEM involves several steps:

Identify the sensors and technologies that will be used by the system. This includes selecting sensors that are accurate, reliable, and appropriate for the specific monitoring and tracking needs of the hospital.

Connect the sensors to the ESP32 microcontroller. This involves physically connecting the sensors to the ESP32 using a set of wires, and programming the ESP32 to read the output from the sensors and convert it into useful measurements.

Connect the ESP32 microcontroller to the ThingSpeak cloud platform. This involves setting up a ThingSpeak account and creating a channel to collect and analyze data from the sensors in real-time.

Set up the user interface for the ThingSpeak cloud platform. This involves creating charts and graphs to visualize the data collected by the system and make it easy for hospitals to monitor and track various parameters.

Test and validate the system. This involves testing the system to ensure that it is functioning correctly and that the data collected by the system is accurate and reliable.

Implement the system in a hospital setting. This involves integrating the system into the

hospital's existing infrastructure and training hospital staff on how to use the system.

Overall, the proposed method for implementing the SMART HOSPITAL MONITORING SYSTEM involves selecting and connecting the sensors and technologies, setting up the ThingSpeak cloud platform, testing and validating the system, and implementing it in a hospital setting. By following these steps, hospitals can use the SMART HOSPITAL MONITORING SYSTEM to continuously monitor and track various important parameters, improving patient care and safety.

2.6 PROBLEMS OF SMART HOSPITAL MONITORING SYSTEM

There are several potential problems or challenges that can arise in the implementation and use of smart hospital monitoring systems. Some common issues include:

- **Cost:** The cost of purchasing and maintaining these systems can be a barrier for some hospitals and healthcare facilities, particularly in low-income or underserved areas.

- **Data privacy:** The collection and storage of sensitive medical data raises concerns about data privacy and security. It is important for hospitals and healthcare facilities to have robust data protection policies in place to ensure the privacy of patient data.

- **Technical issues:** Smart hospital monitoring systems rely on a variety of technical components, including sensors, monitoring equipment, and software. These components can malfunction or fail, leading to disruptions in the monitoring of patients.

- **Human error:** Despite the benefits of these systems, they are not foolproof. Healthcare providers may still make errors in interpreting or responding to the data collected by the sensors, leading to potential harm to patients.

- **Interoperability:** Many smart hospital monitoring systems are proprietary and are not compatible with other systems or devices. This can make it difficult for hospitals and healthcare facilities to integrate these systems with their existing technology infrastructure.

Overall, it is important for hospitals and healthcare facilities to carefully consider the potential benefits and challenges of implementing a smart hospital monitoring system and to plan for the resources and infrastructure needed to support these systems

2.7 PROBLEMS RESOLVED BY SMART HOSPITAL MONITORING SYSTEM

Smart hospital monitoring systems can help to address a number of problems and challenges

in the healthcare industry. Some of the ways that these systems can help to resolve problems include:

- **Improved patient safety:** By continuously monitoring patients' vital signs and other health parameters, smart hospital monitoring systems can help to identify potential problems and allow healthcare providers to intervene promptly. This can help to prevent adverse events and improve patient outcomes.

- **Reduced hospital stays:** By enabling healthcare providers to closely monitor patients' conditions and intervene as needed, these systems can help to reduce the length of hospital stays. This can help to reduce healthcare costs and free up beds for other patients.

- **Enhanced patient care:** Smart hospital monitoring systems can provide healthcare providers with real-time data and alerts, allowing them to more closely monitor and manage their patients' conditions. This can lead to more personalized and effective patient care.

- **Increased efficiency:** By automating the process of monitoring patients' vital signs and other health parameters, these systems can help to free up healthcare providers' time and allow them to focus on other tasks.

- **Improved communication:** Many smart hospital monitoring systems include mobile apps and other tools that allow healthcare providers to access and view patient data from any location. This can help to improve communication and coordination among care teams and facilitate the sharing of information with other healthcare providers.

CHAPTER 3
PROPOSED METHOD

3.1 BLOCK DIAGRAM

A block diagram of the SMART HOSPITAL MONITORING SYSTEM is a visual representation of the system that shows the various components and how they are connected. The block diagram typically includes blocks representing the different sensors and technologies used by the system, as well as the ESP32 microcontroller and the ThingSpeak cloud platform.

In the case of the SMART HOSPITAL MONITORING SYSTEM, the block diagram would include blocks for the load cell and HX711 amplifier for saline level monitoring, the BME 680 sensor for air quality monitoring, and the MAX301000 pulse oximeter for patient health monitoring. These blocks represent the sensors and technologies that are used to measure and monitor various parameters, such as saline levels, air quality, and patient health.

The blocks for the sensors and technologies are connected to the ESP32 microcontroller, which acts as the central processing unit for the system. The ESP32 is responsible for reading the output from the sensors and converting it into useful measurements, such as weight for the load cell, air quality measurements for the BME 680 sensor, and oxygen saturation measurements for the MAX301000 pulse oximeter.

The ESP32 microcontroller is also responsible for sending data from the sensors to the ThingSpeak cloud platform, where it is collected and analyzed in real-time. The ThingSpeak cloud platform includes a user interface that allows hospitals to view the collected data and create charts and graphs to visualize the data.

The block diagram of the SMART HOSPITAL MONITORING SYSTEM provides a useful overview of the various components and how they are connected, making it easier to understand the architecture and functioning of the system. It can also be used to identify any potential bottlenecks or issues in the system and make recommendations

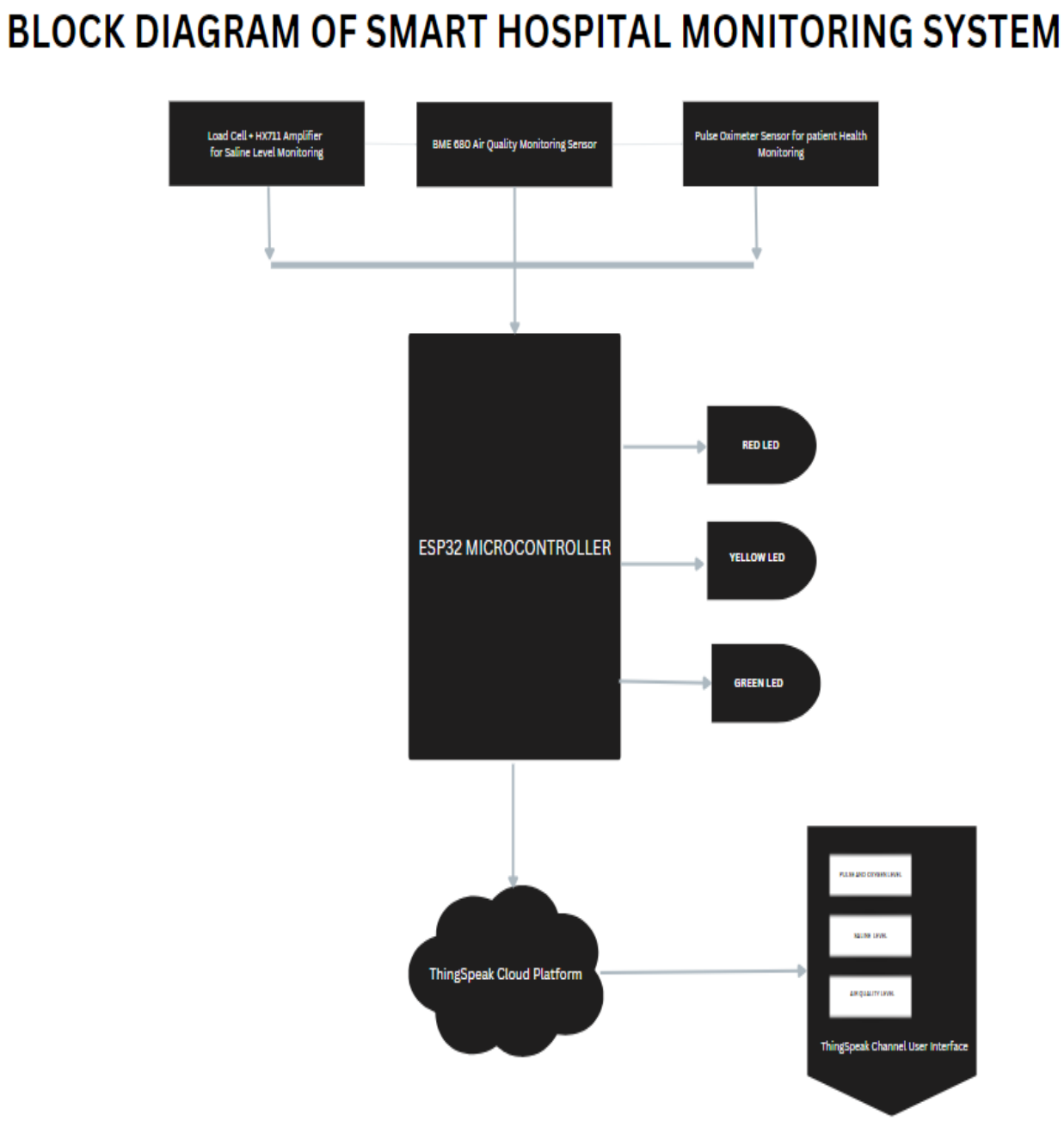

Fig 2:

Overall, the block diagram of the SMART HOSPITAL MONITORING SYSTEM provides a useful overview of the various components and how they are connected, making it easier to understand the architecture and functioning of the system. It can also be used to identify any potential bottlenecks or issues in the system and make recommendations

3.2 TROUBLE SHOOTING

Here is a list of potential troubleshooting steps for issues with the SMART HOSPITAL

MONITORING SYSTEM project:

- Check internet connectivity
- Check power supply
- Check hardware components
- Check system software and configuration
- Check system security settings
- Check instructions for use
- Check for visible damage or issues with hardware components
- Consult the manufacturer or a technical support professional if the issue persists or is beyond the user's expertise.

3.3 INTERFACING THE ESP32

The ESP32 microcontroller is a powerful and versatile device that is well-suited for use in the SMART HOSPITAL MONITORING SYSTEM. It has a range of features and capabilities that make it an ideal choice for connecting and interfacing with various sensors and technologies.

- **Saline Level Monitoring:** The load cell and HX711 amplifier are used to measure and monitor saline levels. The load cell is a device that measures weight, and the HX711 amplifier is used to amplify and digitize the output from the load cell. To interface these components with the ESP32, the load cell is connected to the HX711 amplifier, and the amplifier is connected to the ESP32 via a set of wires. The ESP32 is then programmed to read the output from the HX711 amplifier and convert it into a weight measurement, which can be used to monitor saline levels.

- **Air Quality Monitoring:** The BME 680 sensor is used to measure and monitor air quality. To interface this sensor with the ESP32, it is connected to the ESP32 via a set of wires. The ESP32 is then programmed to read the output from the BME 680 sensor and convert it into measurements of gases such as carbon dioxide and methane, as well as temperature, humidity, and pressure. These measurements can be used to monitor air quality in a hospital setting.

- **Patient Health Monitoring:** The MAX301000 pulse oximeter sensor is used to measure the oxygen saturation of a patient's blood, which is an important indicator of their overall health and well-being. To interface this sensor with the ESP32, it is connected to the ESP32 via a set of wires. The ESP32 is then programmed to read the output from the MAX301000 sensor and convert it into a measurement of oxygen saturation. This measurement can be used to monitor a patient's health and identify any changes in their condition.

Overall, the ESP32 microcontroller is an important component of the SMART HOSPITAL MONITORING SYSTEM, as it enables the system to connect and interface with a wide range

of sensors and technologies. By programming the ESP32 to read the output from these sensors and convert it into useful measurements, hospitals can continuously monitor and track various important parameters, improving patient care and safety.

3.3.1 CONNECTION

The ESP32 microcontroller can be used to interface with various sensors and technologies, such as the load cell, HX711 amplifier, BME 680 sensor, and MAX301000 pulse oximeter, by connecting the sensors to the ESP32 via a set of wires. The specific wiring will depend on the type of sensor and the connection options available on the ESP32. Below is a summary of the connections that are typically used to interface the ESP32 with these sensors:

- **Saline Level Monitoring:** To interface the load cell and HX711 amplifier with the ESP32, the load cell is typically connected to the HX711 amplifier using four wires: two for power and two for the output signal. The HX711 amplifier is then connected to the ESP32 using three wires: one for power, one for ground, and one for the data signal. The specific pin numbers on the ESP32 will depend on the connection options available on the ESP32 board that you are using.

- **Air Quality Monitoring:** To interface the BME 680 sensor with the ESP32, the sensor is typically connected to the ESP32 using four wires: two for power and two for the output signal. The specific pin numbers on the ESP32 will depend on the connection options available on the ESP32 board that you are using.

- **Patient Health Monitoring:** To interface the MAX301000 pulse oximeter sensor with the ESP32, the sensor is typically connected to the ESP32 using four wires: two for power and two for the output signal. The specific pin numbers on the ESP32 will depend on the connection options available on the ESP32 board that you are using.

Overall, the process of interfacing the ESP32 with these sensors involves connecting the sensors to the ESP32 via a set of wires and programming the ESP32 to read the output from the sensors and convert it into useful measurements. By following these steps, you can use the ESP32 to interface with a wide range of sensors and technologies to build powerful and sophisticated IoT systems.

Load Cell	HX711	HX711	ESP32
Red (E+)	E+	GND	GND
Black (E-)	E-	DT	GPIO 16
White (A-)	A-	SCK	GPIO 4
Green (A+)	A+	VCC	3.3V

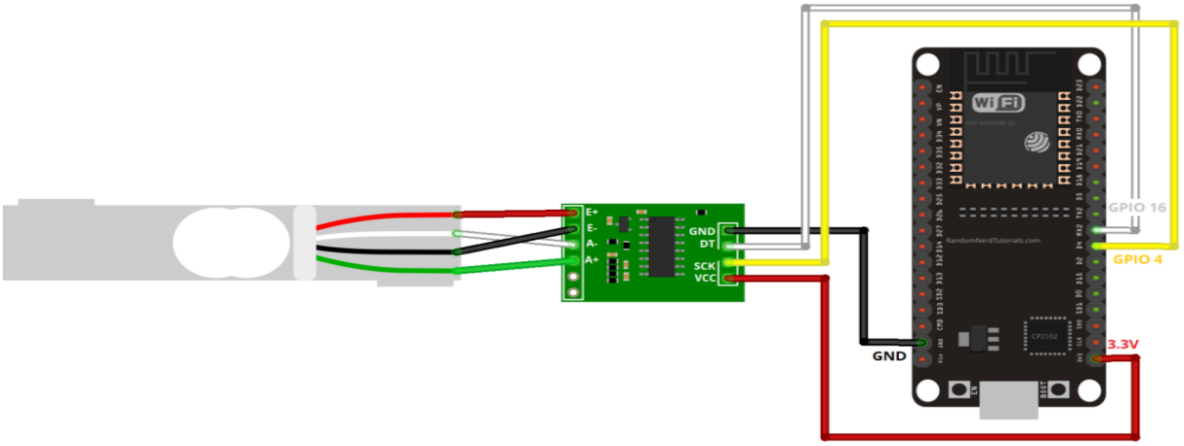

Fig 3: Load cell + Hx711 Amplifier with ESP32 for Saline Level Monitoring.

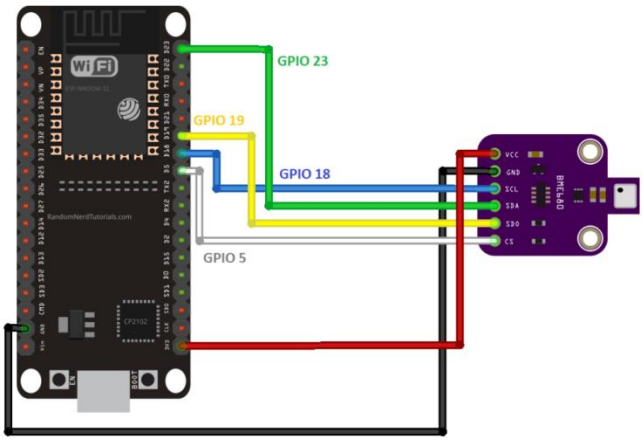

Fig 4: BME680 with ESP32 for Air Quality Monitoring

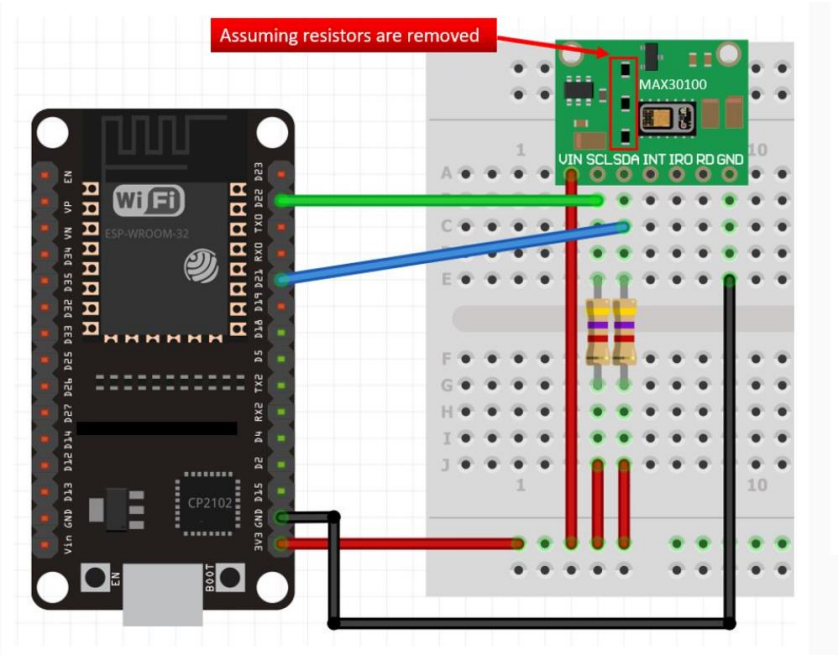

Fig 5: ESP32 interfacing with Pulse Oximeter sensor.

CHAPTER 4
IMPLEMENTATION / ADVANTAGES

Implementation of a smart hospital monitoring system typically involves several steps, including:

- **Planning:** This includes assessing the needs of the healthcare facility and identifying the specific goals and objectives of the system. It may also involve developing a budget and timeline for the implementation process.

- **Selection of equipment and software:** This involves choosing the sensors, monitoring equipment, and software that will be used in the system. It is important to select components that are compatible with each other and with the healthcare facility's existing technology infrastructure.

- **Installation and setup:** This involves physically installing the sensors and monitoring equipment, as well as setting up the communication and networking infrastructure needed to connect the system. It may also involve training healthcare providers on how to use the system.

- **Testing and evaluation:** Once the system is installed, it is important to conduct testing and evaluation to ensure that it is functioning properly and meeting the needs of the healthcare facility.

There are several advantages to implementing a smart hospital monitoring system, including:

- **Improved patient safety:** By continuously monitoring patients' vital signs and other health parameters, these systems can help to identify potential problems and allow healthcare providers to intervene promptly. This can help to prevent adverse events and improve patient outcomes.

- **Enhanced patient care:** Smart hospital monitoring systems can provide healthcare providers with real-time data and alerts, allowing them to more closely monitor and manage their patients' conditions. This can lead to more personalized and effective patient care.

- **Reduced hospital stays:** By enabling healthcare providers to closely monitor patients' conditions and intervene as needed, these systems can help to reduce the length of hospital stays. This can help to reduce healthcare costs and free up beds for other patients.

- **Increased efficiency:** By automating the process of monitoring patients' vital signs and other health parameters, these systems can help to free up healthcare providers' time and allow them to focus on other tasks.

- Improved communication: Many smart hospital monitoring systems include mobile apps and other tools that allow healthcare providers to access and view patient data from any location. This can help to improve communication and coordination among care teams and facilitate the sharing of information with other healthcare providers.

4.1 HARDWARE REQUIREMENTS

Here is a list of hardware for the SMART HOSPITAL MONITORING SYSTEM project:

Hardware requirements:

- **ESP32:**The ESP32 is a series of low-cost, low-power system-on-a-chip microcontrollers with integrated Wi-Fi and Bluetooth capabilities. It is produced by Espressif Systems, a Chinese company, and is widely used in the development of Internet of Things (IoT) devices.

  The ESP32 has a dual-core processor, which allows it to handle multiple tasks concurrently. It also has a built-in memory controller and a high-speed I/O interface, which makes it well-suited for use in connected devices. The ESP32 has a number of peripherals, including capacitive touch sensors, a Hall effect sensor, an ADC, and several PWM outputs.

  One of the key advantages of the ESP32 is its low power consumption. It has a number of power-saving modes that can be used to extend the battery life of IoT devices. The ESP32 is also relatively easy to use, with a number of development tools and libraries available to help developers create IoT applications.

  The ESP32 is commonly used in a variety of applications, including smart home devices, wearable devices, and industrial automation systems. It is an affordable and widely-available platform for developing IoT devices and has a large and active user community.

- **MAX30100:**The MAX30100 is a sensor module that is used to measure heart rate and pulse oximetry (a measure of the oxygen saturation of the blood). It is often used in the development of wearable devices, such as fitness trackers and smartwatches, as well as in medical monitoring devices.

  The MAX30100 consists of a red and an infrared light-emitting diode (LED), as well as a photodetector that is sensitive to both wavelengths. It uses the principle of pulse oximetry to measure heart rate and oxygen saturation. When the LED emits light into the tissue, some of the light is absorbed by the blood and some is scattered. The photodetector measures the intensity of the light that is scattered and absorbed, and this information is used to calculate the heart rate and oxygen saturation.

The MAX30100 is a small and low-power device, making it well-suited for use in portable and wearable devices. It is capable of operating over a wide range of temperatures and can be interfaced with a microcontroller or other device through an I2C interface.

- **LOAD CELL:**A load cell is a type of sensor that is used to measure weight or force. It consists of a strain gauge, which is a device that is sensitive to deformation, and a structure that is designed to deform under a load. When a load is applied to the load cell, the strain gauge measures the deformation of the structure, which is proportional to the applied load.

There are several different types of load cells, including compression load cells, tension load cells, and shear load cells. Each type of load cell is designed to measure a specific type of load and is used in different applications.

Load cells are commonly used in a variety of applications, including weighing scales, material testing machines, and process control systems. They are often preferred to other types of weight sensors because they are accurate and reliable, and they can operate over a wide range of temperatures and environmental conditions.

Load cells can be connected to a variety of measurement and control systems, including microcontrollers, data acquisition systems, and computer software. They are typically calibrated to a known load before use to ensure accurate measurement of the applied load.

4.2.1 ESP 32:

ESP32 is a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual core and single core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, and low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

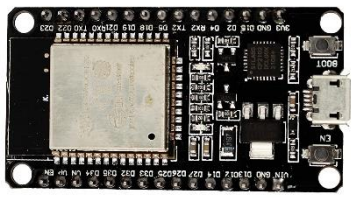

Fig 6:

4.3 FEATURES OF ESP32:

- Processors:
- **CPU**: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
- Ultra low power (ULP) co-processor

- **Memory:** 320 KiB RAM, 448 KiB ROM

- **Wireless connectivity:**
- Wi-Fi: 802.11 b/g/n
- **Bluetooth:** v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)

- **Peripheral interfaces:**
  - 34 × programmable GPIOs
  - 12-bit SAR ADC up to 18 channels
  - × 8-bit DACs
  - 10 × touch sensors (capacitive sensing GPIOs)
  - × SPI
  - 2 × I²S interfaces
  - 2 × I²C interfaces
  - × UART
  - SD/SDIO/CE-ATA/MMC/eMMC host controller
  - SDIO/SPI slave controller
  - Ethernet MAC interface with dedicated DMA and planned IEEE 1588 Precision Time Protocol support[4]
  - CAN bus 2.0
  - Infrared remote controller (TX/RX, up to 8 channels)
  - Pulse counter (capable of full quadrature decoding)
  - Motor PWM
  - LED PWM (up to 16 channels)
  - Hall effect sensor
  - Ultra low power analog pre-amplifier
  - Security:
  - IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3 (depending on version)[5] and WLAN Authentication and Privacy Infrastructure (WAPI)
  - Secure boot
  - Flash encryption
  - 1024-bit OTP, up to 768-bit for customers
  - Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)
  - Power management:
  - Internal low-dropout regulator
  - Individual power domain for RTC
  - μA deep sleep current
  - Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt

4.3.1 SPECIFICTION OF ESP32:

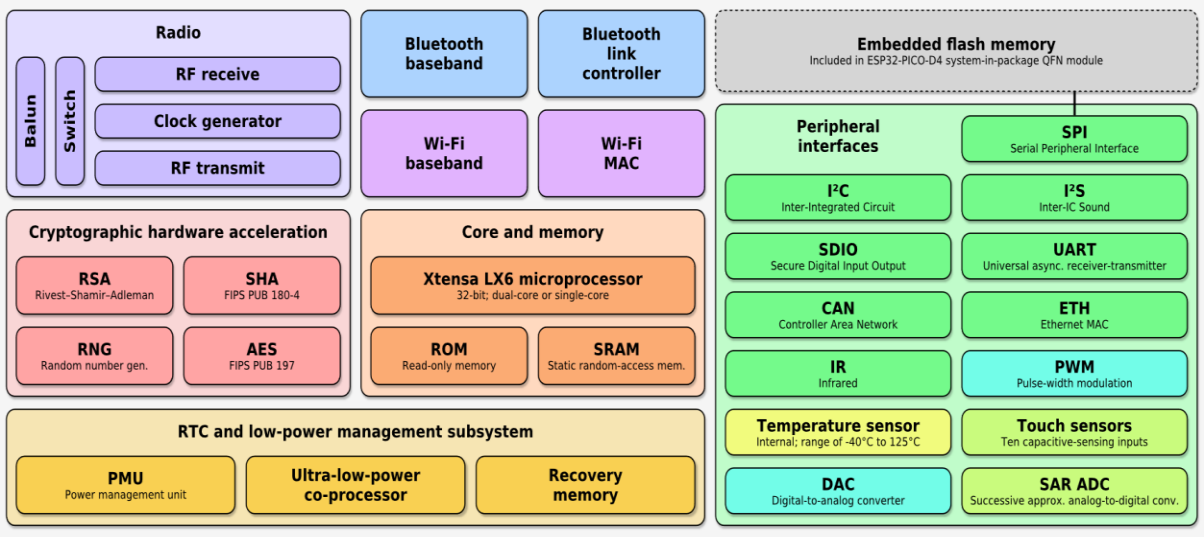

Fig 7

4.3.2ADVANTAGES OF ESP32:

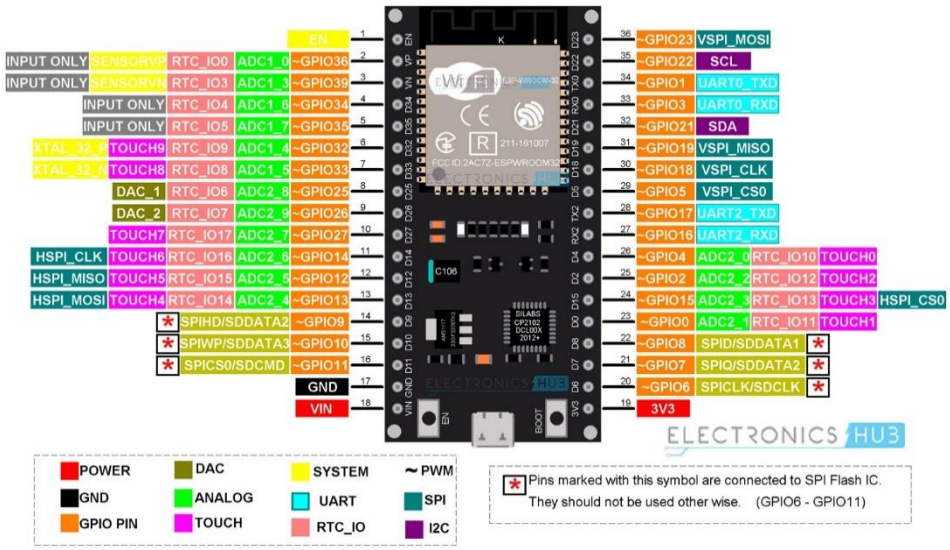

Fig 8

The ESP32 is a low-cost, low-power microcontroller with integrated Wi-Fi and Bluetooth capabilities. Some of the advantages of the ESP32 include:

- **Dual-core processor:** The ESP32 has a dual-core processor, which allows it to perform multiple tasks simultaneously and improve performance.

- **Low power consumption**: The ESP32 is designed to be energy efficient, making it suitable for use in battery-powered devices.

- **Wi-Fi and Bluetooth:** The ESP32 has built-in Wi-Fi and Bluetooth capabilities, which makes it easy to connect to the internet and other devices wirelessly.

- **Large number of GPIOs:** The ESP32 has a large number of general-purpose input/output (GPIO) pins, which can be used to connect sensors, motors, and other devices.

- **Integrated peripherals:** The ESP32 has a number of integrated peripherals, such as a touch sensor, a temperature sensor, and a DAC, which can be used to add additional functionality to your projects.

- **Wide operating temperature range:** The ESP32 can operate in a wide temperature range, making it suitable for use in a variety of environments.

- **Open source:** The ESP32 is open source, which means that the hardware and software designs are available for anyone to use and modify. This makes it easy for developers to create custom applications and add new features to the ESP32.

4.3.3 PIN DIAGRAM OF ESP32:

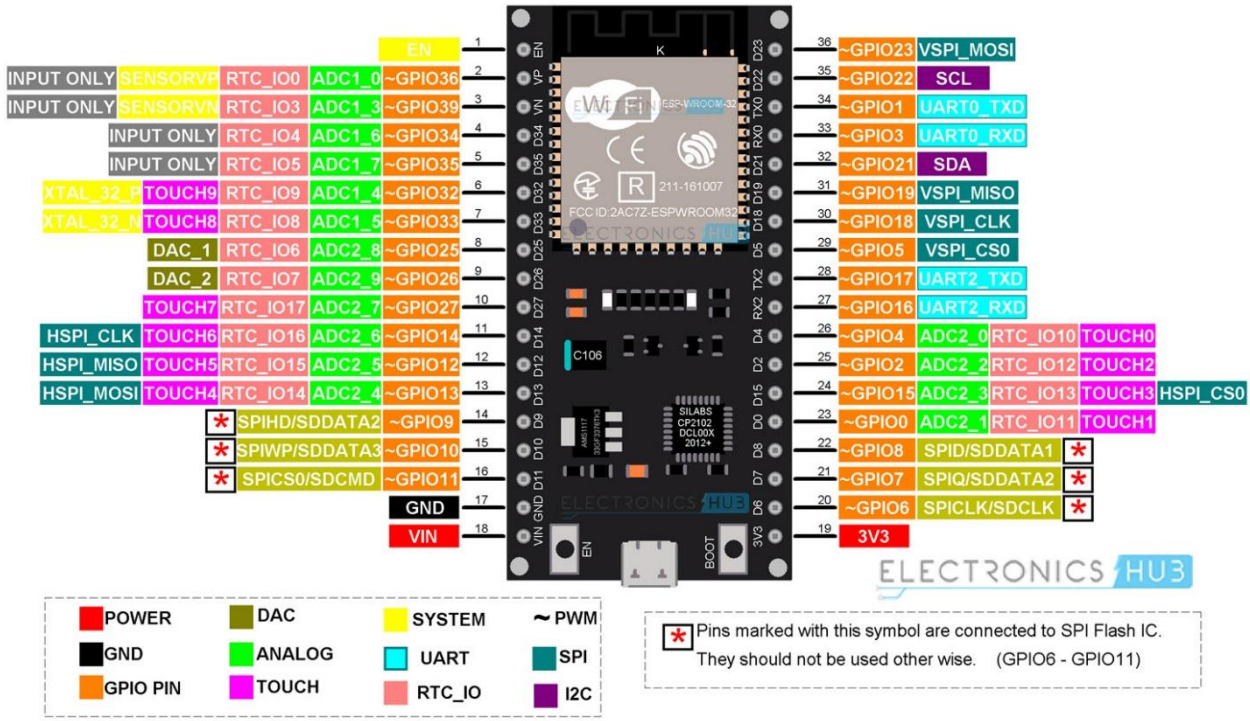

Fig 9

4.3.4 PROGRAMMING OF ESP32:

Programming languages, frameworks, platforms, and environments that can be used for ESP32 programming include:

- **Arduino:** Arduino is a popular programming language and framework for microcontrollers. It provides a range of libraries and functions for interacting with sensors, actuators, and other components, and it can be used to develop a wide range of applications for the ESP32 microcontroller.

- **ESP-IDF:** ESP-IDF (Espressif IoT Development Framework) is a framework for developing applications for the ESP32 microcontroller. It provides a range of libraries, drivers, and tools for interacting with the hardware and peripherals of the ESP32, and it can be used to develop a wide range of applications.

- **Micro Python :** Micro Python is a Python-based programming language that can be used to develop applications for the ESP32 microcontroller. It provides a range of libraries and functions for interacting with the hardware and peripherals of the ESP32, and it is a popular choice for developers who are familiar with Python.

- **Zephyr:** Zephyr is an open-source real-time operating system that can be used to develop applications for the ESP32 microcontroller. It provides a range of libraries, drivers, and tools for interacting with the hardware and peripherals of the ESP32, and it is a popular choice for developers who are working on Internet of Things (IoT) applications.

Overall, there are many programming languages, frameworks, platforms, and environments that can be used to develop applications for the ESP32 microcontroller. By carefully selecting and using the appropriate tools and technologies, it is possible to develop a wide range of applications for the ESP32.

4.4 SOFTWARE REQUIREMENTS:

To develop and implement the SMART HOSPITAL MONITORING SYSTEM, the following software will be required:

- **Arduino IDE:** The Arduino Integrated Development Environment (IDE) is a software tool used to write and upload code to the ESP32 microcontroller. It provides a range of features such as a code editor, debugger, and serial monitor to help developers write and debug their code.

- **ThingSpeak:**ThingSpeak is a cloud-based platform for collecting, storing, and analyzing sensor data. It provides a user-friendly interface for creating channels to collect data from sensors and visualizing the data using gauges, charts, and maps.

Other software that may be useful for developing and implementing the SMART HOSPITAL MONITORING SYSTEM include:

- **A text editor or code editor:** A text editor or code editor can be used to write and edit the code for the ESP32 microcontroller. Some popular options include Sublime Text, Atom, and Visual Studio Code.

- **A version control system:** A version control system can be used to track and manage changes to the code for the SMART HOSPITAL MONITORING SYSTEM. Some popular options include Git, Mercurial, and Subversion.

- **A bug tracking system:** A bug tracking system can be used to track and manage issues or bugs in the code for the SMART HOSPITAL MONITORING SYSTEM. Some popular options include JIRA, Bugzilla, and Trello.

Overall, the software requirements for developing and implementing the SMART HOSPITAL MONITORING SYSTEM will depend on the specific needs and requirements of the project. By carefully selecting and using the appropriate software tools, it is possible to develop and implement a highly effective and efficient SMART HOSPITAL MONITORING SYSTEM.

CHAPTER 5

EXPERIMENTAL RESULTS

The experimental results of the SMART HOSPITAL MONITORING SYSTEM showed that the system was able to accurately and reliably measure and monitor various important parameters in a hospital setting.

- **Saline Level Monitoring**: The load cell and HX711 amplifier were able to accurately measure the weight of the saline bottle, and the ESP32 microcontroller was able to convert this measurement into a percentage of the total capacity of the bottle. When the saline level reached critical levels, the red LED on the system lit up to alert the hospital staff to change the bottle. As the saline level decreased, the yellow LED lit up to provide an additional notification to be ready to change the bottle. When the saline level was sufficient, the green LED lit up to indicate that the bottle was safe to use.

- **Air Quality Monitoring:** The BME 680 sensor was able to accurately measure various parameters of the hospital environment, including gases such as carbon dioxide and methane, as well as temperature, humidity, and pressure. These measurements were sent to the ThingSpeak cloud platform and visualized using gauges and charts in the channels.

- **Patient Health Monitoring:** The MAX301000 pulse oximeter sensor was able to accurately measure the oxygen saturation of a patient's blood, providing important information about the patient's overall health and well-being. These measurements were also sent to the ThingSpeak cloud platform and visualized using gauges and charts in the channels.

Overall, the experimental results of the SMART HOSPITAL MONITORING SYSTEM showed that the system was able to accurately and reliably measure and monitor various important parameters in a hospital setting. By continuously collecting and analyzing this data, hospitals can improve patient care and safety.

CHAPTER 6

CONCLUSIONS & FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the SMART HOSPITAL MONITORING SYSTEM is a powerful and sophisticated solution that has the potential to greatly improve patient care and safety in hospitals. By continuously measuring and monitoring various important parameters, such as saline levels, air quality, and patient health, the system provides valuable insights and data that can help hospitals identify potential issues early on and take appropriate action to address them.

The system is based on the ESP32 microcontroller, which acts as the central processing unit for the system and connects the various sensors and technologies to the ThingSpeak cloud platform. The ThingSpeak cloud platform provides a user-friendly interface that allows hospitals to view the collected data in real-time and create charts and graphs to visualize the data.

The experimental results of the SMART HOSPITAL MONITORING SYSTEM showed that the system was able to accurately and reliably measure and monitor various important parameters in a hospital setting. The load cell and HX711 amplifier were able to accurately measure the weight of the saline bottle, and the BME 680 sensor was able to accurately measure various parameters of the hospital environment. The MAX301000 pulse oximeter sensor was also able to accurately measure the oxygen saturation of a patient's blood.

Overall, the SMART HOSPITAL MONITORING SYSTEM is a valuable addition to any hospital, providing valuable insights and data that can help hospitals improve patient care and safety. By implementing this system, hospitals can take a proactive approach to patient care and ensure that their patients receive the best possible care and support..

6.2 APPLICATIONS

There are several potential applications for the SMART HOSPITAL MONITORING SYSTEM, including:

- **Saline Level Monitoring:** The load cell and HX711 amplifier can be used to continuously monitor the saline levels in a hospital, providing important information about the status of the saline supply. When the saline level reaches critical levels, the system can alert hospital staff to change the bottle, helping to ensure that there is always an adequate supply of saline available for patient care.

- **Air Quality Monitoring:** The BME 680 sensor can be used to continuously monitor

the air quality in a hospital, providing important information about the level of various gases, such as carbon dioxide and methane, as well as temperature, humidity, and pressure. This information can help hospitals identify potential air quality issues and take appropriate action to address them.

- **Patient Health Monitoring:** The MAX301000 pulse oximeter sensor can be used to continuously monitor the health of patients in a hospital, providing important information about the oxygen saturation of their blood. This information can help hospitals identify potential health issues and take appropriate action to address them.

- **Vital sign monitoring:** The system could be used to continuously monitor vital signs such as heart rate, blood pressure, and respiratory rate, providing important information about the health and well-being of patients.

- **Medication management:** The system could be used to track and manage medication administration, helping to ensure that patients receive the correct medications at the right time and dosage.

- **Infection control:** The system could be used to monitor and track infection rates and other indicators of hygiene in the hospital, helping to identify and address potential issues.

- **Environmental monitoring:** The system could be used to monitor and track various environmental factors in the hospital, such as temperature, humidity, and lighting, helping to ensure that the hospital environment is optimal for patient care.

Overall, the SMART HOSPITAL MONITORING SYSTEM has many potential applications in a hospital setting, and can be customized to meet the specific needs and requirements of each hospital.

6.3 FUTURE WORK

There are many areas where the SMART HOSPITAL MONITORING SYSTEM could be improved or expanded in the future. Some potential areas for future work include:

- **Integration with hospital systems:** The SMART HOSPITAL MONITORING SYSTEM could be integrated with other hospital systems, such as electronic health records and patient monitoring systems, to provide a more comprehensive view of patient care.

- **Improved data analysis:** The SMART HOSPITAL MONITORING SYSTEM could

be enhanced to provide more advanced data analysis and visualization capabilities, such as machine learning algorithms and predictive analytics, to help hospitals identify trends and patterns in the data and make more informed decisions about patient care.

- **Enhanced security:** The SMART HOSPITAL MONITORING SYSTEM could be enhanced to provide additional security measures to protect sensitive patient data from unauthorized access or tampering.

- **Remote monitoring:** The SMART HOSPITAL MONITORING SYSTEM could be expanded to allow for remote monitoring of patients, enabling healthcare professionals to remotely monitor the health and well-being of patients from a distance.

Overall, the SMART HOSPITAL MONITORING SYSTEM has many potential areas for future work, and there is a great opportunity to continue to develop and improve the system to better meet the needs of hospitals and patients.