

# **VOICE CONTROLLED HOSPITAL BED WITH SMART MONITORING AND ALERT SYSTEM FOR PATIENT CARE**

Submitted in partial fulfillment of the requirements for the award of Bachelor of  
Technology degree in Biomedical Engineering

by

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**DEPARTMENT OF BIOMEDICAL ENGINEERING  
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

## **SATHYABAMA**

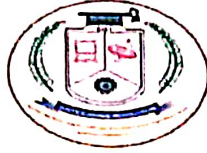
**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A++" by NAAC**

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# SATHYABAMA

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DEPARTMENT OF BIOMEDICAL ENGINEERING

## BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of MEENATCHI S (40240018), SARASWATHI B (40240030) who have done the project work as a team and carried out the project entitled "VOICE CONTROLLED HOSPITAL BED WITH SMART MONITORING AND ALERT SYSTEM FOR PATIENT CARE" under our supervision from November 2023 to April 2024.

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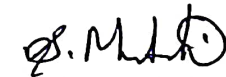
## DECLARATION

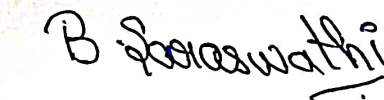
We MEENATCHI S (40240018) AND SARASWATHI B(40240030), hereby declare that the Project Report entitled "VOICE CONTROLLED HOSPITAL BED WITH SMART MONITORING AND ALERT SYSTEM FOR PATIENT CARE"" done by us under the guidance of Dr. S. KRISHNAKUMAR is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biomedical Engineering .

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## **ABSTRACT**

In the recent twentieth century, medical beds are subjected to advanced techniques particularly in the domain of making it intelligent for patient care. The past fifteen years have brought out various changes in the smart-bed technologies concept but no legit proof for existence of the project were shown. These and other earlier systems more often utilize at least one push button or pressure-sensitive type switches to enact the different correspondence and control capacities. project introduces an innovative solution, modern technology to enhance patient care in healthcare facilities. This system utilizes an Arduino UNO microcontroller and Bluetooth connectivity to develop a user-friendly Android application. The application allows caregivers and medical staff to control the hospital bed remotely using voice commands, providing ease of operation and convenience in adjusting bed positions. Two servo motors are employed to control the head and leg positions of the bed, facilitating optimal patient comfort and positioning. Additionally, the system incorporates a smart monitoring and alert system to enhance patient safety and healthcare management. IR sensor is used patient present in bed are not condition can be monitor. Touch sensor is used for if any emergency condition and pressure sensor is used for patient body pressure monitor. Sensors integrated into the bed continuously monitor vital parameters such as temperature. In the event of any abnormality or emergency, such as irregular vital signs or patient distress, the system automatically triggers alerts. This proactive approach enables timely intervention and ensures prompt medical attention, thereby improving patient outcomes and reducing the risk of adverse events.

Key words: Smart bed, Arduino UNO, Servomotor, Sensors.

## TABLE OF CONTENTS

| CHAPTER<br>NO | CONTENTS                                    | PAGE NO |
|---------------|---------------------------------------------|---------|
|               | <b>ABSTRACT</b>                             | V       |
|               | <b>LIST OF FIGURES</b>                      | VII     |
|               | <b>LIST OF TABLES</b>                       | IX      |
|               | <b>LIST OF ABBREVIATIONS</b>                | X       |
| <b>1</b>      | <b>INTRODUCTION</b>                         | 1       |
|               | 1.1 OVERVIEW                                | 1       |
| <b>2</b>      | <b>LITERATURE SURVEY</b>                    | 5       |
| <b>3</b>      | <b>AIM AND SCOPE</b>                        | 7       |
|               | 3.1 AIM                                     | 7       |
|               | 3.2 SCOPE                                   | 7       |
| <b>4</b>      | <b>MATERIALS AND METHODS</b>                | 9       |
|               | 4.1 BLOCK DIAGRAM OF VOICE CONTROLLED BED   | 9       |
|               | 4.2 CIRCUIT DIAGRAM OF VOICE CONTROLLED BED | 10      |
|               | <i>4.2.1 CIRCUIT DISCRIPTION</i>            | 11      |
|               | 4.3. ARDUINO UNO MICROCONTROLLER            | 11      |
|               | <i>4.3.1 HARDWARE AND SOFTWARE</i>          | 12      |
|               | <i>4.3.2 TYPES OF ARDUINO BOARDS</i>        | 13      |
|               | <i>4.3.3 ARDUINO UNO</i>                    | 13      |
|               | 4.4 POWER SUPPLY                            | 15      |

|       |                                                     |    |
|-------|-----------------------------------------------------|----|
| 4.5   | 7805 IC VOLTAGE REGULATOR                           | 16 |
| 4.5.1 | <i>PIN DIAGRAM OF 7805 VOLATGE<br/>REGULATOR IC</i> | 17 |
| 4.5.2 | <i>BASIC CIRCUIT OF 7805</i>                        | 19 |
| 4.6   | LCD DISPLAY                                         | 19 |
| 4.6.1 | <i>LCD DIPLAY PINS</i>                              | 20 |
| 4.6.2 | <i>16 x 2 CHARACTER LCD DISPLAY</i>                 | 21 |
| 4.7   | BLUETOOTH                                           | 22 |
| 4.7.1 | <i>HC-05 BLUETOOTH MODULE</i>                       | 22 |
| 4.7.2 | <i>PIN DICSRIPTION</i>                              | 23 |
| 4.7.3 | <i>HC-05 MODULE INFORMATION</i>                     | 24 |
| 4.7.4 | <i>BLUETOOTH COMMUNICATION</i>                      | 25 |
| 4.7.5 | <i>BLUETOOTH MODULE SERIAL INTERFACE</i>            | 25 |
| 4.7.6 | <i>PAIR HC-05 AND SMARTPHONE</i>                    | 26 |
| 4.7.7 | <i>COMMAND MODE</i>                                 | 26 |
| 4.7.8 | <i>APPLICATIONS</i>                                 | 27 |
| 4.8   | BUZZER                                              | 27 |
| 4.9   | TEMPERATURE SENSOR                                  | 28 |
| 4.9.1 | <i>FEATURES</i>                                     | 29 |
| 4.9.2 | <i>FUNCTIONAL DESCRIPTIONS</i>                      | 29 |
| 4.9.3 | <i>TEMPERATURE SENSOR WORKING</i>                   | 30 |
| 4.9.4 | <i>APPLICATIONS OF TEMPERATURE SENSOR</i>           | 30 |

|          |                                     |    |
|----------|-------------------------------------|----|
| 4.10     | SERVOMOTOR                          | 31 |
| 4.10.1   | <i>SERVOMOTOR WORKING MECHANISM</i> | 32 |
| 4.10.2   | <i>SERVOMOTOR WORKING PRINCIPLE</i> | 33 |
| 4.11     | PRESSURE SENSOR                     | 34 |
| 4.12     | IR SENSOR                           |    |
| <b>5</b> | <b>RESULTS AND DISCUSSION</b>       | 38 |
| 5.1      | RESULTS                             | 38 |
| 5.2      | DISCUSSION                          | 40 |
| <b>6</b> | <b>SUMMARY AND CONCLUSION</b>       | 41 |
| 6.1      | SUMMARY                             | 42 |
| 6.2      | CONCLUSION                          | 43 |
|          | <b>REFERENCE</b>                    | 44 |

## LIST OF FIGURES

| FIGURE No. | DESCRIPTION                             | PAGE No. |
|------------|-----------------------------------------|----------|
| 4.1        | BLOCK DIAGRAM OF VOICE CONTROLLED BED   | 8        |
| 4.2        | CIRCUIT DIAGRAM OF VOICE CONTROLLED BED | 9        |
| 4.3        | ARDUINO UNO CONTROLLER DIGITAL PINS     | 13       |
| 4.4        | ARDUINO UNO ANALOG PINS                 | 14       |
| 4.5        | CIRCUIT DIAGRAM FOR POWER SUPPLY        | 15       |
| 4.6        | 7805 REGULATOR                          | 17       |
| 4.7        | BASIC CIRCUIT OF 7805                   | 18       |
| 4.8        | LIQUID CRYSTAL DISPLAY                  | 19       |
| 4.9        | HC-05 MODULE                            | 22       |
| 4.10       | HC-05 PIN CONFIGURATION                 | 22       |
| 4.11       | BUZZER                                  | 27       |
| 4.12       | LM35 IC                                 | 28       |
| 4.13       | LM35 IC PIN CONNECTION                  | 29       |
| 4.14       | SERVOMOTOR                              | 31       |
| 4.15       | PRESSURE SENSOR                         | 33       |
| 4.16       | BLOCK DIAGRAM FOR IR SENSOR             | 34       |
| 4.17       | CIRCUIT DIAGRAM FOR IR SENSOR           | 36       |
| 5.1        | PROTOTYPE OF VOICE CONTROLLED BED       | 38       |
| 5.2        | MOBILE APP FOR CONTROLLING OF BED       | 39       |

## LIST OF TABLES

| TABLE No. | DESCRIPTION OF TABLE              | PAGE No. |
|-----------|-----------------------------------|----------|
| 4.1       | PIN DESCRIPTION OF REGULATOR 7805 | 16       |
| 4.2       | PIN DESCRIPTIPON OF LCD           | 21       |
| 4.3       | HC-05 DEVICE PINOUT               | 24       |
| 4.4       | HC05 COMMENT TABLE                | 25       |

## LIST OF ABBREVIATIONS

| ABBREVIATIONS | FULLFORM               |
|---------------|------------------------|
| IR            | INFRARED RADIATION     |
| LCD           | LIQUID CRYSTAL DISPLAY |
| HC-05         | HOST CONTROLLER 05     |
| LM35          | LINEAR MONOLITHIC 35   |
| DC            | DIRECT CURRENT         |
| IC            | INTEGRATED CIRCUIT     |
| GND           | GROUND                 |
| CRT           | CATHOD RAY TUBE        |

# CHAPTER 1

## INTRODUCTION

The majority of patients spend their time in hospital beds. a significant portion of their time, necessitating a strong understanding of patient care, as well as the ability to be safe while attendants study data and enhance patient care. The specific purpose is to empower patients with self- sufficiency, allowing them to perform some essential tasks when nurses or caregivers are late or unavailable. As a result, such solutions assist the vast majority of patients in their condition, which is unavoidable and necessitates a quick shift in mobility. Access to quality medical care in hospitals turns out to be a This is a crucial issue. The expanding cost of therapeutic consideration and the reduction of the quantity of guardians are the two main motivations behind this (for example: health care providers). If the patient is confined and has lock-in issues, this becomes even more of a problem. ,Dealing with those patients needs a great deal of effort and consideration. In this way, it's critical to provide customised replies to caregivers of In nursing homes or hospitals, patients. It is suggested that you use a hospital bed. in this study for patients who are unable to move and are suffering from the effects of a severe disorder, such as Long-term coma, quadriplegia, clinical death, and so on are all possible outcomes. Because they are unable to move any extension of thinking, these patients require special attention (Baichander K.S, and E. A. M. Garcia (2011)). Furthermore, each exchange of a few hours implies that one must be regularly available to work; this includes during the night. The project's purpose is to develop a smart city. It is primarily focused on a small prototype that can be measured in considerable part if it is proven to be effective, and it responds quickly to user commands utilising voice commands to deliver the desired result. The proposed framework's major goal is to make a way for It's a lot easier to cope with a patient who can't move while sitting in bed.Long periods of bed rest can cause a variety of problems.

The "Voice-Controlled Hospital Bed with Smart Monitoring and Alert System for Patient Care" project is a groundbreaking endeavor poised to revolutionize patient care in medical settings (Alice Linsie, et al (2014)).

Leveraging the latest advancements in technology, this project seeks to address the pressing challenges faced by healthcare facilities in managing patient comfort, safety,

and monitoring. By integrating voice control functionality into hospital beds, caregivers can remotely adjust bed positions with ease, enhancing patient comfort and accessibility. Additionally, smart monitoring sensors embedded within the bed enable continuous tracking of vital signs, ensuring timely detection of any abnormalities or emergencies. This proactive approach to patient monitoring not only enhances patient safety but also empowers medical staff to deliver more efficient and effective care (Dragomir, M., et al (2016).

Through this innovative solution, the project aims to set new standards for patient care, paving the way for improved outcomes and experiences in healthcare facilities.

In traditional hospital settings, manual adjustments are typically required for patient beds, and monitoring systems often rely on physical checks by healthcare staff.

While some hospitals may have basic remote control features for adjusting bed positions, they are usually limited in functionality and lack integration with comprehensive patient monitoring systems.

Additionally, alert systems for monitoring patient vital signs or emergencies may be separate from the bed control mechanism, leading to disjointed workflows and potential delays in responding to critical situations. Overall, the existing systems lack the seamless integration of bed control and smart monitoring features offered by the proposed voice-controlled hospital bed with a smart monitoring and alert system.

The proposed system revolutionizes hospital bed management by integrating voice-controlled bed adjustment with a comprehensive patient monitoring and alert system.

It comprises an Arduino UNO microcontroller interfaced with servo motors for adjusting the bed's head position and leg position. A Bluetooth module facilitates communication between the Arduino UNO and a dedicated mobile application installed on the user's smartphone.

The mobile application serves as the user interface, allowing caregivers to control the bed's movements using voice commands head and leg position. Through the app, users can issue commands such as "bed up" or "bed down," triggering the corresponding actions in real-time. the system incorporates smart monitoring features to track patient vitals and environmental conditions.

Sensors embedded in the bed collect data on parameters like temperature. This information is continuously monitored and analyzed by the Arduino UNO. Overall, the proposed system enhances patient care by offering seamless bed control, real-time monitoring, and timely alerting capabilities, all accessible through a user-friendly mobile interface(Texas et al.,(2020)).

IR sensor is used patient present in bed are not condition can be monitor , if patient not in bed means it will send notification to the care taker are authorized person. Touch sensor is used for if any emergency condition means it send the notification to authorized person. Pressure sensor is used for patient body pressure monitor, if pressure is high means the notification sent to authorized person, so that we can easily reduce the bed source(Yousefi., et al(2020)).

Main objective of this project is to develop a system that allows hospital beds to be adjusted using voice commands, providing patients with a convenient and accessible means to adjust their bed positions according to their comfort (T. Harada, et al (2002)).

Incorporate sensors into the hospital bed to monitor vital signs such as body temperature in real-time, enabling continuous patient monitoring and early detection of any abnormalities or emergencies. This includes implementing features such as visual indicators for bed position, easy navigation, and clear instructions for voice commands to ensure smooth interaction for both patients and caregivers (Mukesh Kumar et al.,(2015)).

## **CHAPTER 2**

### **LITERATURE SURVEY**

Ignacio Gherzi et al., (2020) This paper represents a clear view on electronic medical beds, which is defined as “smart beds”, as part of an increasingly protective patient-care habitat. Raspberry pi is interfaced with a stepper motor using a motor driver circuit and is then brought forward with an audio input. The accuracy for detecting the voice commands was found to be troublesome. Wireless communication can be a hinderance to the patient.

Panik et al.,(2021) This paper talks about the plan of voice-controlled automatic wheelchair-using Arduino. The structure is made with a voice acknowledgment framework, which empowers the physically incapacitated individual to control the wheelchair by voice direction who have issues near to improvement as a result of the loss of motion or loss of movement for joystick-controlled wheelchairs. In the proposed arrangement the discourse.

Tawfik et al.,(2020) The main aim of the proposed model is to simplify the way toward dealing with a patient who can't move and for all time lies on a bed. The proposed medicinal bed is to automate it when required; to be specific, a bed that rotates by itself every a few hours. The electrical buttons of the bed control the moving parts and been pre-programmed for the desired positions.

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wheelchair by voice direction who have issues near to improvement as a result of the loss of motion or loss of movement for joystick-controlled wheelchairs. In the proposed arrangement the discourse preparing is done only with the coordinated module of voice recognition (VR3) which takes out the requirement for any bulky complex extra processing modules. Moreover, the proposed plan is relatively less complex and more affordable to execute with the all-around accessible electronic gadgets interestingly with other existing structure which impacts under developing nations.

Kaiser et al.,(2021) The plan and execution of a minimal effort solar-power oriented controlled wheelchair for physically disabled individuals. The required signal for the motion of the wheelchair is acquired by the muscles of the hand utilizing surface Electromyography (sEMG) framework. To obtain the essential characteristics for the production of the control signals for the automatic movement of the medical bed the raw sEMG signals are gathered from the muscles in the upper limb which is then processed, characterized and classified.

Ignacio Gherzi et al.,(2019) This study presents a medical care bed with the Internet of Things technologies. A bed designed specifically for hospital patients or other people who need specific forms of treatment, controlled by a button, voice commands, or phone apps. Common features include adjustable height for the entire bed, for the head and feet, adjustable temperature, adjustable pressure, voice command, and programs to run both families using sensors and monitoring the patient's body temperature. This group of traits is distinctive in that it caters to both the convenience and comfort of patients as well as the comfort of medical professionals.

## **CHAPTER 3**

### **AIM AND SCOPE**

#### **3.3 AIM**

- Develop a smart-bed system using Arduino UNO microcontroller.
- Implement Bluetooth connectivity for remote control functionality.
- Create a user-friendly Android application for convenient bed adjustment via voice commands.
- Utilize servo motors to control head and leg positions, enhancing patient comfort.
- Integrate sensors to monitor vital parameters such as temperature continuously.
- Implement a proactive alert system to notify caregivers of any abnormalities or emergencies for timely intervention.
- Enhance patient safety through real-time monitoring of vital signs and automatic alerts for irregularities.
- Improve healthcare management by providing caregivers with remote access and control over bed functions.
- Enable prompt medical attention by triggering alerts in case of patient distress or abnormal vital signs.
- Ensure optimal patient positioning and comfort through precise control of bed angles using servo motors.
- Facilitate ease of operation for medical staff and caregivers through intuitive Android application interface.

#### **3.4 SCOPE**

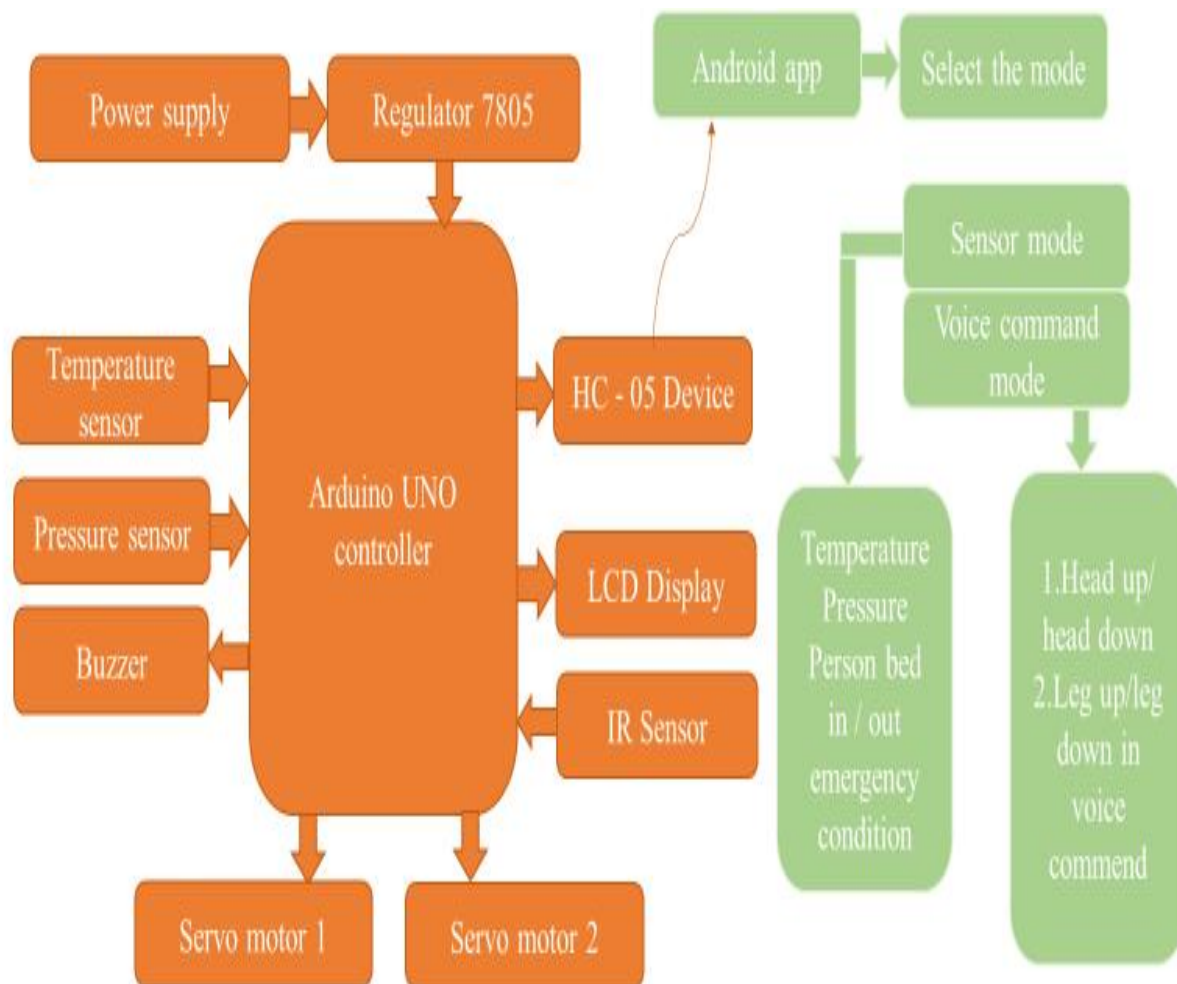
- Design and develop the hardware components of the smart-bed system, including Arduino UNO microcontroller, servo motors, and sensors.
- Implement Bluetooth connectivity and develop the necessary communication protocols for remote control functionality.

- Design and create a user-friendly Android application interface for caregivers to interact with the smart-bed system.
- Integrate voice command functionality into the Android application for hands-free bed adjustment.
- Incorporate sensors to continuously monitor vital signs and environmental parameters such as temperature.
- Develop algorithms for real-time data analysis to detect abnormalities or emergencies.
- Design and implement the alert system to notify caregivers of any detected issues promptly.
- Design and fabricate a prototype of the smart-bed system, including the mechanical structure and electronic components.
- Develop and test the firmware for the Arduino UNO microcontroller to ensure proper functionality and communication with peripherals.
- Create and validate the Android application for remote control and monitoring of the smart-bed system, ensuring compatibility and user-friendliness across various devices.

## CHAPTER 4

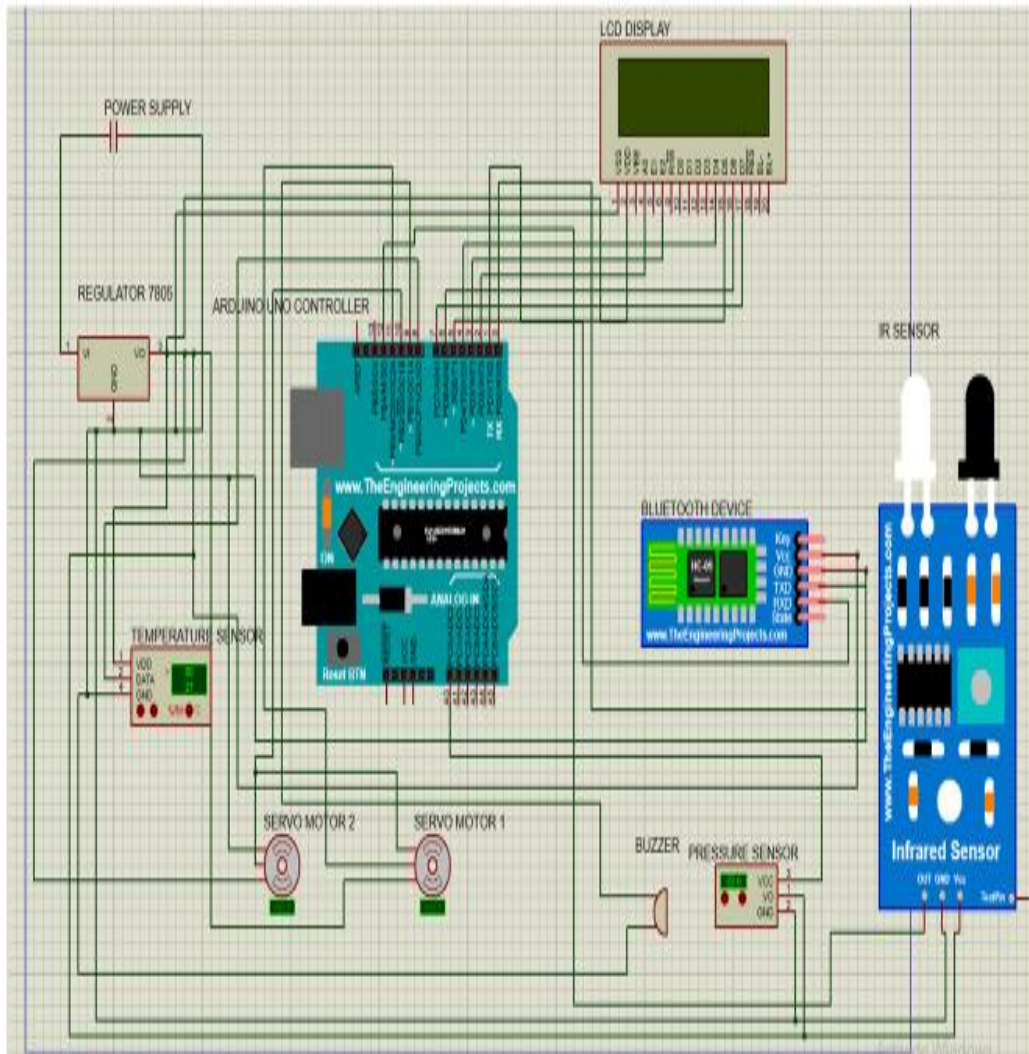
### MATERIALS AND METHODS

#### 4.1 BLOCK DIAGRAM OF VOICE ACTUATED BED



**Fig 4.1: Block diagram for voice controlled bed**

## 4.2 CIRCUIT DIAGRAM OF VOICE CONTROLLED BED



**Fig 4.2: Circuit diagram for voice controlled bed**

### **4.2.1 Circuit Description**

- The above circuit components of LCD Display, regulator 7805, power supply, Arduino UNO controller, buzzer, Bluetooth device, temperature sensor and servo motor.
- In 12v input power source is given to regulator for voltage regulator it converting 12 v to 5v, then 5v connected to controller and negative pin connected to GND and 5v connecting to controller.
- Liquid crystal display are 8 pins. The positive pin is connected to 5v, negative pin connected to GND and remaining data pins are connected to controller digital d2, d3, d4, d5, d6, d7.
- Buzzer is connected to controller digital pin and GND is connected to ground.
- Temperature sensor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and out pin is connected to controller digital pins.
- Pressure sensor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and out pin is connected to controller digital pins.
- IR sensor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and out pin is connected to controller digital pins.
- Bluetooth device are 4 pins. Then (+) pin is connected to 5v, (-) pin is connected to GND. Rx is connected to Tx and Tx is connected to Rx.
- Servo motor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and signal pin is connected to controller digital pins.

### **4.3 ARDUINO UNO MICROCONTROLLER**

Arduino is an open-source prototyping platform in electronics based on easy-to-use hardware and software. Subtly speaking, Arduino is a microcontroller based prototyping board which can be used in developing digital devices that can read inputs

like finger on a button, touch on a screen, light on a sensor etc. and turning it in to output like switching on an LED, rotating a motor, playing songs through a speaker etc.

The Arduino board can be programmed to do anything by simply programming the microcontroller on board using a set of instructions for which, the Arduino board consists of a USB plug to communicate with your computer and a bunch of connection sockets that can be wired to external devices like motors, LEDs etc.

The aim of Arduino is to introduce the world of electronics to people who have small to no experience in electronics like hobbyists, designers, artists etc.

Arduino is based on open source electronics project i.e. all the design specifications, schematics, software are available openly to all the users. Hence, Arduino boards can be bought from vendors as they are commercially available or else you can make your own board by if you wish i.e. you can download the schematic from Arduino's official website, buy all the components as per the design specification, assemble all the components, and make your own board.

#### **4.3.1 Hardware and Software**

- Arduino boards are generally based on microcontrollers from Atmel Corporation like 8, arduino uno architecture based microcontrollers.
- The important feature of the Arduino boards is the standard connectors. Using these connectors, we can connect the Arduino board to other devices like LEDs or add-on modules called Shields.
- The Arduino boards also consist of on board voltage regulator and crystal oscillator. They also consist of USB to serial adapter using which the Arduino board can be programmed using USB connection.

- In order to program the Arduino board, we need to use IDE provided by Arduino. The Arduino IDE is based on Processing programming language and supports C and C++.

#### **4.3.2 Types of Arduino Boards**

- There are many types of Arduino boards available in the market but all the boards have one thing in common: they can be programmed using the Arduino IDE. The reasons for different types of boards are different power supply requirements, connectivity options, their applications etc.
- Arduino boards are available in different sizes, form factors, different no. of I/O pins etc. Some of the commonly known and frequently used Arduino boards are Arduino UNO, Arduino Mega, Arduino Nano, Arduino Micro and Arduino Lilypad.
- There are add-on modules called Arduino Shields which can be used to extend the functionalities of the Arduino boards. Some of the commonly used shields are Arduino Proto shield, Arduino WiFi Shield and Arduino Yun Shield.

#### **4.3.3 Arduino UNO**

- In this tutorial, we will be discussing the Arduino UNO board. Arduino UNO is a basic and inexpensive Arduino board and is the most popular of all the Arduino boards with a market share of over 50%. Arduino UNO is considered to be the best prototyping board for beginners in electronics and coding.
- UNO is based on ATmega328P microcontroller. There are two variants of the Arduino UNO: one which consists of through – hole microcontroller connection and other with surface mount type. Through-hole model will be beneficial as we can take the chip out in case of any problem and swap in with a new one.

- Arduino UNO comes with different features and capabilities. As mentioned earlier, the microcontroller used in UNO is ATmega328P, which is an 8-bit microcontroller based on the AVR architecture.
- UNO has 14 digital input – output (I/O) pins which can be used as either input or output by connecting them with different external devices and components. Out of these 14 pins, 6 pins are capable of producing PWM signal. All the digital pins operate at 5V and can output a current of 20mA.



***Fig 4.3: Arduino uno controller digital pins***

Some of the digital I/O pins have special functions which are describe below.

- Pins 0 and 1 are used for serial communication. They are used to receive and transmit serial data which can be used in several ways like programming the Arduino board and communicating with the user through serial monitor.
- Pins 2 and 3 are used for external interrupts. An external event can be triggered using these pins by detecting low value, change in value or falling or rising edge on a signal.
- As mentioned earlier, 6 of the 14 digital I/O Pins i.e. 3, 5, 6, 9, 10, and 11 can provide 8-bit PWM output.

- Pins 10, 11, 12 and 13 (SS, MOSI, MISO AND SCK respectively) are used for SPI communication.
- Pin 13 has a built-in LED connected to it. When the pin is HIGH, the LED is turned on and when the pin is LOW, it is turned off.

Arduino Uno has 6 analog input pins which can provide 10 bits of resolution i.e. 1024 different values. The analog pins on the Arduino UNO are labelled A0 to A5.



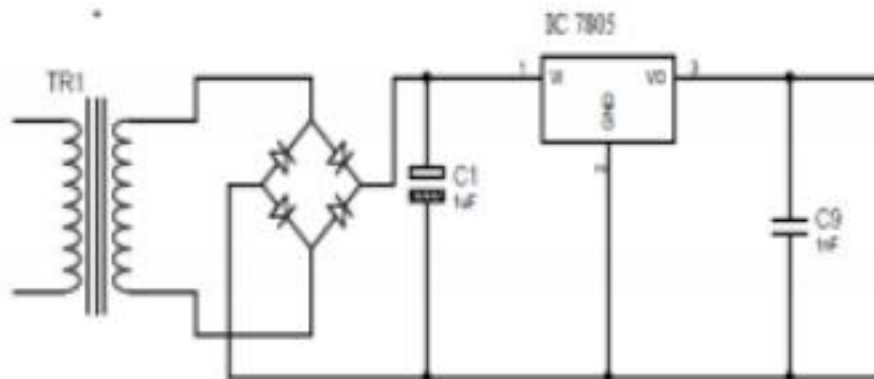
**Fig 4.4: Arduino uno analog pins**

- By default, all the analog pins can measure from ground to 5V. Arduino UNO has a feature, where it is possible to change the upper end of the range by using the AREF pin but the value should be less than 5V.
- Additionally, some analog pins have specialized functionality. Pins A4 and A5 are used for I2C communication.
- There are different ways in which we can power the Arduino UNO board. The USB cable, which is used to program the microcontroller, can be used as a source of power.

- There is a power jack, using which an external regulated power supply in the range of 7V – 12V can be supplied. Additionally, the power can also be supplied from a battery through the VIN pin.
- The UNO board has on-board voltage regulators for 5V and 3.3V, which can be used as power supply for small external devices like LEDs.
- This is a brief introduction to Arduino and Arduino UNO board. In the next tutorial, we'll see the installation and setup of the Arduino IDE.

#### 4.4 POWER SUPPLY

The present chapter introduces the operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an AC voltage, a steady DC voltage is obtained by rectifying the AC voltage, then filtering to a DC level, and finally, regulating to obtain a desired fixed DC voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a DC voltage and provides a somewhat lower DC voltage, which remains the same even if the input DC voltage varies, or the output load connected to the DC voltage changes.



**Fig 4.5: Circuit Diagram for Power Supply**

#### 4.5 7805 IC VOLTAGE REGULATOR:

In this tutorial, we will see about one of the most commonly used regulator IC's, the 7805 Voltage Regulator IC. A regulated power supply is very much essential for several electronic devices due to the semiconductor material employed in them have a fixed rate of current as well as voltage. The device may get damaged if there is any deviation from the fixed rate.

One of the important sources of DC Supply are Batteries. But using batteries in sensitive electronic circuits is not a good idea as batteries eventually drain out and lose their potential over time.

Also, the voltage provided by batteries are typically 1.2V, 3.7V, 9V and 12V. This is good for circuits whose voltage requirements are in that range. But, most of the TTL IC's work on 5V logic and hence we need a mechanism to provide a consistent 5V Supply.

Here comes the 7805 Voltage Regulator IC to the rescue. It is an IC in the 78XX family of linear voltage regulators that produce a regulated 5V as output.

They are available in several IC Packages like TO-220, SOT-223, TO-263 and TO-3. Out of these, the TO-220 Package is the most commonly used one (it is the one shown in the above image).

| PIN NO | PIN NAME     | DESCRIPTION               |
|--------|--------------|---------------------------|
| 1      | Input (v+)   | Unregulated input voltage |
| 2      | Ground (gnd) | Connected to ground       |
| 3      | Output (v0)  | Outputs regulator + 5v    |

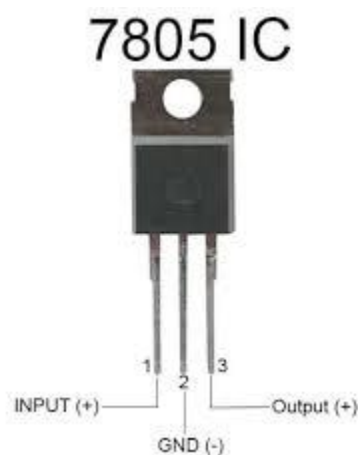
#### ***Table 4.1 pin description of regulator 7805***

Some of the important features of the 7805 IC are as follows:

- It can deliver up to 1.5 A of current (with heat sink).
- Has both internal current limiting and thermal shutdown features.
- Requires very minimum external components to fully function.

##### ***4.5.1 Pin Diagram of 7805 Voltage Regulator IC***

As mentioned earlier, 7805 is a three terminal device with the three pins being 1. INPUT, 2. GROUND and 3. OUTPUT. The following image shows the pins on a typical 7805 IC in To-220 Package.

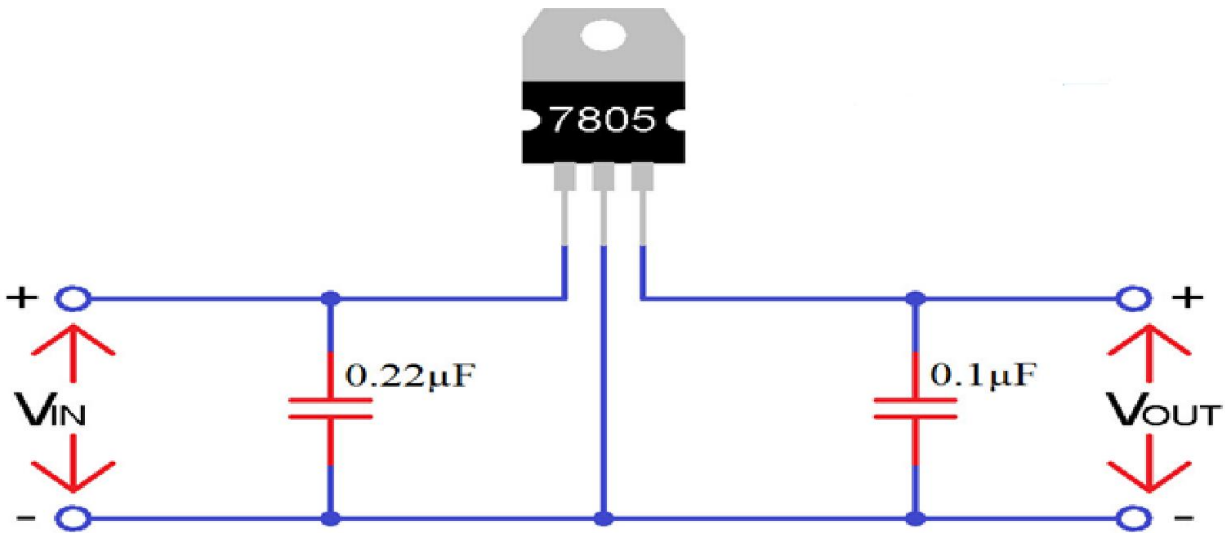


***Fig 4.6: 7805 regulator***

##### ***4.5.2 Basic Circuit of 7805***

As I have previously talked about regulated power supply as a device that works on DC voltages and it can uphold its output accurately at a fixed voltage all the time even if there is a significant alteration in the DC input voltage.

As per the datasheets of 7805 IC, the basic circuit required for 7805 to work as a complete regulator is very simple. In fact, if the input supply is an unregulated DC Voltage, then all you need are two capacitor (even those are not mandatory depending on the implementation).

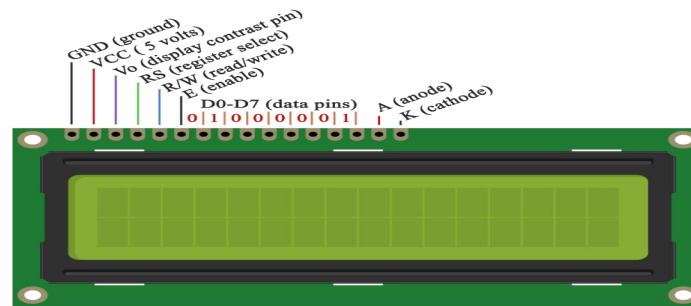


**Fig 4.7: Basic Circuit of 7805**

The above circuit shows all the components required for a 7805 IC to work properly. The  $0.22\mu F$  Capacitor near the input is required only if the distance between the regulator IC and the power supply filter is high. Also, the  $0.1\mu F$  Capacitor near the output is optional and if used, it helps in the transient response.

In this circuit,  $V_{IN}$  is the input voltage to the 7805 IC and the source can be from either a battery or an unregulated DC.  $V_{OUT}$  is the output of the 7805 IC, which is a Regulated 5V.

## 4.6 LCD DISPLAY



**Fig 4.8: Liquid crystal display**

Reflective twisted nomadic liquid crystal display.

1. Polarizing filter film with a vertical axis to polarize light as it enters.
2. Glass substrate with ITO electrodes. The shapes of these electrodes will determine the shapes that will appear when the LCD is turned ON. Vertical ridges etched on the surface are smooth.
3. Twisted nematic liquid crystal.
4. Glass substrate with common electrode film (ITO) with horizontal ridges to line up with the horizontal filter.
5. Polarizing filter film with a horizontal axis to block/pass light.
6. Reflective surface to send light back to viewer. (In a backlit LCD, this layer is replaced with a light source.)

### **4.6.1 LCD display:**

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden,

such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source(backlight) or reflector to produce images in color or monochrome. Liquid crystals were first discovered in 1888.

#### ***4.6.2 16 x 2 character LCD display:***

An LCD is a small low cost display. it is easy to interface with a micro-controller because of an embedded controller (the black blob on the back of the board). This controller is standard across many displays (hd 44780), which means many micro-controllers have libraries that make displaying messages as easy as a single line of code.

**Table 4.2 LCD of pin description**

| LCD breakout<br>board pin number | designation      | function        | on Wemos<br>connected with |
|----------------------------------|------------------|-----------------|----------------------------|
| 1                                | GND              | GND             | GND                        |
| 2                                | VCC              | power           | 5V                         |
| 3                                | V0               | contrast        |                            |
| 4                                | RS (chip select) | register select | pin D8                     |
| 5                                | RW (data, MOSI)  | read/write      | pin D7                     |
| 6                                | E (CLK, clock)   | clock           | pin D5                     |
| 7                                | DB0              | parallel data   |                            |
| 8                                | DB1              | parallel data   |                            |
| 9                                | DB2              | parallel data   |                            |
| 10                               | DB3              | parallel data   |                            |
| 11                               | DB4              | parallel data   |                            |
| 12                               | DB5              | parallel data   |                            |
| 13                               | DB6              | parallel data   |                            |
| 14                               | DB7              | parallel data   |                            |
| 15                               | PSB              | SPI enable      | GND                        |
| 16                               | NC               |                 | GND                        |
| 17                               | RST              | reset           |                            |
| 18                               | Vout             |                 |                            |
| 19                               | BLA              | background led  | 3.3V                       |
| 20                               | BLK              | GND             | GND                        |

## 4.7 BLUETOOTH

It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.

- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

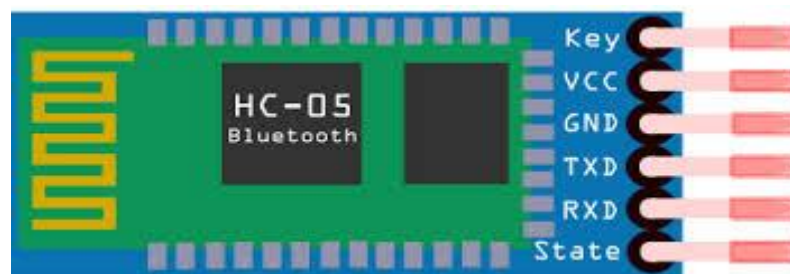
#### **4.7.1 HC-05 Bluetooth Module**

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.



**Fig 4.9: hc-o5 module**

#### **4.7.2 Pin Description**



**Fig 4.10: HC-O5 pin configuration**

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

1. **Data mode:** Exchange of data between devices.
2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.
2. **VCC:** Connect 5 V or 3.3 V to this Pin.
3. **GND:** Ground Pin of module.
4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
5. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
6. **State:** It tells whether module is connected or not.

#### ***4.7.3 HC-05 module Information***

- HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.

- This module works on 3.3 V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.

As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

**Table 4.3 HCO5 Device in pin out**

| HC-05 Pinout |            |                                                                                                       |
|--------------|------------|-------------------------------------------------------------------------------------------------------|
| Pin#         | Pin Name   | Working                                                                                               |
| Pin#1        | Enable Pin | The purpose of this pinout is to set data value at a high and low level.                              |
| Pin#2        | Vcc        | At this pinout, the input supply is provided to the module. Its operating voltage is plus five volts. |
| Pin#3        | GND        | Ground (0V)                                                                                           |
| Pin#4        | TX         | Serial Transmitting Pin.                                                                              |
| Pin#5        | RX         | Serial Receiving Pin                                                                                  |

#### **4.7.4 Bluetooth communication between Devices**

E.g. Send data from Smartphone terminal to HC-05 Bluetooth module and see this data on PC serial terminal and vice versa.

To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. You can find Bluetooth terminal applications for android and windows in respective app. store.

#### 4.7.5 Bluetooth Module Serial Interface

So, when we want to communicate through smartphone with HC-05 Bluetooth module, connect this HC-05 module to the PC via serial to USB converter.

Before establishing communication between two Bluetooth devices, 1st we need to pair HC-05 module to smartphone for communication.

#### 4.7.6 Pair HC-05 and smartphone:

Search for new Bluetooth device from your phone. You will find Bluetooth device with “HC-05” name. Click on connect/pair device option; default pin for HC-05 is 1234 or 0000.

| Command                                 | Description                                       | Response                                                              |
|-----------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------|
| AT                                      | Checking communication                            | OK                                                                    |
| AT+PSWD=XXXX                            | Set Password<br>e.g. AT+PSWD=4567                 | OK                                                                    |
| AT+NAME=XXXX                            | Set Bluetooth Device Name<br>e.g. AT+NAME=MyHC-05 | OK                                                                    |
| AT+UART=Baud rate, stop bit, parity bit | Change Baud rate<br>e.g. AT+UART=9600,1,0         | OK                                                                    |
| AT+VERSION?                             | Respond version no. of Bluetooth module           | +Version: XX OK<br>e.g. +Version: 2.0 20130107 OK                     |
| AT+ORGL                                 | Send detail of setting done by manufacturer       | Parameters: device type, module mode, serial parameter, passkey, etc. |

**Table 4.4 Hc-05 comment Table**

After pairing two Bluetooth devices, open terminal software (e.g. Teraterm, Realterm etc.) in PC, and select the port where we have connected USB to serial module. Also select default baud rate of 9600 bps.

In smart phone, open Bluetooth terminal application and connect to paired device HC-05.

It is simple to communicate, we just have to type in the Bluetooth terminal application of smartphone. Characters will get sent wirelessly to Bluetooth module HC-05. HC-05 will automatically transmit it serially to the PC, which will appear on terminal. Same way we can send data from PC to smartphone.

#### **4.7.7 Command Mode**

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device's name etc.
- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect "Key" pin to High (VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.
- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these command through serial terminal of PC.

#### **5.5.8 Applications:**

1. Wireless communication between two microcontrollers
2. Communicate with Laptop, Desktops and mobile phones
3. Data Logging application
4. Consumer applications
5. Wireless Robots

## 6. Home Automation

### 4.8 BUZZER

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles. It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.



***Fig 4.11: Buzzer***

### 4.9 TEMPERATURE SENSOR

National Semiconductor's LM35 IC has been used for sensing the temperature. It is an integrated circuit sensor that can be used to measure temperature with an electrical

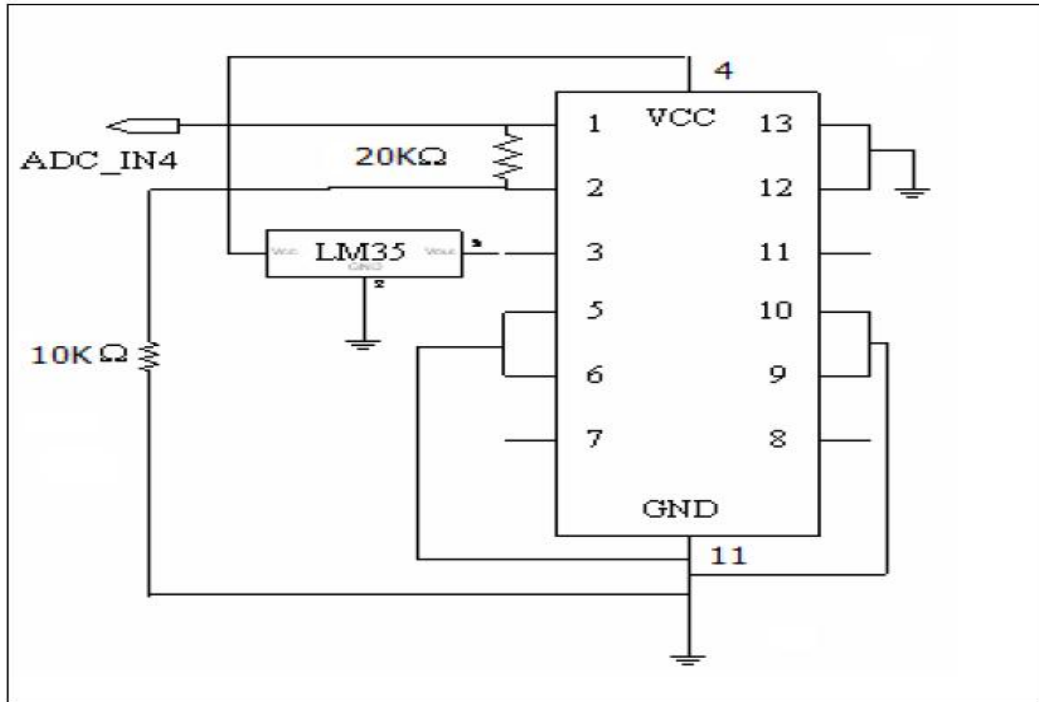
output proportional to the temperature (in °C). The temperature can be measured more accurately with it than using a thermistor. The sensor circuitry is sealed and not subject to oxidation, etc.



**Fig 4.12: LM35 IC**

#### **4.9.1 Features:**

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteed (at +25°C)
- Rated for full -55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60  $\mu$ A current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only  $\pm 1/4^\circ\text{C}$  typical
- Temperature sensing circuit:



**Fig 4.13: LM35 IC PIN CONNECTION**

#### **4.9.2 Functional description:**

- The sensor has a sensitivity of 10mV / °C.
- The output of LM35 is amplified using a LM324 single power supply (+5V) op-amp.
- The op-amp is designed to have a gain of 5.
- The circuitry measures temperatures with a resolution of up to 0.5 degree Celsius.

#### **4.9.3 Temperature sensor working**

The measurement of the temperature sensor is about the hotness or coolness of an object. The working base of the sensors is the voltage that read across the diode. If the voltage increases, then the temperature rises and there is a voltage drop between the transistor terminals of base & emitter, they are recorded by the sensors. If the difference in voltage is amplified, the analogue signal is generated by the device and it is directly proportional to the temperature. By using the temperature sensor, the

temperature can be measured by four measurement scales and they are divided into different degree units. The metric Celsius scale is used by the measurement scale and they start from zero. The Fahrenheit temperature sensing uses the Rankin scales and these scales are absolute scales. The Rankin scale measures the absolute zero as the 492 degrees Rankin. The temperature sensor determines the absolute zero measurements as close to the minus 46 degrees Fahrenheit.

#### ***4.9.4 Applications of temperatures Sensor***

- The temperature sensors are used in the military/Defense
- It can be used in the home automation systems like air conditioners, refrigerators, microwave Ovens
- It can also use in the industries like warehouses, mushroom cultivation.
- The temperature sensors are used to measure the temperature of the boilers in thermal power plants.

#### **4.10 SERVO MOTOR**

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics. A servo motor usually comes with a gear arrangement that allows us to get a very high torque servo motor in small and lightweight packages. Due to these features, they are being used in many applications like toy car, RC helicopters and planes, Robotics, etc.



***Fig 4.14 Servo Motor***

Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor.

#### ***4.10.1 Servo motor working mechanism***

It consists of three parts:

1. Controlled device
2. Output sensor
3. Feedback system

It is a closed-loop system where it uses a positive feedback system to control motion and the final position of the shaft. Here the device is controlled by a feedback signal generated by comparing output signal and reference input signal.

Here reference input signal is compared to the reference output signal and the third signal is produced by the feedback system. And this third signal acts as an input signal to the control the device. This signal is present as long as the feedback signal is generated or there is a difference between the reference input signal and reference

output signal. So the main task of servomechanism is to maintain the output of a system at the desired value at presence of noises.

#### **4.10.2 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.

Interfacing Servo Motors with Microcontrollers:

Interfacing hobby Servo motors like s90 servo motor with MCU is very easy. Servos have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU. An MG995 Metal Gear Servo Motor which is most commonly used for RC cars humanoid bots etc. The picture of MG995 is shown below:

The color coding of servo motor might differ hence check for your respective datasheet. All servo motors work directly with your +5V supply rails but we have to be careful on the amount of current the motor would consume if you are planning to use more than two servo motors a proper servo shield should be designed.

## 4.11 PRESSUR SENSOR

A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical. Pressure sensors are used for control and monitoring in thousands of everyday applications. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensors can alternatively be called pressure transducers, pressure transmitters, pressure senders, pressure indicators and piezometers, manometers, among other names.

Pressure sensors can vary drastically in technology, design, performance, application suitability and cost. A conservative estimate would be that there may be over 50 technologies and at least 300 companies making pressure sensors worldwide. There is also a category of pressure sensors that are designed to measure in a dynamic mode for capturing very high speed changes in pressure. Example applications for this type of sensor would be in the measuring of combustion pressure in an engine cylinder or in a gas turbine. These sensors are commonly manufactured out of piezoelectric materials such as quartz. Some pressure sensors, such as those found in some traffic enforcement cameras, function in a binary (on/off) manner, i.e., when pressure is applied to a pressure sensor, the sensor acts to complete or break an electrical circuit. These types of sensors are also known as a pressure switch.



***Fig 4.15: pressure sensor***

#### **4.12 IR SENSOR**

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.



***Fig 4.16: BLOCK DIAGRAM FOR IR SENSOR***

#### **Infrared Radiation Theory**

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000 $\mu$ m.

The infrared spectrum can be split into near IR, mid IR and far IR. The wavelength region from 0.75 to 3 $\mu$ m is known as the near infrared region. The region between 3 and 6 $\mu$ m is known as the mid-infrared region, and infrared radiation which has a wavelength greater higher than 6 $\mu$ m is known as far infrared.

### The Types of Infrared Sensors

Infrared sensors can be active or passive and they can be split into two main types:

- **Thermal infrared sensors** – use infrared energy as heat. Their photo sensitivity is independent of the wavelength being detected. Thermal detectors do not require cooling but do have slow response times and low detection capabilities. *Read more about Thermal Infrared Sensors here.*
- **Quantum infrared sensors** – provide higher detection performance and faster response speed. Their photo sensitivity is dependent on wavelength. Quantum detectors have to be cooled in order to obtain accurate measurements.

### The Working Principle of Infrared Sensors

The physics behind infrared sensors is governed by two laws:

1. **Planck's radiation law:** Every object at a temperature T not equal to 0 K emits radiation
2. **Wein's Displacement Law:** Objects of different temperature emit spectra that peak at different wavelengths body is related to the absolute temperature

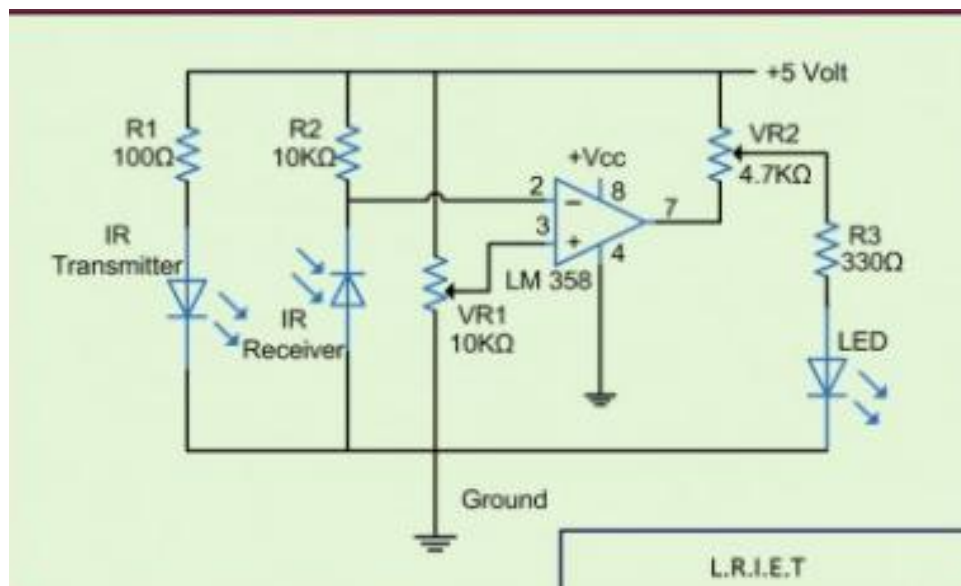
All objects which have a temperature greater than absolute zero (0 Kelvin) possess thermal energy and are sources of infrared radiation as a result.

Sources of infrared radiation include blackbody radiators, tungsten lamps and silicon carbide. Infrared sensors typically use infrared lasers and LEDs with specific infrared

## IR Sensor Circuit Diagram and Working Principle

An infrared sensor circuit is one of the basic and popular sensor module in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real-time. This circuit comprises of the following components

- LM358 IC 2 IR transmitter and receiver pair
- Resistors of the range of kilo-ohms.
- Variable resistors.
- LED (Light Emitting Diode).



**Fig 4.17: CIRCUIT DIAGRAM FOR IR SENSOR**

In this project, the transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analyzed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit.

When the IR receiver does not receive a signal, the potential at the inverting input goes higher than that non-inverting input of the comparator IC (LM339). Thus the output of the comparator goes low, but the LED does not glow.

When the IR receiver module receives signal to the potential at the inverting input goes low. Thus the output of the comparator (LM 339) goes high and the LED starts glowing. Resistor R1 (100  $\Omega$ ), R2 (10k  $\Omega$ ) and R3 (330  $\Omega$ ) are used to ensure that minimum 10 mA current passes through the IR LED Devices like Photodiode and normal LEDs respectively. Resistor VR2 (preset=5k  $\Omega$ ) is used to adjust the output terminals. Resistor VR1 (preset=10k  $\Omega$ ) is used to set the sensitivity of the circuit Diagram. Read more about IR sensors.

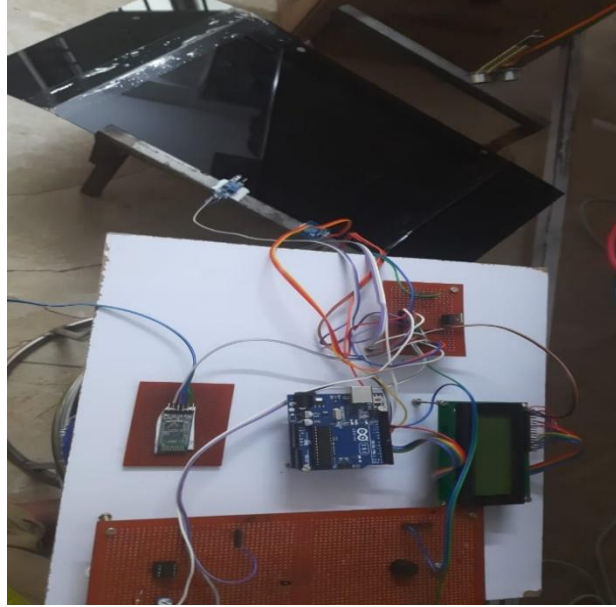
### **IR Sensor Applications**

- IR sensors are used in various Sensor based projects and also in various electronic devices which measures the temperature that are discussed in the below.
- IR sensors are classified into different types depending on the applications. Some of the typical applications of different types of sensors are
- The speed sensor is used for synchronizing the speed of multiple motors.
- The temperature sensor is used for industrial temperature control. PIR sensor is used for automatic door opening system and Ultrasonic sensor are used for distance measurement.

## CHAPTER 5

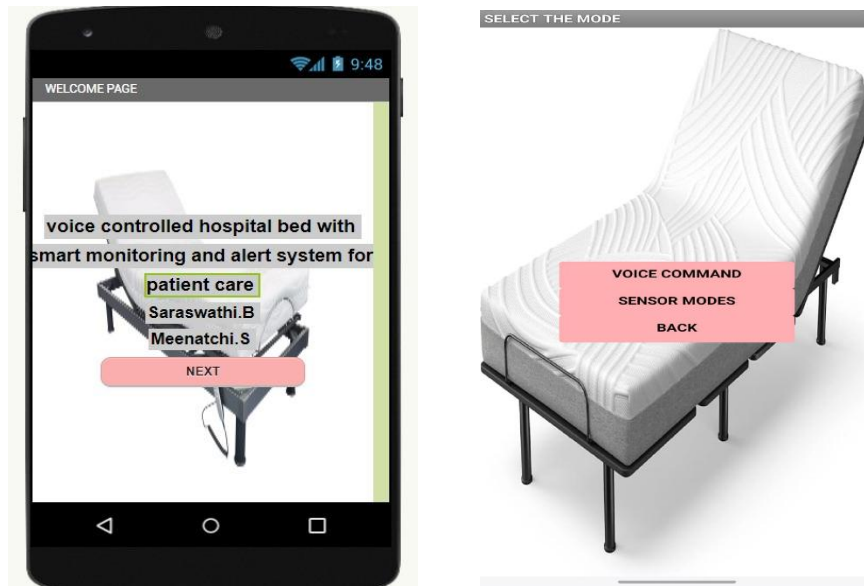
### RESULTS AND DISCUSSION

#### 5.1 RESULTS



***Fig 5.1: PROTOTYPE OF VOICE CONTROLLED BED***

As shown figure 5.1, the circuit components of LCD Display, regulator 7805, power supply, Arduino UNO controller, buzzer, Bluetooth device, temperature sensor and servo motor. In 12v input power source is given to regulator for voltage regulator it converting 12 v to 5v, then 5v connected to controller and negative pin connected to GND and 5v connecting to controller. Liquid crystal display are 8 pins. The positive pin is connected to 5v, negative pin connected to GND and remaining data pins are connected to controller digital d2, d3, d4, d5, d6, d7. Buzzer is connected to controller digital pin and GND is connected to ground. Temperature sensor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and out pin is connected to controller digital pins. Bluetooth device are 4 pins. Then (+) pin is connected to 5v , (-) pin is connected to GND .Rx is connected to Tx and Tx is connected to Rx. Servo motor has 3 pins. VCC pin connected to 5v, GND pin is connected ground and signal pin is connected to controller digital pins.



**Fig 5.2: PROTOTYPE OF VOICE CONTROLLED BED**

The proposed system revolutionizes hospital bed management by integrating voice-controlled bed adjustment with a comprehensive patient monitoring and alert system. It comprises an Arduino UNO microcontroller interfaced with servo motors for adjusting the bed's head position and leg position. A Bluetooth module facilitates communication between the Arduino UNO and a dedicated mobile application installed on the user's smartphone. The mobile application serves as the user interface, allowing caregivers to control the bed's movements using voice commands head and leg position.

In real time as shown in figure 5.2, through the app, users can issue commands such as "bed up" or "bed down," triggering the corresponding actions in real-time. the system incorporates smart monitoring features to track patient vitals and environmental conditions.

Sensors embedded in the bed collect data on parameters like temperature. This information is continuously monitored and analyzed by the Arduino UNO. Overall, the proposed system enhances patient care by offering seamless bed control, real-time monitoring, and timely alerting capabilities, all accessible through a user-friendly mobile interface.

## **5.2 DISCUSSION**

In traditional hospital settings, manual adjustments are typically required for patient beds, and monitoring systems often rely on physical checks by healthcare staff.

While some hospitals may have basic remote control features for adjusting bed positions, they are usually limited in functionality and lack integration with comprehensive patient monitoring systems. Additionally, alert systems for monitoring patient vital signs or emergencies may be separate from the bed control mechanism, leading to disjointed workflows and potential delays in responding to critical situations. Overall, the existing systems lack the seamless integration of bed control and smart monitoring features offered by the proposed voice-controlled hospital bed with a smart monitoring and alert system.

The implementation of the smart-bed system has yielded promising results across various facets of patient care and healthcare management. Through its innovative features such as precise bed adjustments, remote control functionality, and voice command operation, the system has significantly enhanced patient comfort and positioning while improving caregiver efficiency (Bungag .,et al(2006)). Real-time monitoring of vital signs and environmental parameters has enabled timely interventions, reducing the risk of adverse events and ensuring patient safety (Gisin.,et al (2009)). Moreover, the system's proactive alert system has facilitated prompt responses to emergencies, further enhancing patient outcomes. Overall, the integration of the smart-bed system has optimized healthcare management by streamlining processes, reducing manual labor, and providing valuable insights through continuous data collection and analysis. These positive outcomes underscore the potential for widespread adoption of smart-bed technology in healthcare facilities, marking a significant step forward in the delivery of patient-centered care (Dixon SA (2009)).

## **CHAPTER 6**

### **SUMMARY AND CONCLUSION**

#### **6.1 SUMMARY**

The project aims to revolutionize patient care in healthcare facilities by introducing a smart-bed system that leverages modern technology for enhanced functionality and convenience. Utilizing an Arduino UNO microcontroller and Bluetooth connectivity, the system allows caregivers and medical staff to control the bed remotely through a user-friendly Android application, which includes voice command functionality for ease of operation. By employing servo motors to adjust the head and leg positions of the bed, patient comfort and positioning are optimized. Moreover, the system integrates sensors to continuously monitor vital parameters such as temperature, enabling real-time monitoring of patient health. In the event of any abnormalities or emergencies, the system triggers automatic alerts, facilitating prompt medical intervention and ensuring patient safety. Through these innovative features, the smart-bed system aims to improve healthcare management, enhance patient outcomes, and reduce the risk of adverse events, ultimately transforming the way patient care is delivered in healthcare settings.

The project represents a significant advancement in the domain of patient care within healthcare facilities, particularly in the realm of medical beds. Over the past fifteen years, there have been various attempts to introduce smart-bed technologies, but the lack of substantial proof of concept has been evident. This project seeks to fill that gap by introducing an innovative solution that integrates cutting-edge technology to address the needs of both patients and caregivers.

At the core of this solution is the utilization of an Arduino UNO microcontroller, a versatile and widely-used platform known for its flexibility and ease of integration with various components. Coupled with Bluetooth connectivity, this microcontroller serves as

the backbone of the system, enabling seamless communication between the bed and the user interface, which takes the form of a user-friendly Android application.

The Android application is designed to empower caregivers and medical staff with intuitive controls, allowing them to remotely adjust the bed's position and settings with ease. The inclusion of voice command functionality further enhances usability, enabling hands-free operation and reducing the burden on caregivers, especially during critical moments.

A key feature of the smart-bed system is its ability to adapt to the unique needs of each patient. This is achieved through the use of servo motors, which provide precise control over the head and leg positions of the bed. By enabling caregivers to fine-tune the bed's configuration according to the patient's comfort and medical requirements, the system enhances overall patient satisfaction and quality of care. In addition to providing comfort and convenience, the smart-bed system also prioritizes patient safety. Integrated sensors continuously monitor vital parameters such as temperature, enabling real-time tracking of the patient's health status. Should any abnormalities or emergencies arise, the system automatically triggers alerts, allowing medical staff to intervene promptly and mitigate potential risks.

## **6.2 CONCLUSION**

In conclusion, the voice-controlled hospital bed with smart monitoring and alert system represents a promising advancement in healthcare technology. By integrating voice commands, bed adjustment, and patient monitoring, the system enhances patient care and streamlines healthcare processes. Its successful implementation underscores the potential of such innovations to improve patient outcomes and optimize healthcare delivery. Ongoing refinement and adoption of similar technologies hold the key to further enhancing patient safety and healthcare efficiency in the future. The development of the smart-bed system represents a significant leap forward in the realm of patient care technology. Through the integration of cutting-edge components and innovative features such as Arduino UNO microcontroller, Bluetooth connectivity, and voice command functionality, the system offers unprecedented levels of convenience, control, and communication for caregivers and medical staff. By prioritizing patient comfort and safety through precise bed adjustments and continuous vital sign monitoring, the smart-bed system not only enhances the quality of care but also facilitates early intervention in case of emergencies. With its proactive approach to healthcare management, the system has the potential to revolutionize the way patient care is delivered in healthcare facilities, ultimately leading to improved patient outcomes and a higher standard of healthcare provision. As we move forward, continued research and development in this field promise to further refine and enhance the capabilities of smart-bed systems, ultimately benefiting both patients and caregivers alike.

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