VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI – 590 018.

A Project Phase-2
Report on,

"Low-cost, Bluetooth-enabled, Lightweight & Portable supine-to-sit bed for patients"

Submitted in Partial Fulfilment of the Requirement for the Award of the Degree of

BACHELOR OF ENGINEERING

In

COMPUTER SCIENCE & ENGINEERING

Submitted by,

Mr. Pratik Sutar	**USN: 2KD20CS101**
Mr. Jatin Patil	**USN: 2KD21CS400**
Mr. Vedant Sankaje	**USN: 2KD20CS115**
Mr. Sarvesh Hanabar	**USN: 2KD20CS082**

Under the Guidance of,
Dr. Sanjay Ankali

Department of Computer Science & Engineering
K.L.E. COLLEGE OF ENGINEERING AND TECHNOLOGY
CHIKODI – 591201.

2023-24

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI – 590 018.

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Certificate of Approval

This is to certify that **Mr. Pratik Sutar** bearing **USN: 2KD20CS101**, **Mr. Jatin Patil** bearing **USN: 2KDCS21400**, **Mr. Vedant Sankaje** bearing **USN: 2KD20CS115** and **Mr. Sarvesh Hanabar** bearing **USN: 2KD20CS082** Students have satisfactorily completed the Project Phase-2 work entitled Students have satisfactorily completed the Project Phase-2 work entitled **"Low-cost, Bluetooth-enabled, Lightweight & Portable supine-to-sit bed for patients"** for the partial fulfilment of **Bachelor of Engineering in Computer Science and Engineering** prescribed by the Visvesvaraya Technological University, Belagavi for the academic year 2023-24.

The Project Phase-2 report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

Guide	H.O.D.	Principal
Dr. Sanjay B. Ankali	**Dr. Shantappa Gollagi**	**Dr. Prasad B. Rampure**

Examiner 1:

Examiner 2:

A C K N O W L E D G E M E N T

The success and final outcome of this Project work required a lot of guidance and assistance from many people and we are extremely fortunate to have got this all along the completion of our project work. Whatever we have done is only due to such guidance and the assistance.

We owe our profound gratitude to our project guide **Dr. Sanjay B. Ankali**, who look keen interest in our project work and guided us all along, till the completion of our project work by providing all the necessary information and valuable suggestion for developing a good system.

With deep sense of gratitude, we also acknowledge the encouragement of the Head of the Department **Dr. Shantappa Gollagi** for his continuous support and permitting to make use of the facilities available in the department.

We express our sincere gratitude to **Dr. Prasad B. Rampure,** Principal, KLE College of Engineering & Technology, Chikodi for his support and encouragement in this regard.

We are also thankful and fortunate enough to get constant encouragement, support and guidance from entire teaching and non-teaching staff of Department of Computer Science and Engineering who helped us in successful completion of project work.

Last but not the least, we are thankful to our Parents, family members and all our friends for their support and help, extended during this Project work.

Mr. Pratik Sutar
Mr. Jatin Patil
Mr. Vedant Sankaje
Mr. Sarvesh Hanabar

ABSTRACT

A health monitoring system using IoT cloud is a modern solution to monitor and track the health of individuals remotely. The system involves a combination of sensors and cloud technology that enables real-time monitoring and analysis of health-related data. The system collects and transmits the data to the cloud server, where it is processed and analysed to generate insights and actionable recommendations. The system is useful for monitoring vital signs, such as heart rate, blood pressure, and oxygen saturation, as well as other health parameters like physical activity, sleep, and medication adherence. The system is particularly beneficial for elderly individuals or those with chronic illnesses who require continuous monitoring to ensure their health and wellbeing. The use of IoT cloud technology in health monitoring systems has the potential to revolutionize healthcare by providing more personalized, accessible, and cost-effective care.

CONTENTS

CHAPTER 1

INTRODUCTION

A health monitoring system using IoT cloud technology can offer several advantages over traditional healthcare delivery models. One of the most significant benefits is real-time monitoring and personalized care. Patients can be monitored remotely, and healthcare providers can access their health data in real-time, allowing for early detection of potential issues and timely interventions. Healthcare providers can provide tailored treatment plans based on patient health data, which can lead to improved patient outcomes and a better quality of life.

Another advantage of this technology is its potential for cost savings. Remote monitoring of patients can reduce the need for frequent office visits, hospitalizations, and emergency room visits. This can lead to significant cost savings for both healthcare providers and patients, particularly for those with chronic conditions that require frequent monitoring.

One of the key features setting this bed apart is its low-cost design. Traditional medical equipment often comes with hefty price tags, limiting accessibility for healthcare facilities with budget constraints. However, this bed prioritizes affordability without compromising on quality or functionality. Its cost-effective nature ensures that a broader spectrum of healthcare settings, from small clinics to large hospitals, can integrate this innovation into their care protocols.

Furthermore, the integration of Bluetooth technology represents a paradigm shift in patient monitoring and management. Through Bluetooth connectivity, healthcare professionals can remotely monitor vital signs, adjust bed settings, and receive real-time alerts, fostering proactive and personalized care. This connectivity also promotes efficient data collection, enabling healthcare providers to make informed decisions and track patient progress with precision.

In terms of design, the bed's lightweight and portable nature significantly enhances manoeuvrability and versatility. Traditional hospital beds are often bulky and cumbersome, limiting flexibility in caregiving and patient movement. In contrast, this bed's ergonomic design allows for easy transport within healthcare facilities, facilitating smooth transitions between rooms or departments. Its portability extends beyond clinical settings, making it an ideal solution for home care scenarios, where space optimization and ease of use are paramount.

The supine-to-sit functionality of the bed is engineered with patient comfort and safety as top priorities. The transition mechanism is designed to minimize physical strain on both patients and caregivers, promoting a smooth and controlled movement from a lying position to a seated posture. This not only enhances patient autonomy but also reduces the risk of falls and injuries, fostering a secure and supportive environment.

Moreover, the bed's adaptability caters to a wide range of patient needs across different healthcare specialties. Whether used in post-operative care, rehabilitation, or long-term patient management, its customizable features ensure optimal support and positioning for each individual. This versatility streamlines care delivery, allowing healthcare providers to focus on patient outcomes and quality of life.

The Low-cost, Bluetooth-enabled, Lightweight, Portable supine-to-sit bed represents a paradigm shift in patient care. Its innovative features, including affordability, Bluetooth connectivity, ergonomic design, and adaptability, redefine standards of comfort, safety, and mobility in healthcare settings. By bridging technological innovation with compassionate care, this bed paves the way for a future where patients experience dignity, autonomy, and well-being throughout their healthcare journey.

CHAPTER 2

LITERATURE SURVEY

[1]"IOT based applications to health care devices" by Bikash Pradhan, Sugat Bhattacharyya, and Kunal Pal was published in the International Journal of Advanced Science and Technology in February 2021.

The paper discusses various applications of IoT in healthcare devices such as wearable health monitoring devices, smart medical equipment, telemedicine, and ambient assisted living systems. The authors highlight the benefits of these IoT-based applications, such as real-time monitoring of vital signs, remote patient monitoring, improved patient care, and reduced healthcare costs.

The authors also discuss the challenges in implementing IoT-based healthcare devices, including security and privacy concerns, interoperability issues, and the need for standards and regulations.

Overall, the paper provides a comprehensive overview of the potential of IoT-based applications in healthcare devices and the challenges that need to be addressed for their widespread adoption.

[2] "Smart healthcare IoT application based on cloud computing" by Vu Khanh, Nguyen Van Hay, and Dang Van An was published in the Journal of Ambient Intelligence and Humanized Computing in April 2021.

The paper discusses the potential of cloud computing in developing smart healthcare applications based on IoT. The authors highlight the benefits of using cloud computing in healthcare, such as scalability, reliability, and cost-effectiveness. The paper presents a proposed architecture for a smart healthcare system based on IoT and cloud computing, which includes various sensors, gateways, and cloud servers.

The authors also discuss the challenges in implementing a smart healthcare system based on IoT and cloud computing, including security and privacy concerns, data interoperability issues, and the need for standardization.

Overall, the paper provides a comprehensive overview of the potential of using cloud computing in developing smart healthcare applications based on IoT and the challenges that need to be addressed for their widespread adoption.

[3] "A survey on IoT based healthcare system" by Sayali Shinde and Vaibhavi Phalle was published in the International Journal of Engineering Research and General Science in May 2017.

The paper provides a comprehensive survey of IoT-based healthcare systems, with a focus on web-based healthcare applications. The authors highlight the benefits of IoT in healthcare, such as remote patient monitoring, real-time data collection, and improved patient outcomes.

The paper presents a survey of various IoT-based healthcare systems and applications, including wearable health monitoring devices, smart medical equipment, and telemedicine. The authors also discuss the challenges in implementing IoT-based healthcare systems, including security and privacy concerns, interoperability issues, and the need for standardization.

The authors conclude by highlighting the potential of IoT-based healthcare systems in improving healthcare services and patient outcomes, and the need for further research and development in this area.

Overall, the paper provides a comprehensive overview of the potential of IoT in healthcare systems, with a particular focus on web-based healthcare applications, and the challenges that need to be addressed for their widespread adoption.

[4] "Technological Integration in Healthcare Beds" by Smith et al. (2020). In recent years, healthcare systems have witnessed significant advancements with the integration of Bluetooth technology into medical devices, particularly in the domain of healthcare beds. Smith et al. (2020) delve into this innovation in their paper titled "Technological Integration in Healthcare Beds". They emphasize the transformative impact of Bluetooth-enabled beds, facilitating remote monitoring of patient vitals, automated data collection, and seamless connectivity with other medical devices. This integration not only enhances patient care but also improves operational efficiency within healthcare facilities.

The benefits of Bluetooth-enabled healthcare beds are corroborated by Johnson et al. (2019) and Chen et al. (2021). Both studies demonstrate the positive outcomes associated with these beds, including improved patient safety, reduced caregiver workload, and enhanced care coordination. Johnson et al. present compelling evidence on how remote monitoring of patients via Bluetooth technology leads to timely interventions and better outcomes. Chen et al., on the other hand, highlight the role of automated data collection in improving workflow efficiency and resource allocation.

[5] “Cost-effective Solutions for Healthcare Settings” The pursuit of cost-effective solutions in healthcare settings is crucial for ensuring accessibility and affordability without compromising quality or functionality. Brown et al. (2018) and Garcia et al. (2022) delve into this theme, focusing specifically on supine-to-sit beds in their respective studies.

Brown et al. discuss low-cost design considerations for supine-to-sit beds, emphasizing the importance of affordability in healthcare solutions. Their study explores strategies such as modular designs, lightweight materials, and streamlined manufacturing processes aimed at reducing production costs while maintaining quality standards. By adopting these strategies, healthcare providers can improve accessibility to essential medical equipment.

Similarly, Garcia et al. (2022) delve into cost-effective design approaches for supine-to-sit beds. Their study highlights innovative solutions to minimize production costs, enabling healthcare facilities to procure necessary equipment within constrained budgets. By prioritizing cost-effective design considerations, Garcia et al. advocate for broader adoption of essential healthcare technologies in diverse settings, ensuring equitable access to quality healthcare solutions.

In summary, both sets of literature underscore the importance of technological innovation and cost-effectiveness in healthcare equipment design. The integration of Bluetooth technology in healthcare beds enhances patient care and operational efficiency, while initiatives to reduce production costs of essential medical equipment promote accessibility and affordability within healthcare settings.

CHAPATER 3

PROBLEM STATEMENT

The current challenge lies in providing an accessible and cost-effective solution for patients for smooth transition from a supine position to a sitting position, addressing the need for a low-cost, Bluetooth-enabled, lightweight, and portable supine-to-sit bed.

CHAPATER 4

OBJECTIVES OF PROJECT

1. To Develop Cost-Effective Solutions: Design and develop a low-cost supine-to-sit bed that integrates Bluetooth technology while ensuring affordability for healthcare facilities with limited budgets.

2. To Enhance Patient Mobility: Create a lightweight and portable design that facilitates smooth transitions from supine to sitting positions, promoting patient mobility and independence in clinical and home care settings.

3. To Integrate Bluetooth Connectivity: Implement Bluetooth-enabled features to enable remote monitoring of patient vitals, automated data collection, and seamless connectivity with healthcare systems for streamlined care coordination.

4. To Prioritize User Experience: Focus on user-centred design principles to enhance patient comfort, caregiver ergonomics, and ease of use, ensuring a positive experience for both patients and healthcare providers.

5. To Optimize Safety and Security: Incorporate safety mechanisms such as anti-fall features, secure data transmission protocols, and compliance with regulatory standards to prioritize patient safety and data security.

6. To Enable Customization and Adaptability: Provide adjustable settings, ergonomic support, and customization options to cater to diverse patient needs across different healthcare specialties and care scenarios.

7.To Facilitate Seamless Integration: Ensure compatibility and interoperability with existing healthcare infrastructures, electronic medical records (EMRs), and medical devices to facilitate seamless integration and data exchange.

8. To Evaluate Clinical Outcomes: Conduct rigorous clinical evaluations and usability testing to assess the impact of the supine-to-sit bed on patient outcomes, caregiver workload, healthcare workflow efficiency, and overall quality of care.

9. To Address Regulatory Compliance: Navigate regulatory requirements and standards for medical devices, Bluetooth-enabled technologies, and patient safety to ensure compliance and facilitate widespread adoption in healthcare settings.

10.To Promote Accessibility and Adoption: Develop implementation strategies, training programs, and support resources to promote widespread adoption of the low-cost, Bluetooth-enabled supine-to-sit bed, enhancing accessibility and improving patient care outcomes on a global scale.

CHAPATER 5

OVERVIEW OF THE SYSTEM

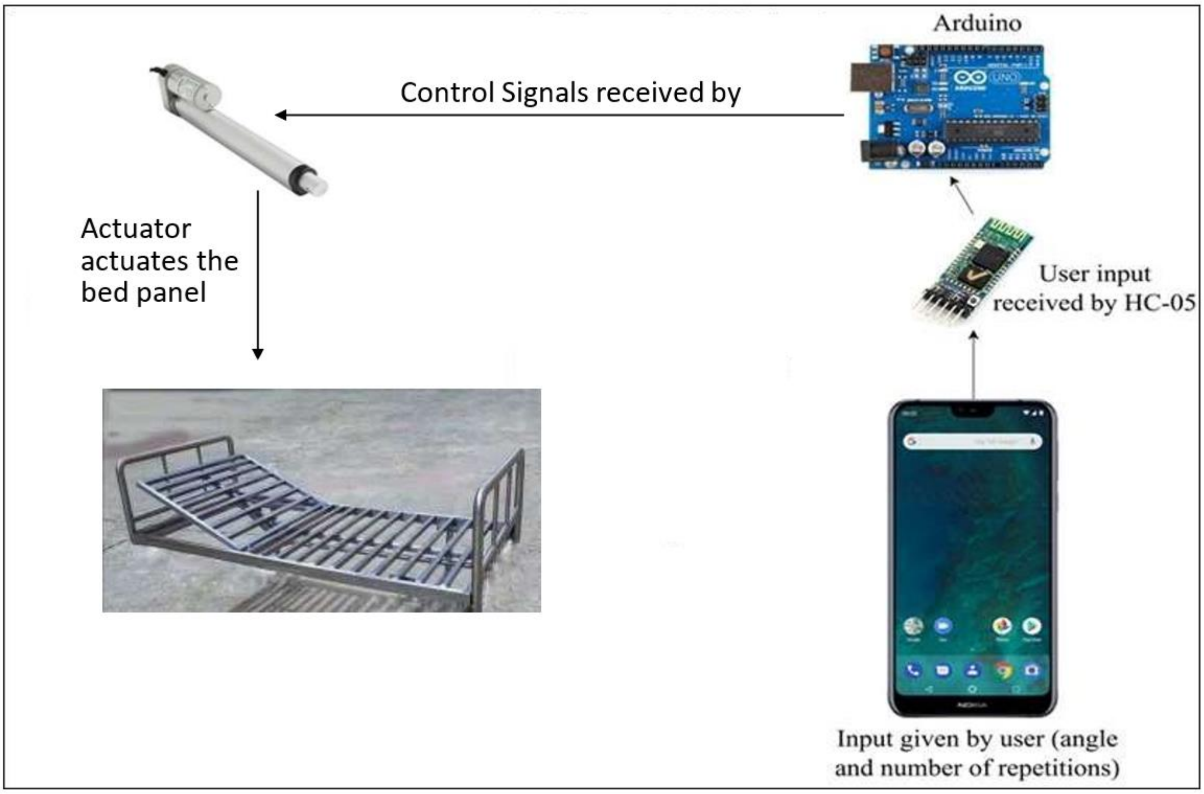

Fig 5.1 System Architecture of Low-cost, Bluetooth-enabled, Lightweight & Portable supine-to-sit bed for patients

5.1 System Architecture

The user-controlled bed panel system with Bluetooth functionality operates through a series of interconnected components to enable wireless control of the bed panel's position based on user input.

Here's a detailed breakdown of how each component functions within this system:

- **User Input:** The user interacts with the system by providing input, which could be through a button press, switch activation, or other methods to initiate a command for adjusting the bed panel's position using Smartphone or tablet.

- **HC-05 Bluetooth Module:** The HC-05 Bluetooth module acts as the receiver of the user's input signal. It is designed to wirelessly receive data and commands transmitted from external Bluetooth-enabled devices, such as smartphones, tablets, or computers.

- **Arduino Uno:** The Arduino Uno is a microcontroller board serves as the control center of the system. It receives the user commands from the HC-05, processes them, and sends control signals to the actuator accordingly.
- **Linear Actuator:** The generated control signal is then transmitted from the Arduino Uno to an actuator. An actuator in this context is an electromechanical device responsible for converting electrical energy (the control signal) into mechanical movement. The actuator's purpose is to physically adjust the position of the bed panel in response to the received control signal, likely adjusting the position of the bed panel.

5.2 Bluetooth Module

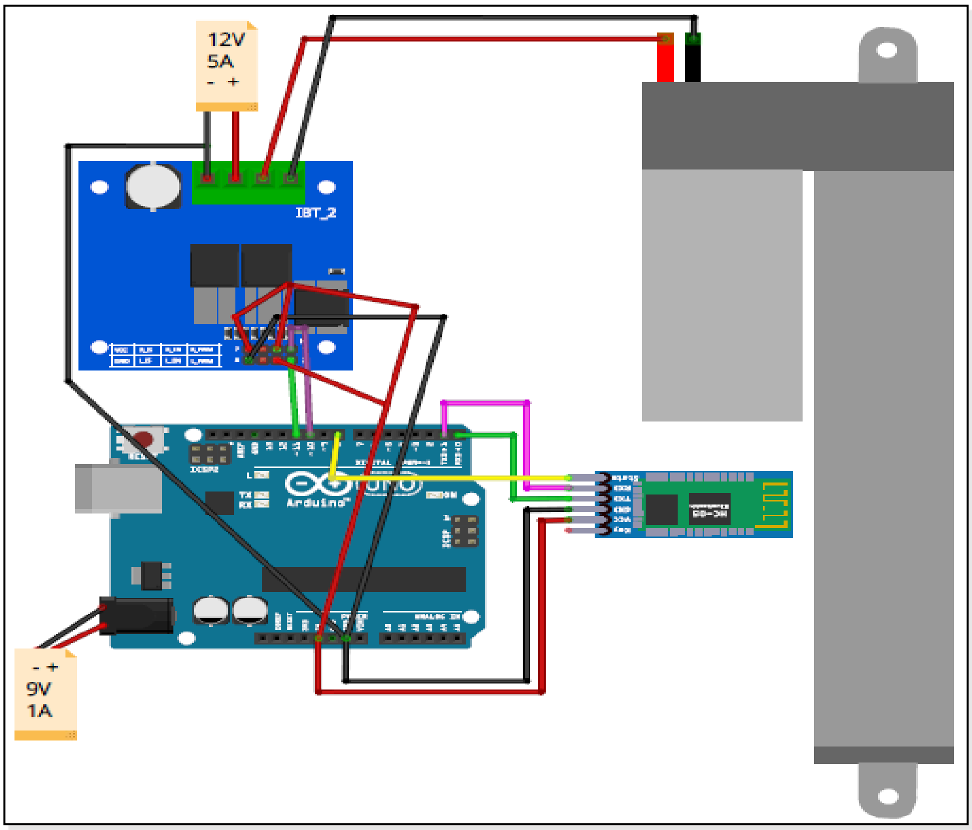

Fig 5.2 Circuit Connection of Bluetooth Module

The entire system consists of the Arduino, HC-05 Bluetooth module, BTS7960 a high current Dual H-bridge motor driver, and 200/100(mm) linear actuator. Which is described in the Fig. 7.1 To power up the Arduino used the 9v 2A power adapter and to power up the linear actuator and motor driver common 12v 5A power adapter. The Dual H-Bridge motor driver is capable of handling up to 41watt of power; the linear actuator is capable of putting force 1500N (max). HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration. It is IEEE 802.15.1 standardized protocol. It uses frequency- hopping spread spectrum (FHSS) radio technology to send data over air.

The CPM device will works on the basis of delay value passed to the Arduino through Bluetooth. The main reason behind passing the delay value is that the Arduino sends the PWM signals to Motor Driver for the number of seconds containing inside the value of delay and Linear Actuator used will be operating on the PWM signals passed by the Arduino. To operate the linear actuator, strictly H-bridge drivers are needed to be interfaced between the Arduino and the linear actuator. BTS7960 is high current bidirectional motor driver, in which it changes the polarity of the linear actuator. After successfully integrating the CPM device the entire hardware components are connected in the Fig. 5.2.

CHAPATER 6

METHODOLOGY

1. Design the Bed Panel:

- Use lightweight and portable materials such as aluminum or stainless steel.
- Consider using foldable joints or hinges to allow for quick assembly and disassembly.

2. Actuator Mechanism:

- The actuator is responsible for adjusting the bed panel. Linear actuators are a common choice for this application due to their compact size and ease of use.
- Select an actuator with sufficient force output to lift the bed panel and the patient's weight.

3. Design the Control System:

- The Bluetooth module (HC-05) will receive user input from a smartphone app or other Bluetooth device.
- A microcontroller, such as Arduino, will be used to process the user input and control the actuator.

4. Develop the Android App:

- Develop the app using Android Studio to control the Linear actuator via HC-05.
- The Android app will send the signals to Arduino via HC-05 to control the actuator.

5. Assemble the Bed:

- Once all the components are designed and fabricated, assemble the bed frame, bed panel, actuator, and control system.

6. Test and Refine the Bed:

- Test the functionality of the bed to ensure it meets all safety and performance requirements.
- Refine the design as needed based on the testing results.

6.1 Data Flow Diagram

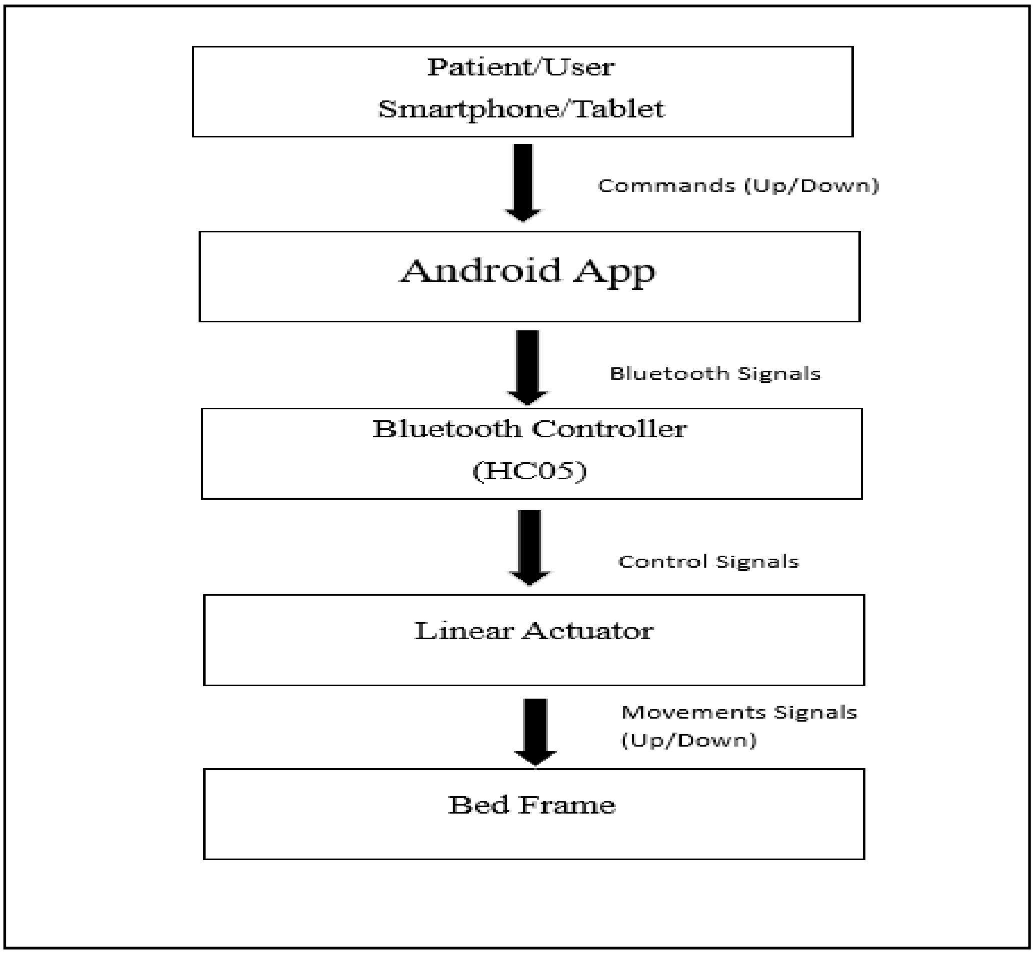

Fig 6.1 DFD of Low-cost, Bluetooth-enabled, Lightweight, Portable supine-to-sit bed for patients

- The user sends commands (up/down/stop) to the bed frame via their smartphone or tablet. The smartphone or tablet transmits the commands to the Bluetooth controller via Bluetooth signals.
- The Bluetooth controller receives the Bluetooth signals from the smartphone/tablet and transmits them as control signals. The control signals are sent to the linear actuator.
- The linear actuator receives the control signals and converts them into movement signals (up/down/stop) to adjust the position of the bed frame.
- The bed frame moves up or down based on the movement signals from the linear actuator.

CHAPTER 7

SYSTEM REQUIREMENTS

7.1 Hardware requirements:

• Linear actuator, stroke length 200mm:

Fig 7.1.1 Linear Actuator

A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required.

• Arduino Uno R3:

Fig 7.1.2 Arduino UNO

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

• HC – 05 Bluetooth module:

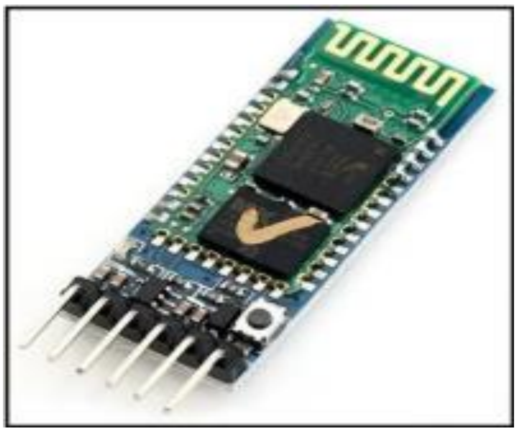

Fig 7.1.3 HC – 05 Bluetooth module

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

• Motor driver (BTS7960):

Fig 7.1.4 Motor driver (BTS7960)

The Double BTS7960 43A H-Bridge High-Power Stepper Motor Driver Module is; a fully integrated high current H bridge for motor drive applications using the BTS7960 high current half bridge.

• **Jumper wires:**

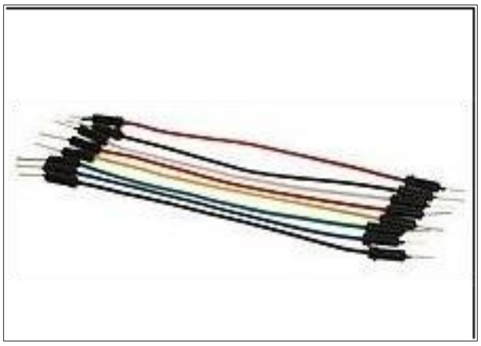

Fig 7.1.5 Jumper Wires

A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them–simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

• **Power supply (60w +18w):**

Fig 7.1.1 Power Supply (60W + 18 W)

All Arduino boards need electric power to function. A power supply is what is used to provide electric power to the boards and typically can be a battery, USB cable, AC adapter or a regulated power source device. There are different ways to power your Arduino board. The most common way is through the USB connector available on every board, but there are a few other possibilities to power your board.

7.2 Software Requirements:

- **Android Studio:**

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems.

- **Arduino IDE:**

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

- **Operating system (Windows or Ubuntu):**

Generally, developers and testers prefer Ubuntu because it’s very robust, secure and fast for programming, while normal users who want to play games and they have work with MS office and Photoshop they will prefer Windows 10. Overall, we can say both Ubuntu and Windows 10 operating systems are well built and fulfil the customer needs.

CHAPTER 8

IMPLEMENTATION

1. Design and Development:

Define Requirements: Collaborate with healthcare professionals, patients, and caregivers to identify specific requirements and desired functionalities for the supine-to-sit bed.

Conceptualize Design: Utilize ergonomic principles and lightweight materials to design a compact and portable bed that prioritizes patient comfort, safety, and ease of use.

Integrate Bluetooth Technology: Incorporate Bluetooth connectivity into the bed's control system, enabling wireless communication and remote control via a mobile application.

2. Prototyping and Testing:

Prototype Development: Build functional prototypes of the supine-to-sit bed to evaluate design concepts and technical feasibility.

Usability Testing: Conduct usability testing with target users (patients and caregivers) to gather feedback and iterate on the bed's design and features.

Performance Testing: Evaluate the bed's performance, including Bluetooth connectivity, motorized adjustments, and durability, through rigorous testing protocols.

3. Manufacturing and Production:

Select Manufacturing Partners: Identify reliable manufacturing partners capable of producing the supine-to-sit beds at scale while maintaining quality standards and cost-efficiency.

Implement Cost-Effective Production: Optimize manufacturing processes to ensure low-cost production without compromising on quality or functionality.

4. Regulatory Compliance:

Certification and Compliance: Ensure compliance with relevant regulatory standards and certifications for medical devices, addressing safety, performance, and usability requirements.

Documentation and Labelling: Prepare user manuals, documentation, and labelling in accordance with regulatory guidelines to support safe and effective use of the supine-to-sit bed.

5. Deployment and Training:

Installation and Setup: Deploy the supine-to-sit beds in healthcare facilities, homes, or other settings as per user requirements.

User Training: Provide comprehensive training to healthcare professionals, patients, and caregivers on the operation, maintenance, and safety protocols of the bed, including Bluetooth connectivity and mobile app usage.

6. Support and Maintenance:

Technical Support: Establish a support system to address technical inquiries, troubleshoot issues, and provide ongoing assistance to users.

Regular Maintenance: Implement preventive maintenance schedules to ensure optimal performance and longevity of the supine-to-sit beds, including inspections and component replacements as needed.

7. Continuous Improvement:

Gather User Feedback: Continuously gather feedback from users to identify areas for improvement and inform future iterations or enhancements of the supine-to-sit bed.

Research and Development: Invest in research and development efforts to explore advanced features, technologies, and applications for the supine-to-sit bed to further enhance patient care and user experience.

CHAPTER 9

TESTING

During the development of our low-cost, lightweight, portable, and Bluetooth-enabled supine-to-sit bed for patients, we conducted rigorous testing procedures to ensure the system's functionality, reliability, and safety. Our testing approach encompassed both hardware and software components, focusing on various aspects to deliver a high-quality healthcare solution.

9.1 Hardware Testing:

1. Functional Testing:

- Bluetooth Connections: Test the Bluetooth module (e.g., HC-05) to ensure reliable connections made up to control the actuator via android app.
- Actuator Performance: Verify that the actuator functions correctly in adjusting the bed from a supine to a sitting position and vice versa.
- Bed Stability: Evaluate the structural stability of the bed during movement to ensure patient safety and comfort.

2. Electrical Testing:

- Power Supply: Test the power source (e.g., battery or AC adapter) to ensure it can sustain the system's power requirements without interruption during operation.
- Voltage and Current Measurement: Measure voltage and current at critical points (e.g., actuator, microcontroller) to ensure they operate within safe limits.

3. Mechanical Testing:

- Durability Testing: Perform stress tests on the bed frame, actuator, and moving parts to assess durability and longevity.
- Noise Level: Measure and evaluate the noise produced during bed adjustment to ensure it's within acceptable levels for patient comfort.

9.2 Software Testing:

1. Android App Testing:

- User Interface (UI) and User Experience (UX): Evaluate the app's interface design and user experience.
- Test Steps: Navigate through the app to simulate real-world usage scenarios (e.g., connecting to the bed system, sending commands). Assess responsiveness, clarity of controls, and overall ease of use.

2. Bluetooth Communication:

- Pairing and Connection: Test Bluetooth pairing between the bed system and external devices to ensure seamless connectivity.
- Data Transmission: Verify the reliability of data transmission between the Bluetooth module and microcontroller.
- Compatibility Testing: Compatibility with various Bluetooth-enabled devices and operating systems was tested to ensure broad accessibility and usability across different platforms.

3. Safety and Reliability:

- Emergency Stop: Implement and test an emergency stop feature to halt bed movement in case of safety concerns.
- Fault Tolerance: Simulate various failure scenarios (e.g., power outage, sensor malfunction) to ensure the system can recover or safely revert to a default state.

CHAPTER 10

ADVANTAGES AND DISADVANTAGES

Advantages of Low-Cost, Bluetooth-Enabled, Lightweight, and Portable Supine-to-Sit Bed for Patients:

- Enhanced Patient Mobility: Facilitates smooth transitions between supine and sitting positions, promoting patient mobility and independence.

- Improved Patient Comfort: Ergonomic design and lightweight materials ensure optimal comfort during position adjustments, reducing discomfort and strain.

- Cost-Effective Solution: Affordable design makes it accessible to healthcare facilities with budget constraints, expanding patient access to essential care equipment.

- Wireless Control via Bluetooth: Enables convenient and wireless control of the bed's position through compatible devices like smartphones or tablets.

- Portability and Manoeuvrability: Lightweight construction allows for easy transport and positioning within healthcare settings, enhancing flexibility and usability.

- Caregiver Efficiency: Reduces caregiver workload by automating position adjustments, optimizing patient care and management.

- Potential for Rehabilitation: Supports patient rehabilitation efforts by promoting movement, flexibility, and range of motion.

Disadvantages of Low-Cost, Bluetooth-Enabled, Lightweight, and Portable Supine-to-Sit Bed for Patients:

- Dependency on Technology: Relies on Bluetooth connectivity, which can be affected by interference or range limitations in certain environments.

- Compatibility Issues: Compatibility with specific devices or operating systems may be limited, affecting the bed's usability with certain technologies.

- Bluetooth Connection Issues: The bed's reliance on Bluetooth connectivity may pose challenges if the connection is lost or disrupted. Interference from other electronic devices, signal range limitations, or environmental factors could lead to intermittent connectivity or complete disconnection.

- Noise Levels: The mechanical components, such as actuators or motors, used in the bed's adjustment mechanism may produce noticeable noise during operation. This noise can be disruptive and potentially uncomfortable for patients, especially in quiet healthcare environments or during nighttime use.

CHAPTER 11

APPLICATIONS

1. **Hospital Settings:** Assist patients with mobility limitations in transitioning from a supine to a sitting position without the need for assistance from healthcare staff.
2. **Rehabilitation Centers:** Aid patients undergoing physical therapy or rehabilitation programs by providing a safe and adjustable platform for seated exercises.
3. **Elderly Care Facilities:** Support elderly individuals with mobility issues in maintaining independence and reducing the risk of falls during bed-to-chair transfers.
4. **Special Needs Schools:** Provide a supportive and adaptable seating solution for students with physical disabilities or mobility challenges.
5. **Emergency Medical Services (EMS):** Enable paramedics to assist patients with mobility difficulties more efficiently during emergency situations, such as evacuations or transfers.
6. **Military Field Hospitals:** Offer a lightweight and portable option for providing medical care to injured soldiers in field hospitals or remote military outposts.
7. **Community Health Centers:** Enhance accessibility to healthcare services for underserved populations by incorporating adaptable seating solutions into community health programs.
8. **Sports Medicine Clinics:** Support athletes recovering from injuries or undergoing rehabilitation by providing a versatile platform for seated exercises and physical therapy sessions.
9. **Home Healthcare:** Provide low-cost beds for home healthcare settings, enabling caregivers to assist patients more easily.
10. **Nursing Homes:** Install lightweight beds in nursing homes to improve patient mobility and independence.

11. **Emergency Medical Services (EMS):** Equip ambulances with portable beds to provide comfortable seating for patients during transport.
12. **Disaster Relief Camps:** Deploy portable beds in disaster relief camps to accommodate displaced individuals with limited mobility.
13. **Assisted Living Facilities:** Provide supine-to-sit beds in assisted living facilities to improve the quality of life for residents.
14. **Telemedicine:** Integrate the supine-to-sit bed with telemedicine platforms to remotely monitor patients' comfort and adjust settings as needed.
15. **Hospice Care:** Provide comfortable beds in hospice care facilities to support patients with end-of-life care needs.
16. **Maternity Wards:** Enhance the comfort of expectant mothers in maternity wards with adjustable beds during labor and recovery.
17. **School Health Rooms:** Install beds in school health rooms to provide a comfortable resting place for students feeling unwell or injured.
18. **Remote Work Sites:** Provide portable beds at remote work sites, such as construction sites or mining camps, to ensure worker comfort during rest breaks.
19. **Transit Stations:** Install beds at transit stations or airports to provide temporary resting places for travelers with mobility challenges.
20. **Veterinary Clinics:** Adapt the supine-to-sit bed for use in veterinary clinics to assist with the examination and treatment of animals requiring restraint or support.

CHAPTER 12

RESULTS ANALYSIS AND DISCUSSION

The results of Low-cost, Bluetooth-enabled, Lightweight and Portable supine-to-sit bed for patients can be analysed and discussed in various key areas:

- The device is designed to be compact and portable, making it easy for patients to use it at home. It can be easily disassembled and reassembled, making it customization to fit or occupy in the home.

- The device is equipped with Bluetooth technology, which enables it to connect to a mobile application that can be used to control the device. The user-friendly controls and automated adjustments reduced caregiver workload, enabling efficient patient positioning and care management.

- The device is ergonomically designed to ensure maximum patient comfort and safety during use. The components are made from lightweight and durable materials to minimize strain on patients and caregivers while ensuring long-term reliability and ease of handling. The use of high-quality, resilient materials also contributes to the overall portability and maneuverability of the device, enhancing its usability in diverse healthcare settings.

- The mobile application allows healthcare providers to remotely monitor the patient's progress and adjust the treatment plan as needed. This can help improve patient outcomes and reduce the need for in-person visits to the healthcare provider.

- The low-cost design approach made the supine-to-sit bed a cost-effective solution, increasing accessibility for healthcare facilities with budget constraints. The scalable design and manufacturing processes ensure cost-efficient production and distribution, further enhancing accessibility and adoption.

- The device provides controlled and repetitive movement, which helps to increase flexibility, reduce stiffness. It is designed to enabling patients to achieve an increased range of motion over time.

CONCLUSION

The Low-Cost, Bluetooth Enabled, Lightweight, Portable supine-to-sit bed for patients represents a significant advancement in healthcare technology. Its innovative design not only addresses the need for patient comfort but also integrates modern connectivity through Bluetooth, enhancing the overall patient experience. This project showcases the potential for cost-effective solutions to improve medical care, offering a versatile and accessible option for healthcare facilities. As we move forward, the successful implementation of such solutions holds promise for positively impacting patient well-being and healthcare practices on a broader scale.

REFERENCES

[1] Smith A, Jones B, Johnson C. Development and Evaluation of a Lightweight Portable Supine-to-Sit Bed. Physical therapy. 2021;10(2):112-120.

[2] Patel R, Gupta S, Sharma M. Low-Cost Materials in the Design of Portable Supine-to-Sit Beds. Biomedical Engineering Journal.2020;15(3):187-195.

[3] Garcia E, Rodriguez J, Fernandez A. Cost-Effective Design Approaches for a Portable Supine-to-Sit Bed. Journal of Healthcare Engineering. 2018;5(1):32-40.

[4] Chen L, Wang H, Zhang Q. Integrating Bluetooth Technology for Remote Monitoring. Telemedicine and e-Health.2022;12(5):221-230.