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Smart Wheelchair Cum Bed Based on Voice Recognition for Disabled Person

Dr. Maddala Seetha[1], Farah Anjum[2]

[1] Professor and HOD, Dept. of CSE, G. Narayanamma Institute of Engineering and Technology, Telangana, India.
[2]Student, Dept. of CSE, G. Narayanamma Institute of Engineering and Technology, Telangana, India

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Abstract - *The Internet of Things (IOT) is a growing and disruptive technology with standards emerging for wireless communication between sensors, actuators, and gadgets in everyday human life. With the development of IOT systems, it is obvious that the medical industry needs a technology system for providing health care to those with disabilities. This paper describes a voice-activated wheelchair convertible bed prototype that was created especially for bedridden individuals. The goal of this study is to design, develop, and build a voice-controlled wheelchair cum bed that can be moved using voice commands. Additionally, this bed allows the patient to turn to the side. The patient can choose to sleep on their left or right side by using separate mechanisms on the left and right sides of the bed. Additionally, using voice commands, the bed may be transformed into a chair position. There are two stages to the bed's design and development. A bed with movable parts is designed first. The addition of a side-turning mechanism later improves this design. Secondly, voice instructions can be used to control wheelchair movement by using the input provided. A wheelchair that has been designed includes an automated obstacle detection system that uses ultrasonic sensors to stop the wheelchair as soon as an obstruction suddenly blocks its path. To plan and evaluate bed operations and positions, computer modeling, simulation, fabrication, and testing are used. Both immobile patients and their caretakers would benefit much from this device. Therefore, the created voice-controlled wheelchair cum bed may offer simple access for individuals with physical disabilities and provide automated protection from an obstacle collision if any voice command error occurs.*

***Key Words*: Smart Bed, Arduino UNO, Voice recognition, Wheelchair, Sensors, Motors.**

1. INTRODUCTION

Health monitoring is essential to our daily lives. The use of various specialized sensors in hospitals has increased recently because of efforts to enhance patient outcomes and overall construction efficiency. Modern hospital beds serve more purposes than simply providing sleeping space for patients. To make the people who are bedridden more comfortable and at ease. The voice-controlled wheelchair convertible bed that can be operated via voice commands is described in the proposed system along with its design and prototype development. The bed has unique characteristics that set it apart from other beds. Moreover, the bed may be transformed into a chair position using voice instructions. Therefore, this study proposes a wheelchair that may be operated by the user's simple vocal instructions and discusses the design and development of a voice-controlled automatic wheelchair. Additionally, the created wheelchair has ultrasonic sensors that can detect obstructions and halt the wheelchair's motion. The users will be more secure as a result.

1.1 LITERATURE SURVEY

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. [1].

A smart bed is a medical bed that is a 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 of detecting the voice commands was found to be troublesome. Wireless communication can be a hindrance to the patient [2].

Voice recognition software in a variety of languages is used to regulate wheelchair movement. The wheelchair may stop or pause when an obstruction or barrier is present in front of it because of the obstacle-detecting technology. The level of user safety is raised by this strategy. If the user does not adjust with voice control, the wheelchair system additionally has a keypad option. Only large obstructions are detected by the obstacle detection system [3].

In order, the design and implementation of an electric chair for patients that can ascend stairs successfully, automatic control is used. The chair receives an input of DC voltage and is around 125×88 cm and weighs 90 kg. Hydraulic electrical mechanical jacks, DC motors, and electric control circuits are among the electromechanical components. When there is no climbing of stairs it works normally whereas when the machine is facing a set of stairs, the first stair that the machine touches activate the motor and climb upstairs. As a result, the stability issue is addressed in this paper using hydraulic jacks that employ angle measuring tools [4].

This proposed medical bed is meant to solve the issue of rotten skin and/or ulcers and the inability to reach the bathroom through a unique design that rotates the patient and provides an innovative designed lavatory for cleansing. By using an android tablet connected to the Arduino micro controller via Bluetooth, the caretaker can rotate the bed in either direction to move the pressure away from the back of the patient and control the sliding lavatory to start cleansing [5].

The evolution of a voice acknowledgment-based smart wheelchair system for physically impaired people who can't handle the wheelchair by their hand is spoken in this paper where the patient can drive the wheelchair-using voice instructions and the region of the patient can be pursued using the GPS module in the wheelchair that trails and sends the information to mobile phone application by methods for Firebase. Voice recognition module VR3 is used to record the user's voice and see that voice holds fast to the bearings of the patient. As this system simultaneously offers voice-recognized wheelchair, motor speed control, hindrance area, and the GPS following of the user utilizing the android application in a perfect world, it will be a fruitful system for handicapped people the world over [6].

1.2 METHDOLOGY

This project aimed to design a bed that can be converted into a wheelchair that can be relied on by running voice commands. The voice-controlled wheelchair convertible bed is made up of the following components:

A. Voice Module

Voice capture and identification are both features of the EasyVR shield 3.0. The user's voice instructions are entered and recorded in the voice recognition module, and the voice capture module uses a comparison between the user's voice commands and the recorded voice commands to identify the voice commands. There are no additional requirements for the languages of voice module. In essence, it may be any language, including English, Thai, or any regional dialect. However, the pronunciation used to train the system should be as like the actual pronunciation as possible. The speech module receives voice commands from the microphone and passes the results from the voice recognition module to the micro controller to convert the voice commands.

B. Micro controller Unit

A micro controller board called Arduino UNO is based on the ATmega328P. It contains six analog inputs, a 16 MHz ceramic resonator, fourteen digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button.

C. Servo Motor

A servo motor is a type of rotary actuator or motor that offers more accurate control over angular position, acceleration, and velocity than a conventional motor can. It uses a standard motor and connects a sensor to it to provide position feedback. It moves the bed position.

D. Motor Driver Module

The L298 N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

E. DC Motor

Two DC motors are employed for the motion of the wheelchair. The right rear wheel is connected to one DC motor, while the left rear wheel is connected to the other. The operating voltage and power are 24 Volts and 350 watts, respectively.

F. Power Supply

The electrical voltages of 5V,9V, and 12V are used to supply to the micro controller system, the servo motor, and the motor speed control module, respectively.

G. Front and Rear Ultrasonic Sensor

For automatic obstacle detection, two ultrasonic sensors (HC-SR04) are used. The ultrasonic sensors detect the nearby object by producing a brief ultrasonic pulse and receiving the returned echo. The distance to an item is evaluated using the amount of time needed for the pulse signal to go there and back to the ultrasonic sensor.

Figure 1 represents the schematic diagram of the voice automated wheelchair convertible bed.

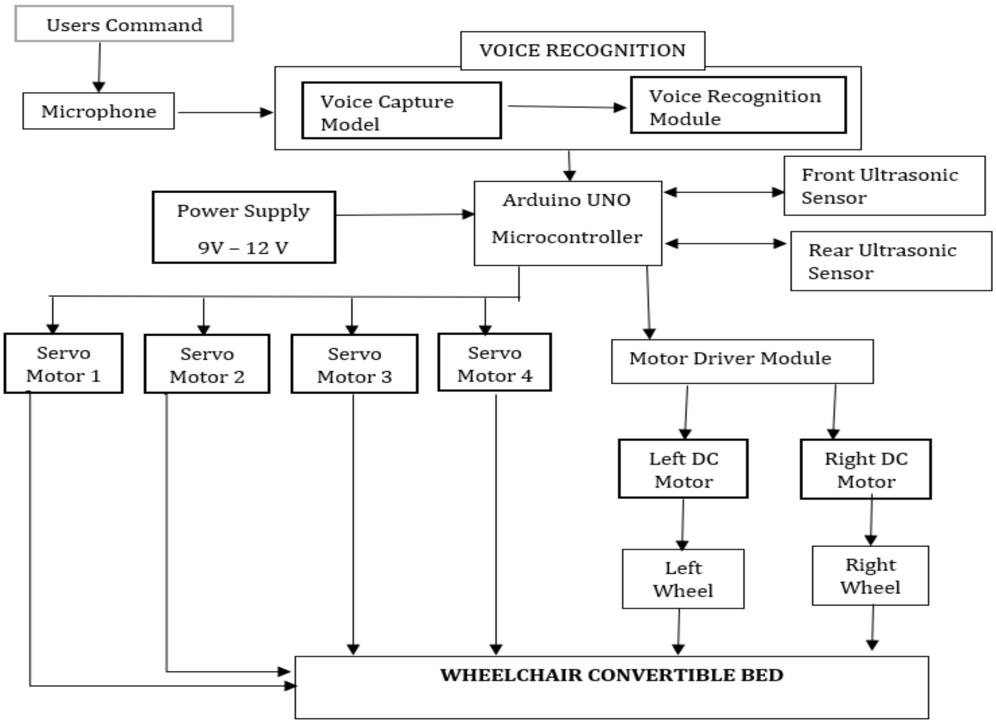

Figure 1: Schematic diagram of the voice automated wheelchair convertible bed.

1.3 IMPLEMENTATION

The proposed system consists of two phases:
a. Movement of Bed
b. Movement of Wheelchair

a. The Movement of Bed.

The idea is to design a bed that can be relied upon to conduct voice orders so that it can be used in care facilities, homes, and hospitals. Below is a schematic diagram that shows how the designed system functions. There are seven distinct categories of instructions for moving the bed: rest, wake, sit, up, down, lift, and fall. Figure 2 represents the schematic diagram of the movement of the bed. The microphone picks up the user's voice orders and converts them into electrical impulses. The voice module receives electrical impulses and digitizes and stores them as templates to represent user commands. Initially, users voice must be trained to utilize the established system before that command is saved in the voice module. When a user issues a command to the system, the speech module, if the command matches one that has already been saved, sends the output to the micro controller. Then servo motor will perform the specified function.

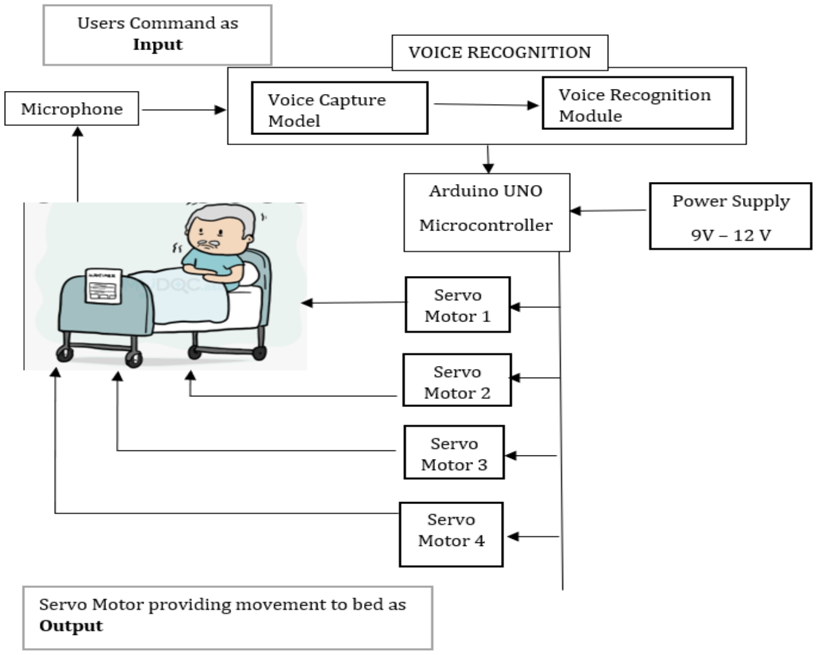

Figure 2: Schematic diagram for the movement of bed.

b. Movement of Wheelchair.

A wheelchair is a device that is used for mobility purposes. The developed system enables disabled patients to lead life independently without external assistance and without moving out of bed. The proposed voice-controlled wheelchair convertible bed's schematic diagram is shown in Figure 3, respectively. A microphone is used to receive speech commands from the user and transform them into electrical impulses. Electrical signals are transmitted to the voice module, which digitizes and stores the voice signals as templates to represent user commands. Before that command is saved in the voice module, the user's voice must first be trained to use the established system. If the command given by the user matches one that has been previously stored, the speech module sends the output to the micro controller when the user offers the command to the system. The front and rear ultrasonic sensors' output signals are also sent to the micro controller, which serves as an obstacle detection system. The output of the micro controller is connected to the motor speed control module and the servo motors. L298n motor driver module is used to regulate the rotation of the DC motors that provide forward and backward movement of the designed wheelchair. A battery is utilized to supply the operational voltages of the motor speed control module, servo motors, and the micro controller system which are 5V, 9V, and 12V, respectively.

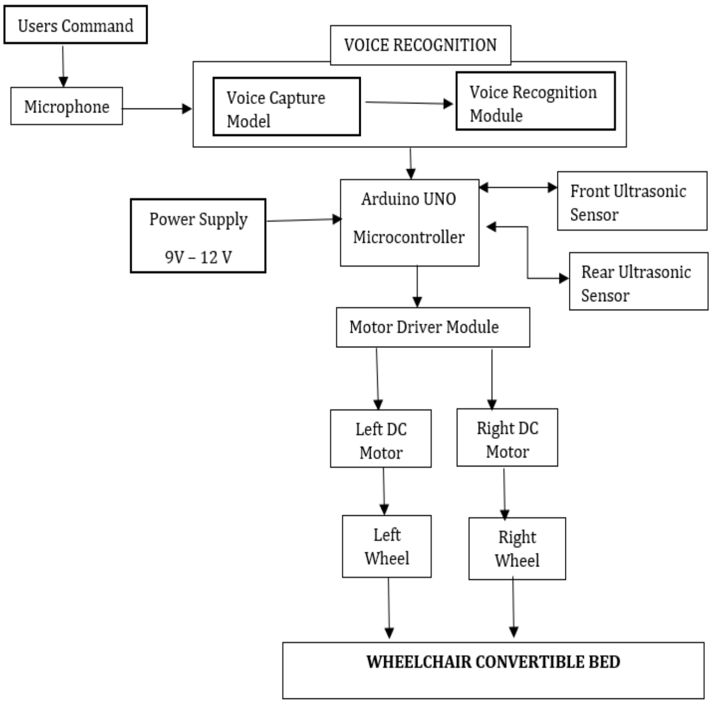

Figure 3: Schematic diagram for the movement of wheelchair.

2. RESULTS

The prototype of a voice-automated wheelchair convertible bed is developed as shown in figures 4 and 5.

Figure 4: Prototype of developed Bed.

Figure 5: Bed converted to wheelchair

The interactions between the user vocal instructions, microprocessor, motor driver module, and motors are established to assess the performance of the produced wheelchair cum bed. Tables 1 and 2 show the outcomes of the interaction between the micro controller, motor driver module, and motors upon activation by the user's voice commands. When the designed system is supplied with voltage, the system begins to operate. The machine then enters standby mode while it waits for a voice instruction to activate it. Both servo motors (1&2) will be at 0 degrees during the Rest command. Servo motor one will be at a 35-degree angle for the Wake command. Servo motors 1 and 2 will be at 60 degrees and 90 degrees, respectively, for Sit command. Whereas Servo motor three will be at 40 degrees for the Up command and 0 degrees for the Down command and Servo motor four will be at 35 degrees for the Lift command, and 0 degrees for the Fall command.

TABLE 1: Interaction of user voice commands and servo motors for the movement of the bed.

COMMANDS	Servo motor 1	Servo motor 2	Servo motor 3	Servo motor 4	Working of Servo Motors
Rest	0	0	-	-	The bed will be in a resting position
Wake	35	0	-	-	The bed will slightly be lifted to 35 degrees.
Sit	60	90	-	-	The bed will be converted into a chair position.
Up	-	-	35	0	The patient can turn to its right side.
Down	-	-	0	0	The bed will be in a resting position.
Lift	-	-	0	35	The patient can turn to their left side.
Fall	-	-	0	0	The bed will be in a resting position.

TABLE 2: Interaction of user voice commands, motor driver module, and motors for the movement of a wheelchair.

User Commands	Left wheel PIN 1	Left Wheel PIN 2	Right Wheel PIN 1	Right Wheel PIN 2	Working of motors
Forward	LOW	HIGH	LOW	HIGH	Wheelchair moves forward
Backward	HIGH	LOW	HIGH	LOW	Wheelchair moves backward
Left	LOW	HIGH	HIGH	LOW	Wheelchair moves towards left
Right	LOW	HIGH	HIGH	LOW	Wheelchair moves toward right
Stop	LOW	LOW	HIGH	HIGH	Wheelchair will stop at its position.

There are five different motions: forward motion, backward motion, left motion, right motion, and stop motion. The wheelchair drives ahead when the forward instruction is given, and the right and left DC motors also move forward. The right and left DC motors will move in the opposite direction in response to the backward command. Left motor moves forward in response to the left command while the right motor moves backward. Whereas right motor moves forward in response to the right command, whereas the left motor moves backward. Both motors will stop rotating in response to the stop command. When any obstructions are detected, the wheelchair's front and back ultrasonic sensors will suddenly stop both motors from moving. The wheelchair system will either end or return to standby mode.

Table 3 describes the distance measured using obstacle sensor. There is a substantial distance measured between Actual distance and Measured Distance.

Table 3 Distance Measured using Obstacle Sensor

Sr. No.	Actual Distance (cm)	Measured Distance (cm)	Percentage error %
1	5	4.94	0.012
2	8	7.86	0.0175
3	10	9.98	0.002
4	13	13.19	0.015
5	15	14.82	0.012
6	18	18.2	0.011
7	20	20.03	0.0015
8	23	23.17	0.007
9	25	24.97	0.0012
10	28	27.87	0.0048

3. CONCLUSIONS

The bed is devised using the results of multiple studies and research. This bed will benefit patients as well as the elderly and those with special needs worldwide by meeting demand. The bed can move, respond to voice orders from the user, and adjust to the patient's various movements, which lowers the risk of infection and pneumonia. Considering that 85 percent of back problems among nurses are caused by dealing with patients, an automatic bed might make life a little simpler for them. Individuals suffering from physical disabilities who are unable to regulate their motions, particularly with their arms and hands, are made more independent because of the wheelchair cum bed. Therefore, the developed voice-controlled wheelchair cum bed can provide easy access for people with physical disabilities and offer more safety due to automatic protection from obstacle collisions.

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BIOGRAPHIES

Dr. M. Seetha received B.Tech from Nagarjuna University in 1992, M. S. from B I T S, Pilani in 1999 and Ph.D in Computer Science and Engineering in the area of image processing in December 2007 from Jawaharlal Nehru Technological University, Hyderabad. She is currently working as a Professor and Head, Department of CSE in GNITS, Hyderabad. She has vast teaching experience of 26 years and worked in reputed colleges including CBIT, Hyderabad and Bapatla Engineering College, Bapatla. Her areas of research include Image processing, Soft Computing, Artificial Intelligence, Data Mining and Optimization Algorithms.

Farah Anjum received B.Tech degree in 2020 from Shadan Womens college of Engineering and Technology. She is currently in final year M.Tech student of G.Narayanamma Institute of Technology & Science and working as a Associate Software Engineer at Thomson Reuters. Her primary research interest is Internet of Things in Healthcare.