Smart Bed Using Voice Recognition for Paralyzed Patient

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Abstract. Smart beds are a way to simplify homework, especially for the elderly (elderly) and those who have physical disabilities, disabilities or paralysis. They can move the height of the bed according to their needs and comfort. The proposed system consists of a speech recognition module, an arduino, a relay circuit, and an adjustable bed. Voice recognition modules need to be trained before they are used to recognize commands. After successfully recognizing the voice command, Arduino directs the charge according to the help of the relay circuit. Adjustable bed height can be adjusted in three different modes according to the user's comfort and needs. The accuracy of the speech recognition module is measured in three bed height modes with different conditions Istirahat, Berbaring dan Bangun, Istirahat in a 145 degree position, Bangun 110 degrees and Berbaring 180 degrees. ON, OFF, Rest, Wake and Lie down. A total of ten experiments were carried out for each order listed in the table. Out of ten experiments, the speech recognition module correctly recognizes voice commands. The percentage accuracy of the voice recognition module in silence is 75%.

1. Introduction
Smart bed is increasingly popular, because of its ease of use and extensive operating capabilities. Smart bed is a way to human homework using technology so that it can provide a sense of comfort, an easier life and more quiet time, especially for the parents (elderly) and those have disabilities or paralysis. Smart bed can also provide improved quality of life for people who might otherwise need caregivers or nurses. Integrating voice recognition technology into Smart bed makes the system more user-friendly and easy to operate. Smart bed is very necessary and provide will great assistance to meet the needs and comfort of people have physical disabilities, disabilities or paralysis.

2. Study of Literature
Proposed a Voice Recognition Based Home Automation System for Paralyzed People which system consists of a voice recognition module, Arduino UNO microcontroller, relay circuit to and an adjustable bed. The voice recognition module needs to be trained first before it can be used to recognize commands. Upon successful recognition of voice command, the Arduino drives the corresponding load with the help of the relay circuit. The adjustable bed elevation can be set to the three different modes as per the user's comfort and need. [1]

There have been several researches and developments on the home automation systems. The voice recognition-based home automation system uses the Microsoft speech API running on PC to recognize the voice commands. The RF transceiver is used to send these commands to the controller to control the various electrical devices. The use of computer makes this system more expensive and difficult to handle [2].

Intelligent home navigation system for disabled and elderly person proposed a system which uses voice recognition module SR-07 for the speech recognition process, an Arduino controller, a wheelchair
and a navigation module. The Arduino receives the command from the voice recognition module and move the wheelchair accordingly thus eliminating the need of any third person’s assistance [3].

The voice recognition-based home automation system uses Lab VIEW to perform speech recognition and Zigbee module with a controller is used to control the devices wirelessly [4].

Proposed a home automation system which comprises a DSP processor for the voice recognition function, a microcontroller and relay module for the appliances control function like switching lights on-off etc. Zigbee wireless module is used which eliminates the need of additional wiring required for the signal transmission [5].

The home automation system proposed two ways to control home appliances that are by using timer or by using the voice commands. The software environment is developed on Virtual Basics 6.0 on PC and devices are controlled using PC parallel ports [6].

In this research, Smart Bed used voice recognition for patients suffering from quadriplegia or paraplegia (who cannot move their limbs but can speak and listen) in controlling and moving the height of the bed. With voice commands they can move the height of the bed according to their needs and comfort. The system consists of voice recognition modules, microcontrollers, relay circuits and adjustable beds. Voice recognition modules are trained in advance so they can be used to recognize commands. After successfully recognizing the voice command, the microcontroller directs the charge in accordance with the help of relay circuits.

The problem in this research considers the breadth of the problem, so this research is limited to the development of Smart Bed using speech recognition to move the bed height of patients suffering from quadriplegia or paraplegia (who cannot move their limbs but can speak and listen).

3. Research Method

The system design of the Smart Bed system uses voice recognition for paralyzed patients as shown in figure 1:

![Figure 1](image-url)

**Figure 1.** System planning of the Smart Bed uses voice recognition for paralyzed patients.

Figure 1 explains the system process ie sound input from a microphone is given to the speech recognition module where the speech signal is compared to a sample of trained voice stored previously. After successfully obtaining a voice command, Arduino moves an electrical device that adjusts the height of the bed using the relay module. Data from the illumination sensor is processed in an Arduino controller and based on setpoint values, automatic control steps are taken to save energy. The hardware of the proposed system is as follows: Microphone and Voice Recognition Module, the microphone used to get voice commands to the speech recognition module is a type microphone in a simple direction with a 3.5 mm jack. Elechouse v3 voice recognition module is used for the speech recognition process as shown in Figure 1. Voice recognition modules need to be trained before known for recognized to recognize voice commands. Voice input from the microphone is given to the speech recognition module...
and compared to previously trained voice commands and if there is a match then the control action through the control circuit is taken. The v3 speech recognition module can store up to 80 commands, out of 80 only 7 commands can be entered into the recognizer for the recognition process. Thus only 7 commands are effective at one time and to add 7 other recognizer commands need to be cleaned first. This module has two ways to control Serial Port, General Input Pins, Shown in Figs. 2.

![Elechouse v3 voice recognition module](image1)

**Figure 2.** Elechouse v3 voice recognition module

### 3.1.1. Arduino Uno

The controller used for the proposed system is Arduino Uno. The Arduino platform provides a cheap and easy way for students and professionals to create devices that interact with their environment using sensors and actuators. Arduino is based on ATmega 328. It has 14 digital input/output pins (of 14 pins 6 its can be used as PWM output) and 6 analog inputs. Arduino works at 5V D.C and has a 16 MHz clock speed, shown in Figs. 3.

![Arduino Uno](image2)

**Figure 3.** Arduino Uno

### 3.1.2. Relay

Control the patient's bed relay using Arduino. The relay used in the system is a 5V-5 pin relay as shown in Figs. 4. The relay remains in normally closed condition. When the relay coil is energized on a relay switch from a normal state which is normally closed to normal due to electromagnetic induction, shown in Figs. 4.
3.1.3. **Linear Actuator**

Linear Actuator circuit is to place the Linear Actuator as a driving force in detecting sound. Linear Actuator will automatically detects the directions up and down the bed with the sound. The linear actuator is connected with a sound sensor to detect the up and down direction of the bed. shown in Figs. 5.

![Figure 5. Linear Actuator](image)

3.2. **Smart Bed Design**

Mechanical design is the first step to making a smart bed play a very important role in voice recognition for the position of the bed. As for some of the mechanical manufacturing stages of the bed is the selection of materials, the material used in the design of the bed is stainless with the aim of avoiding corrosion. Stainless material is cut and shaped as a component holder and bed frame, the frame is designed to be sturdy to support the patient and has a flexible motion function as needed. The number of motion functions is referred to as the degree of freedom (DOF). Overall mechanics can be seen in Figure 6 as follows:
3.3. Series Linear Actuator

Linear Actuator Series is to place the Linear Actuator as a mover in detecting voice. Linear Actuator series will automatically detect the direction in accordance with voice commands. The linear actuator is connected to the Elechouse v3 voice recognition module to detect sound. Schematic Linear Actuator can be seen in Figure 7 below:

![Visual Schematic Linear Driver Actuator](image)

**Figure 7.** Visual Schematic Linear Driver Actuator

4. Results and Discussions

The main objective of this research is to design a smart bed system using speech recognition to control and model a bed with height in accordance with the voice commands given by the user. Recognized voice commands make Arduino change the relay and change the direction of the motor because which jack lifts the bed or brings the bed back to a lower altitude angle. The bed can be adjusted to fit three positions, *tidur* position, *istirahat* position, and *bangun* position. *Tidur* position is a position where the bed is at a height of 180 degrees to the ground. The person can *tidur* comfortably in this position. In a resting position, the bed is *istirahat* at 145 degrees to the ground and one can comfortably relax in this position. In the *bangun* position, the height of the bed is almost equal to 110 degrees and almost the person is in a *bangun* condition. The current drawn by the motor when lifting a bed or lowering at different weights.
5. Commands Voice and Their Functions

Table 1. Voice Command And Their Functions

| No. | Voice Commands | Position bed | Experimental Trial | Total Responses |
|-----|----------------|--------------|--------------------|-----------------|
| 1   | On             | -            | 1 1 1 1 1 1 1 1 1 1| 10              |
| 2   | Off            | -            | 1 1 1 1 1 1 1 1 1 1| 10              |
| 3   | Istirahat      | 145 degrees  | 0 1 0 0 1 1 1 1 0 1| 6               |
| 4   | Bangun         | 110 degrees  | 1 0 0 0 1 1 1 0 0 1| 5               |
| 5   | Tidur          | 180 degrees  | 1 1 1 1 0 0 1 1 1 1| 8               |

Table 1 shows the results of the path tests carried out in the speech recognition module on the smart bed system, to determine accuracy in determining each condition namely, ON, OFF, Rest, Wake and Lie down. A total of ten experiments were carried out for each order listed in the table. Out of ten experiments, the voice recognition module correctly recognizes voice commands. The percentage accuracy of the speech recognition module in silence is 75%.

In the noise conditions of the Ten trials, only three were recognized correctly so that the accuracy of the voice recognition module in the noise conditions was 65%.

References
[1] Mukesh Kumar and Shimi S. L., “Voice Recognition Based Home Automation System for Paralyzed People,” vol. 4, no. 10, pp. 2508–2515, 2015.
[2] T. Kirankumar and B. Bhavani, “A Sustainable Automated System for Elderly People Using Voice Recognition and Touch Screen Technology,” vol. 2, no. 8, pp. 265–267, 2013.
[3] R. K. Megalingam, R. N. Nair, and S. M. Prakhy, “Automated Voice based Home Navigation System for the Elderly and the Physically Challenged,” pp. 603–608, 2011.
[4] A. C. E and M. Jagadeeswari, “Control of Electrical Appliances through Voice Commands,” IOSR J. Electr. Electron. Eng., vol. 9, no. 1, pp. 13–18, 2014.
[5] S. K. Gopy, G. Hurry, and T. T. Gopaul, “A Study on Smart Home Control System through Speech,” vol. 69, no. 19, pp. 30–39, 2013.
[6] S. M. A. Haque, S. M. Kamruzzaman, and A. Islam, “A System for Smart-Home Control of Appliances Based on Timer and Speech Interaction,” pp. 4–7, 2006.
[7] S. M. Metev and V. P. Veiko, Laser Assisted Microtechnology, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[8] J. Breckling, Ed., The Analysis of Directional Time Series: Applications to Wind Speed and Direction, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.
[9] M. Wegmuller, J. F. von der Weid, P. Oberson, and N. Gisin, “High resolution fiber distributed measurements with coherent OFDR,” in Proc. ECOC’00, 2000, paper 11.3.4, p. 109.
[10] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, “High-speed digital-to-RF converter,” U.S. Patent 5 668 842, Sept. 16, 1997.
[11] (2002) The IEEE website. [Online]. Available: http://www.ieee.org/
[12] M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/FLEXChip Signal Processor (MC68175/D) Motorola, 1996.
[13] “PDCA12-70 data sheet,” Opto Speed SA, Mezzovico, Switzerland.
[14] A. Karnik, “Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP,” M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.
[15] J. Padhye, V. Firoiu, and D. Towsley, “A stochastic model of TCP Reno congestion avoidance and control,” Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.