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Automatic Bed Position Control Based on Hand Gesture Recognition for Disabled Patients

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***Abstract*—In recent years, society is facing many sociological and financial challenges, so there is less time for the elderly or disabled persons. There is an increase in the number of disabled patients in society in which the patient cannot take care of themselves. A full time caretaker may be required to continuously monitor these patients, which is not always possible due to social or financial constraints. The existing electronic bed systems available in hospitals have only two movements of the bed (Up and Down). So, to minimize care takers requirement and increase the comfort level of the patients here, we have proposed an automatic bed position control system for disabled patients in which we have added two more movements to the existing electronic bed systems (Left and Right) movement of the bed based on different hand gestures. A particular gesture input is given by the patient to the system, then this gesture is given to the micro-controller via RS-232 communication cable. The micro-controller further processes this input from the system and changes the position of the bed automatically with the help of DC motors and the accelerometer is used as a sensor to detect and display the patient fall.**

***Keywords*- :- Accelerometer, Bed Model, DC Motor Driver, Hand Gesture Recognition, Micro-controller(AVR), RS-232 Cable.**

I. INTRODUCTION

The electronic bed systems available in hospitals are specially designed for patients and others in need of special health services. These electronic beds are designed with special features, which are comfortable to the patient and also convenient to the health care workers. There are different types of beds available in the hospitals as well as in health care centers which have different features and specifications. Mainly there are two types of beds available in hospitals such as hydraulic beds and pneumatic beds. The hydraulic beds those are in the form of electronic beds and remote sensing beds and pneumatic beds are used in health care centers, cancer centers and old age homes. An electronic bed system is used in various cases such as for disabled persons, paralyzed patients, accident and old age people. The existing electronic bed systems are available with two movements of the bed that is up and down movements. The existing electronic bed system study is based on the visiting to the different hospitals in Pune.
There is always the requirement of caretakers for changing the position of the patients if they want to move to their right or left side. So, to minimize the requirement of caretakers and to increase the patient comfort level here two more movements are added to the existing bed system that is the right and left side movement of the bed. Therefore the bed is designed to control the position of the bed automatically by using hand gesture recognition. The advantage of using a bed is that the position of the bed is automatically controlled as per the requirement of the patients. So with our bed system there are total four movements of the bed that is up, down, right and left can be achieved. Here the position of the bed is automatically controlled by using different hand gestures with the help of the DC motor driver. The gesture given to the micro-controller as an input through a RS-232 cable and these given gesture is processed in micro-controller, after processing with at some time delay the motor is moved clockwise or anti-clockwise depend on the gesture input given and the corresponding bed movement achieved.

II. LITERATURE REVIEW

The survey for hospital beds was done in different hospitals in Pune like Aditya Birla Memorial Hospital, Ruby Hall, Bharti Vidyapith, Nobel Hospital and Nawale Hospital. Various types of beds are available in hospitals with different specifications provided by the companies. The Hill-Rom company beds are widely used in different hospitals in Pune, which includes manually operated beds, electronic beds and remote sensing beds. These beds provide different specifications for each type of bed that is adjustable height of the entire bed, the head, and the feet, adjustable side rails and electronic buttons to operate both the bed and other nearby electronic devices. These beds with their specifications are as shown below: These beds with their specifications are as shown in fig.1.

1. Hill-Rom M: 305 :- The Hill-Rom 305 is an adjustable, manual hospital bed designed to deliver Hill-Rom quality and safety at an affordable price with easy-to-use features facilitate caregiver tasks.
2. Hill Rom 80 :- The Hill-Rom-80 Extended Care Bed distributed by Hill-Rom offers residential comfort in a safe, reliable, and flexible solution at the right price.
3. Hill-Rom M: 405 :- Side-rail design shields the patient, to help prevent patient falls. One step head board removal for rapid access to the patients head.
4. Hill-Rom M: 900 :- The Hill-Rom 900 beds offer maximum functionality with minimal complexity, so you spend less time and energy operating the bed and more time focusing on

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essential tasks such as mobilizing patients and ensuring their safety.

(a) Hll-Rom 305 (b) Hill-Rom 80

(c) Hill-Rom 405 (d) Hill-Rom 900

Fig. 1. Hospital Beds

Here, the hand gesture recognition is carried out by using background subtraction algorithm. Background subtraction is a common method of motion detection. It is a technique used for the detection of difference between the background image and the current image. There are different tools for gesture recognition, based on the approaches ranging from statistical modeling, computer vision and pattern recognition, image processing, connection systems.

The objective of this paper is to control the position of the bed by adding two more movements to the existing electronic bed systems, so that the comfort level of the patient increases by using hand gesture recognition.

The rest of the paper is organized as follows: Section III explains the block diagram for hand gesture recognition based bed system in detail. Experimental results are given in section IV. Finally, the conclusion of the paperwork is given in section V.

III. HAND GESTURE RECOGNITION BASED BED SYSTEM

Fig.2. Shows block diagram for hand gesture recognition based bed system.

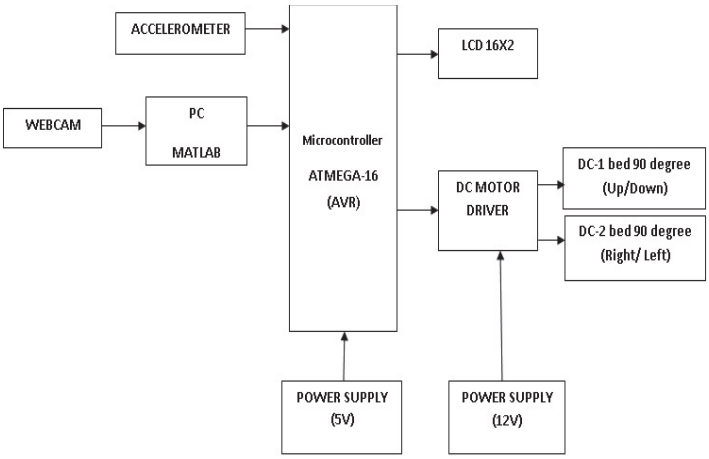


Fig. 2. Block diagram of hand gesture recognition based bed system.

A. *Image Processing Based Hand Gesture Recognition:*

Fig.3. Shows block schematic for image processing based hand gesture recognition.

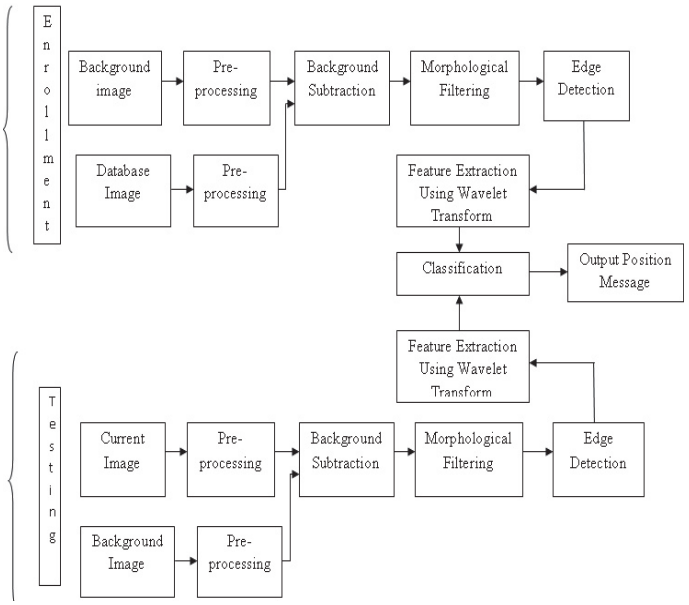


Fig. 3. Block diagram of image processing based hand gesture recognition.

It consists of two main sections enrollment and testing. The current image is captured by the camera of the machine and the image is processed in pre-processing, in which the current image is first resized to change the resolution, then the median filtering is done to remove random noises in the current image then the colored current image is converted to a grayscale image. The current image and the background processed image are given to the background subtraction to subtract the background part of the current image than by using morphological filters remaining noise is eliminated from the segmented image. Different edge detection operators are used for the edge detection of the segmented image, then by using wavelet transform feature extraction of the segmented image is done and classification of this image is done by using Euclidean Distance (ED).

B. *Power-Supply:*

Power supply is a basic need to design any systems. Here, we have used two different power supplies. One is a 5v supply for micro-controller circuit and another a 12v supply for DC motors to drive. 5v power supply is generated using a regulated IC 7805 and the bridge rectifier and capacitor input filter and the 12v supply is generated using an IC 7812. The power supply circuit used is as shown in fig. 4.

C. *Micro-controller:*

AVR ATMEGA-16 bit micro-controller is used by the system. Micro-controller consists of four different ports which is used by different circuits to interface with the controller. Port A and port C are used for the power supply connection (5v) and ground connections. The pin number 31 of port A is used for ground connection and pin number 30 of port C is used

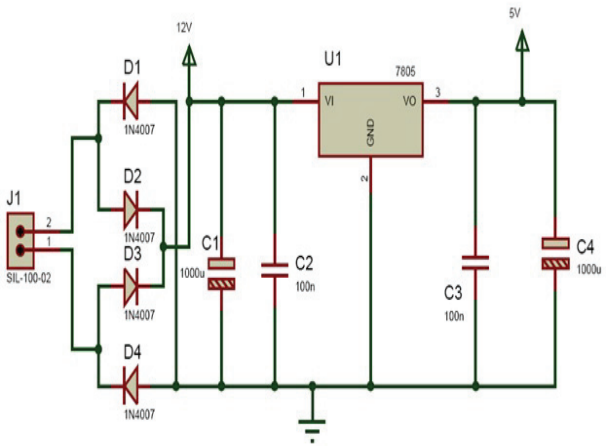


Fig. 4. Power Supply Circuit

for supply connection. Port B and port D are used for the reset circuit and crystal circuit connection of the controller and the supply connection. The pin number 9 and 10 of port B are used for reset circuit connection and supply connection respectively, and the pin number 12,13 and 11 of port D are used for crystal circuit connection and ground connection respectively. The output gesture code given by the system software is transferred to the micro-controller via a RS-232 communication cable. The micro-controller processes the transferred code data and passes to the DC motors to drive or to change the position of the bed depend on the input gesture code given. The controller circuit with pin connections ia as shown in fig. 5.

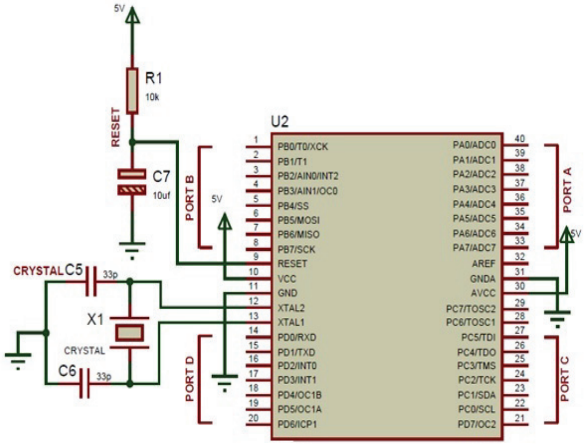


Fig. 5. Micro-controller Circuit

D. DC-Motor Driver:

DC motors are basically used to drive the motors as per the requirement of applications provided by the system. DC motors are the important part of the system to change the position of the bed atomatically. The driver Ic L293D is used here, because it is capable to drive two DC motors at a time. The two DC motors of 10 RPM are used clockwise and anti-clockwise to change the position of the bed as per the input given by the micro-controller. The motors are fitted to the bed model for proper bed movements.

E. Accelerometer:

Accelerometer is an electromechanical device used to measure acceleration forces and angle in different axis. Here, 3-axis accelerometer is used to measure the tilt of different axis. The accelerometer is used to detect and display the patient fall if happens during the bed movement. The two states of patient are coded for the accelerometer that is normal and the not steady state.

F. LCD Display:

In this system the LCD displays used is a 16*2 display. The LCD is basically used to display some values, messages given by the system. Here, we used LCD display to display the patient fall during the movement of the bed. If the patient is in the normal position display indicates normal either not steady state if a patient fall occurs which is shown in fig.6.

Fig. 6. LCD Display

IV. EXPERIMENTAL RESULTS

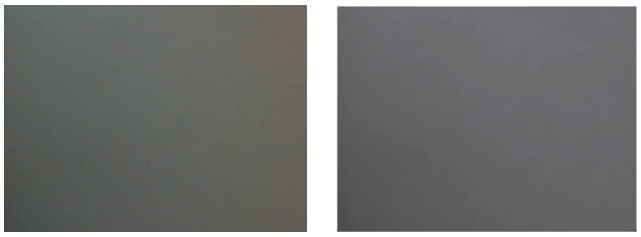
In order to recognize the hand gesture recognition using the background subtraction algorithm, the accurate preprocessing operations are performed on current images, taken from the created database as well as the on hand gesture images of people of varying age group. These images are captured by machine inbuilt 1 Megapixel web camera with a resolution of 1280×720 pixels. The preprocessing operations include image resizing, RGB to grayscale conversion processing, filtering. Further the algorithm is implemented in MATLAB and tested on 50 images with different input gestures. After gesture recognition the patient gave some input gesture which is matched with the database gesture images this gesture is transferred to the micro-controller via RS-232 communication cable. The transferred gesture code is processed in the controller and further passes to the DC motor driver to change the position of the bed as per the patient's requirement.

A. Pre-processing:

In pre-processing RGB to gray conversion, the resizing of the image and noise removal using median filter processes are carried out and the results are shown in fig.7.

B. Edge Detection:

The different types of edge detection operators are used to show the segmented image edges. The canny edge operators give best edge results, which is shown in fig.8.



(a) Background Image (b) Pre-processed Background

(c) Gesture Image (d) Pre-processed Gesture

Fig. 7. Pre-processed Images

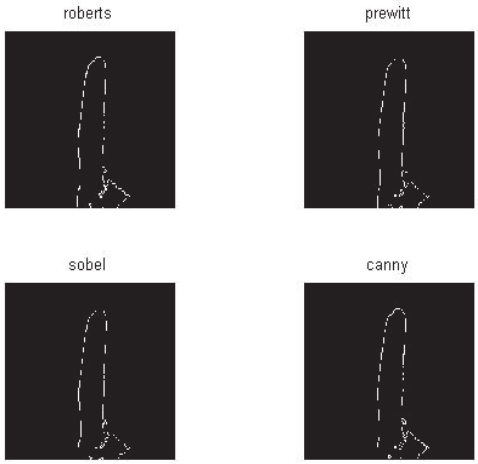


Fig. 8. Edge Detection Image For Different operators

C. Segmentation:

In this stage, the background image is subtracted from the current image and this current image is segmented, the segmented image is as shown in fig.9.

D. Wavelet Decomposition:

After 1-level wavelet decomposition of the segmented gesture images, the four subband images are shown in fig.10. out of which the approximate subband image is further used for feature extraction.

E. Feature Extraction and Classification:

The features of the segmented images are calculated using different shape features, such as area, eccentricity, and solidity. These features are compared with a threshold value defined as 0.68. The classification of these extracted images is carried out by using the Euclidean distance (ED) as a classifier. When

Fig. 9. Background Subtracted Image

Fig. 10. Wavelet Transformed Image

the database image and the current gesture image matched the message window appear as the images are matched or not, which is as shown in fig.11.

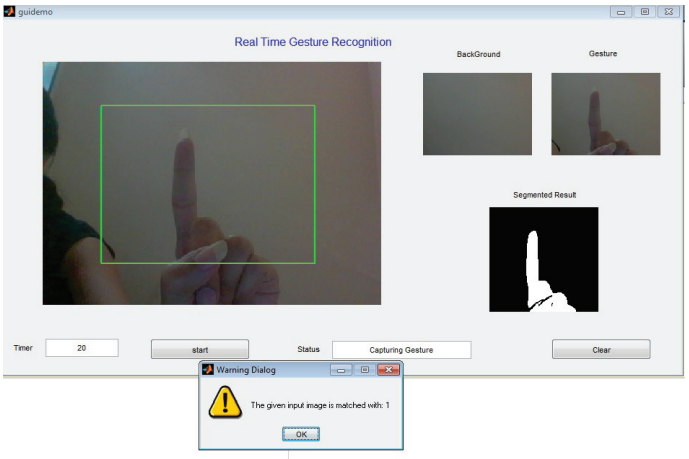


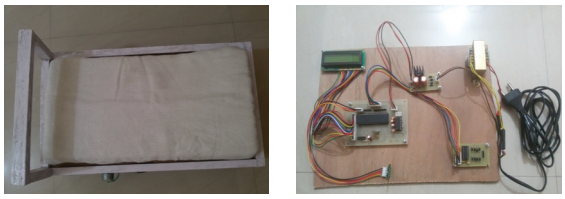
Fig. 11. Resultant GUI Image

In this paperwork out of 50 images, the algorithm gives the best results of hand gesture recognition on 48 images with an average accuracy of 96%. The performance of the tested images is shown in table I, to check the robustness of the system. The results of hand gesture recognition are obtained from using different wavelet transform, from these Symlet wavelet transform is gave best accuracy results. But sometimes

the system may give incorrect results due to the variation in background, light luminance and improper gesture given. To overcome this, different wavelet transforms can be used with algorithm to check the distortion-free results and to improve the accuracy of the system.

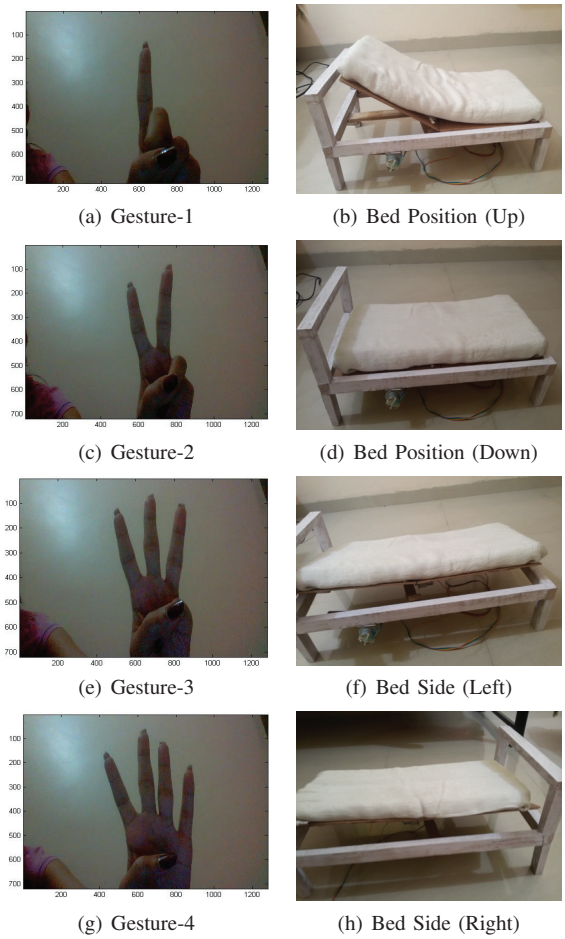
Wavelet	Testing Images	Correct Results	Accuracy (%)
Haar	50	46	92%
Daubechies-4	50	42	84%
Symlet-2	50	48	96%
Coiflets-2	50	43	86%

TABLE I. PERFORMANCE EVALUATION BASED ON DIFFERENT WAVELET DECOMPOSITION



(a) Bed Model (b) Hardware

Fig. 12. Hardware Implementation



(a) Gesture-1 (b) Bed Position (Up)

(c) Gesture-2 (d) Bed Position (Down)

(e) Gesture-3 (f) Bed Side (Left)

(g) Gesture-4 (h) Bed Side (Right)

Fig. 13. Gestures with Bed Position

V. CONCLUSION

This paper presents the background subtraction algorithm, giving the promising results for hand gesture recognition. This can be effectively used in real time processing in real time applications. Here we use different wavelet transform out of which Symlet wavelet transform give results accurate as compared with other transforms. The Symlet wavelet transform gives an accuracy of 96%. The gesture is then given to the micro-controller via RS-232 communication cable for further processing, the controller processes the transferred data code gesture and passes this to DC motor driver to drive the motor clockwise or anti-clockwise depend on the gesture given by the patient the position of the bed changes as per the given gesture input as up/down and right/left.

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