

IR based Wheel Chair

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Abstract— To meet the challenges in today's world of global computing, fast technologies, and increasingly old age population, the researchers have been trying to switch from traditional modes of navigation to automatically operated modes of navigation. This gives a level of independence in their daily activities inside the house without much effort. The demand for assistive navigation technologies to help elderly and disabled peoples has also risen due to the modern life style and nuclear family. In this project our goal is to design and develop an intelligent wheelchair for severely disabled i.e, multiple sclerosis, quadriplegic patients and old age people based on head gesture control. The Automatic wheelchair developed basically works on the principle of acceleration. According to the head tilt movement of user the accelerometer MMA7361 used in the system gives variation in the voltage across x- axis &y-axis as output. The accelerometer is connected to ATMEGA328 Microcontroller which sends commands according to the head gesture recognition of user. Further μ C controls the direction of wheelchair by using H-Bridge Motor driver ICL293D. The Obstacle avoidance ultrasonic sensor attached to the wheelchair in front provides safe navigation and LCD attached on top gives user friendly interface.

Key words: ATMEGA328 microcontroller, Accelerometer MMA7361L, H-Bridge Motor Driver IC L293D, Multiple Sclerosis, Quadriplegic, Intelligent Wheelchair, LCD

I. INTRODUCTION

In our rapid moving materialistic world, people need to modernize and make progress in their lives. The world population is rising day by day which increases number of old age and physically challenged people. These people face lots of problem to even navigate inside the house without help of external aids. The wheelchairs are among the most popular assistive device in medical area. So, the demand for wheelchairs has been ever rising in market. The utility rate of people with wheelchairs is nearly 3.3 million in this world. The recent shift in robotic artificial intelligence gives enormous scope for designing an automated wheelchair. Nowadays the elderly people are switching from traditional wheelchairs to automated wheelchairs an easy means of locomotion Several Researchers are currently working to develop robotic wheelchairs which are more flexible and can overcome limitations of the traditional wheelchairs. Our aim in this project is to design and develop an automated navigation system which can be used by both the elderly and the physically challenged people in a user friendly manner using head gesture recognition for operation. The complex existing systems can be reduced in this project by simply using an accelerometer IC placed on the head of the user and also placing a group of ultrasonic sensors in front to have safe navigation.

II. RESEARCH WORK ON ROBOTIC WHEELCHAIRS

Most recent research works into the field of intelligent robotics have come out with various methods of navigation using wheelchair. Some of such methods are discussed here. A smart wheelchair equipped with sensors and driven by Head movement control that allows the rider to interact with and command the system at various levels of abstraction as in [1]. A novel hands-free control system for Intelligent Wheelchairs is proposed in [2]. A robust Hand Gesture Interface is designed for vision-based head gesture recognition of the Robot Chair user. The recognized gestures are used to generate motion control commands so that the Robot Chair can be controlled according to the user's intention. An integrated approach to real time detection, tracking and direction recognition of hands, which is intended to be used as a human-robot interaction interface for the intelligent wheel chair is presented in [3]. The author here demonstrates that accelerometers can be used to effectively translate finger and hand gestures into computer interpreted signals. A different gesture recognition methods that are employed in wheelchair used for navigation and that is affordable by the people in developing nations is given in [4]. In this technique a GGUI (Gesture Controlled User Interface) prototype application, called Open Gesture, to help users carry out everyday activities such as making phone calls, controlling their television and performing mathematical calculations is proposed as in [5]. Open Gesture uses simple hand gestures to perform a diverse range of tasks via a television interface. This technique proposes a reactive navigation algorithm that guarantees the safety of automated intelligent wheelchairs for people with mobility impairments in dynamic uncertain environments as in [6]. The proposed navigation algorithm restricts neither the natures nor the motions of the obstacles; the shapes of the obstacles can be time-varying (deforming obstacles) and does not require prior information about the positions and velocities of the obstacles to accomplish obstacle avoidance.

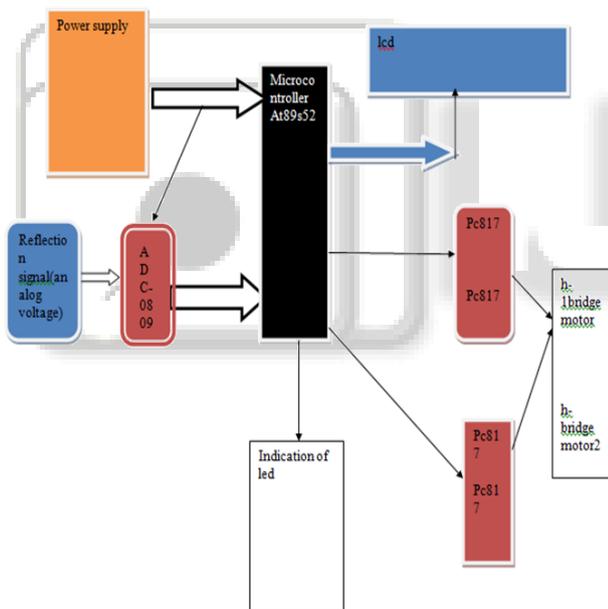
In this method the development of a novel architecture of an intelligent wheelchair working on wireless hand gesture control is shown as in [7]. This Wheelchair also has a distress call system (GSM) to alert the concerned people or family in times of necessity for the person, or when there is any sudden detection of edge or staircase during backward motion, thus saving the chair from accidents. A voice and gesture based system to control a wheelchair using voice commands and moment of hand (MEMS sensor is connected to hand) is proposed as in [8]. In the speech recognition module, hidden Markov models are used as the main method in recognizing voice commands. The MEMS sensor senses the angle of the hand, i.e. according to the tilt of hand it gives voltages to microcontroller. The wheelchair control unit is developed using ARM controller. This method proposes a device in which by pressing the keypad (buttons), people with disabilities can move the wheelchair as in [9]. Here, the line

following algorithm is implemented. By pressing a button, an automatic call to the doctor can be made. The GSM modem is used to forward the call. The LCD placed in centre of home shows the basic needs of people with disabilities (PWD) which is already assigned in the buttons. On pressing the button, a text is displayed in the LCD with a buzzer sound. By the buzzer signal the helper comes to know the needs of the disabled people. This device provides a unique mobility for the people with disabilities.

III. HEAD GESTURE CONTROLLED WHEELCHAIR

This novel method of the gesture recognition uses very small accelerometer IC MMA7361L placed on the head of the user as the main component in the module to detect the gesture and control the wheelchair. The benefit of using this system is that it recognizes simple gestures accurately cutting down the cost of implementation. So, a prototype intelligent wheelchair using head gesture control is developed. The sensors are interfaced in front along with the main modules for safety and the ATMEGA328 microcontroller is used as control unit. This gives a better technique of gesture identification which can be easily operated by the user himself.

A. Block Diagram of Head Gesture Control Wheelchair:



1) Working Principle:

This system is fed with 12V dc supply. Further 5V regulated voltage is fed to ATMEGA 328 microcontroller, MMA7361L accelerometer, ultrasonic sensor, LCD and Motor Driver IC L293D. As shown in block diagram Atmega328 microcontroller is connected to every module on circuit like LCD, Ultrasonic Sensor, Motor Driver, and Accelerometer. Whenever the circuitry operates through accelerometer mounted on the head of the user, the head tilt movement shows variation in voltage on the two axes of accelerometer. According to voltage variation in X and Y axis the direction of motor is controlled using Motor Driver IC via microcontroller. The microcontroller on receiving the signal directs the motors through the control circuit. The change of direction is achieved by changing the direction of current flow through the motor and speed as shown in fig. 3

of dc motor for forward and reverse movement.

Collector of both the transistor is connected to the positive supply 9 volt.

If we give a positive voltage to the base of left junction and negative voltage to the right junction then motor moves to one direction. Because due to positive on base NPN is on and due to negative on base PNP is on. If left side NPN is on and right side PNP is on then motor moves to the one direction. If the voltage is reverse on the base point then motor's moves to the reverse direction.

2) Motor Driver:

We use slow speed gear motor in this project. Working voltage of these motors are 9 volt to 12 volt dc. We use two power source in this project. One for the motor's and second for the controller circuit.

3) H Bridge:

If we give a positive voltage to the base of left junction and negative voltage to the right junction then motor moves to one direction. Because due to positive on base NPN is on and due to negative on base PNP is on. If left side NPN is on and right side PNP is on then motor moves to the one direction. If the voltage is reverse on the base point then motor's moves to the reverse direction.

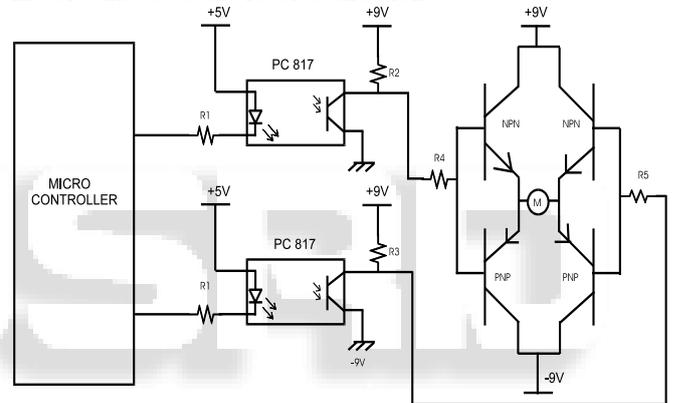


Fig. 3: Motor Driver Circuit

Here 0.3V sensitivity is selected to show the movement of wheelchair corresponding to x,y coordinate orientation.

The interfacing of Accelerometer with Microcontroller is shown below in Figure:4

The features of various pins of the accelerometer in the block diagram is described here-

4) 0g-Detect:

The accelerometer consists of a 0g-Detect feature that gives a logic high signal when all three axes are at 0g. This feature enables the application of Linear Freefall protection if the signal is connected to an interrupt pin or a poled I/O pin on a microcontroller.

5) Self-Test:

The sensor provides a self-test feature that allows the verification of the mechanical and electrical integrity of the accelerometer at any time before or after installation. This feature plays significant role in applications such as hard disk drive protection where system integrity is assured over the life of the product. Customers can use self-test to verify the solderability to confirm that the part was mounted to the PCB correctly. To use this feature to verify the 0g-Detect function, the accelerometer is to held in position upside down so that the z-axis experiences -1g. When the self-test function is initiated, an electrostatic force is applied to each

axis to cause it to deflect. The x- and y-axis are deflected slightly while the z-axis is trimmed to deflect 1g. This procedure assures that both the mechanical (g-cell) and electronic sections of the accelerometer are functioning.

6) *g-Select:*

The g-Select feature in accelerometer permits the selection between two sensitivities. Depending on the logic input placed on pin 10, the device internal gain will be changed allowing it to function with a 1.5g or 6g sensitivity mentioned in Table 3.1. This feature is ideal when a product has applications requiring two different sensitivities for optimum performance. The sensitivity can be changed at any time during the operation of the product. The g-Select pin can be left unconnected for applications requiring only 1.5g sensitivity as the device has an internal pull-down to keep it at that sensitivity (800mV/g).The g-Select pin description is shown in Table:1

g-Select	g-Range	g-Sensitivity
0	1.5g	800mV/g
1	6g	206mV/g

Table 1: g-Select Pin Description

7) *Sleep Mode:*

The 3 axis accelerometer provides a Sleep Mode that is ideal for battery operated products. When Sleep Mode is active, the device outputs are turned off, providing significant reduction of operating current. A low input signal on pin 7 (Sleep Mode) will place the device in this mode and reduce the current to 3 μ A. For lower power consumption, it is recommended to set g-Select to 1.5g mode. By placing a high input signal on pin 7, the device will resume to normal mode of operation.

8) *Filtering:*

The 3 axis accelerometer contains an onboard single-pole switched capacitor filter. Because the filter is realized using switched capacitor techniques, there is no requirement for external passive components (resistors and capacitors) to set the cut-off frequency.

9) *Ratiometricity:*

Ratiometricity simply means the output offset voltage and sensitivity will scale linearly with applied supply voltage. That is, as supply voltage is increased, the sensitivity and offset increase linearly; as supply voltage decreases, offset and sensitivity decrease linearly. This is a key feature when interfacing to a microcontroller or an A/D converter because it provides system level cancellation of supply induced errors in the analog to digital conversion process

IV. RESULT

The proper fabrication of all the components according to the circuit diagram gives us a working prototype model for the Intelligent Wheelchair based on Head Gesture Control. The Intelligent Wheelchair model runs perfectly for the head tilt gesture commands. Both hardware and software implementation is done here. The reaction time for each command send to Wheelchair by Gesture module is displayed on the LCD screen. This reaction time for each command is tabulated to calculate the success rate of Gesture Module.

A. *Gesture Module MMA7361L:*

The accelerometer sensor used in this system recognizes all the head tilt gestures of the user perfectly and accordingly the movement of Wheelchair for each programmed command is done. The 360° movement of the Wheelchair can be made using the accelerometer sensor. The accelerometer data corresponding to the each head tilt movement gives some Voltage threshold value for x and y co-ordinate. The Success Rate can be calculated by the Success Rate= No. of Successful trials*100/ Total No. trials. The reading of Accelerometer is shown in Table:2 corresponding to the head tilt movement.

Direction Of	Reaction time (ms)	Success Rate	Threshold value of Voltage
Forward	30	90%	$\Delta V_x > 0.3V, \Delta V_y > 0.3V,$
Backward	26	80%	$\Delta V_x < -0.3V, \Delta V_y < 0.3V,$
Left	22	90%	$\Delta V_x > 0.3V, \Delta V_y < -0.3V,$
Right	25	90%	$\Delta V_x < -0.3V, \Delta V_y > 0.3V,$
Stop	18	95%	$\Delta V_x < 0.3V, \Delta V_y < 0.3V,$

Table 2: Reaction Time and Voltage Reading of Accelerometer across X and Y axis.

From the study it is seen that success rate of the Intelligent Wheelchair is very fast for the gesture recognition as compared to other other control methods . The IR Sensor is mounted in front of the Wheelchair.It detects the obstacle upto minimum distance d=50 cm programmed for this model perfectly. The Success Rate of the Obstacle Detection Module is also calculated by 10 trials and is mentioned in the Table .1.The Obstacle detection success rate is 95%.These IR Sensors can also be mounted on the back of the wheelchair.

The reaction time and corresponding command "STOP" for the obstacle detection is displayed in the LCD shown in Figure:5

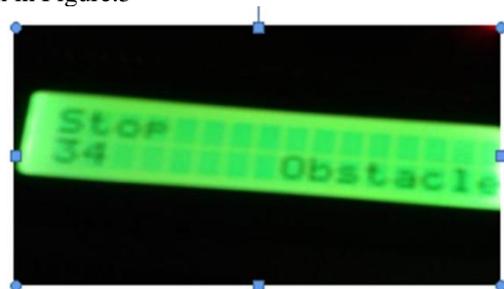


Fig. 5: LCD Displaying Obstacles Detection for the min d=50cm.

V. CONCLUSION AND RECOMMENDATIONS

The design and development of this intelligent wheelchair based on novel head gesture control can be successfully implemented on a commercialized scale for the physically handicapped and old age people. The intelligent wheelchair helps the severely disabled people to lead their life in an uncomplicated way. The low cost of the assembly of this intelligent robotic wheelchair is really a boon for the general

public. For further development the project can be developed as-

- Addition of wireless system.
- IR sensors can also be mounted in different sections left, right and back.
- There can also be the implementation of intelligent home navigation for people with disabilities and elderly to go through the entire house and get help from technological interface for the navigation.
- The object diverting and safe navigation can be improved with line following algorithm based image processing technology.
- This system can be extended by including GPRS modem.
- The other Gesture controls method like expression, thinking etc can be developed in future.

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