

A Smart Wheelchair Robotic System With Health Monitoring And Communication Aid For Paralyzed Person

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Abstract: Hand gesture controllers are used for controlling the smart wheelchair robotic system with health monitoring and emergency communication aid. Many people in the world have lost the ability to control the upper limbs and the lower limbs due to quadriplegia, paralysis or ageing factors. These types of users require specialized controlling systems for using an electrical wheelchair rather than using the traditional control by the joystick. In this type of wheelchair control system, hand gesture-controlled mobile wheelchair robots can be used as a powerful helping system for the severely disabled people in their daily life, especially for helping them move voluntarily.

In this project, we would be using the hand gesture controlled wheel chair robotic system. The hand gesture controlling system uses the movement of our hands to operate the system. Continuous health monitoring is maintained and provided to help during the emergency conditions. Emergency alerting and aiding system helps in alerting the nearby people and send alert messages to the hospital and close family members.

Keywords: Hand gesture controller, emergency communication aid, health monitoring system.

1. Introduction

Many thousands of people in India are facing disability in movement. They face the problem of discrimination on a regular basis which takes place in many forms. The disabled person is seen more as a liability than an asset for the society. Since these disabled people encounter discrimination, they tend to alienate themselves from the society as they feel unwanted and feel rejected. According to census of 2001, in India there were people around 0.6% of population had the disability in their movements that is approximately around 6 million people in India. In addition to that, most of our Indian public infrastructure, Indian public transport and Indian government buildings are mostly not disabled-friendly.

There has to be a concerted effort towards making sure that the disabled people have the access towards those places and they should not feel hampered in anyway. Our mindset has to be changed and should accept these disabled people and help them integrate into our society. For this purpose, we are making a special type of wheelchair which might be helpful to those disabled people, for making themselves self-dependent and it would be very helpful to integrate them into our society.

As the existing system doesn't have an option to know about fall detection if a person falls off a wheelchair. This should be known to the Doctor and Family members. During night time, any emergency condition like heart attack at home cannot be diagnosed immediately. The wellness of a disabled person in a family at any given time cannot be monitored by other people in the family. Immediate communication aid during emergency was not provided often. We can make emergency aid and health monitoring using this special wheelchair.

Our proposed system has an advantage of Hand gesture based wheel chair movement for paralyzed person. Here we are continuously collecting the Hand gesture signals from the person by using sensors, then the collected signal must be sampled by the microcontroller. Once the fixed threshold values are reached then the controller gives the command to driver circuit to run (move) the wheelchair robot.

This system contains some additional features like continuous health monitoring of person, here we are measuring the respiratory and heartbeat of a person. Once it becomes an abnormal state, it means then the microcontroller will automatically send an alert message to the authorized person along with GPS location. And also emergency switch is provided to send an alert message to authorized person during emergency situation. Once the switch is pressed the system makes an alarm to alert the nearby people.

2. System-Design:

The proposed work system design consists of various components such as (i) Microcontroller. (ii) Hand gesture sensor. (iii) Heart beat sensor. (iv) Respiratory sensor. (v) GPS. (vi) GSM module. (vii) Driver circuit. (viii) LCD. (ix) circuit design. (x) Software simulation. (xi) Hardware design. (x) vibration-sensor.

2.1.LCD: :

The commonly used sort of Character based LCDs are mostly supported by the Hitachi's HD44780 controller or other types which are most compatible with the HD44580. Character based LCDs have interfacing with the various microcontrollers, various interfaces (8-bit/4-bit), programming for your application. The most common types of LCD used in the commercial market today are the 1 Line, 2 Line or 4 Line type of LCDs which usually have the only 1 controller and it supports at most of 80 characters, whereas the LCDs supporting more than 80 characters usually make use of the 2-HD44780 type of controllers. Most types of LCDs with the 1 controller has the 14 Pins and LCDs with the 2 controller has about 16 Pins (the two pins is mostly extra in both for the back-light LED-connections). Usually these days, people would find the single controller LCD modules were usually used more in the commercial market.

2.2..ARDUINO MEGA 2560 Microcontroller:

Arduino MEGA 2560 Microcontroller board is simply sort of a brother of Arduino UNO board. The microcontroller board is way too more powerful than the Arduino UNO and it is also twice long from it. This microcontroller board is part of the Arduino MEGA series. It can also be named as ATmega2560. It has more memory space, when compared to other boards of Arduino. Arduino MEGA 2560 microcontroller uses ATmega16U2, and it is programmed as the USB-to-serial converter. It would be programmed with the help of Arduino IDE software for the coding of program in embedded c coding and it is converted into machine level coding by the IDE tool. We donot have to attach any extra parts of components or any devices for forming this board in running condition for usage. As per our requirement, we would just have to plug and run this board as everything is made integrated inside the microcontroller, and this makes it readily available.

Arduino Mega 2560 microcontroller is a tremendous microcontroller for the projects that needs the great deal of input output pins or if the high processing power is needed. It is designed for using in more complex projects because in the easy projects doesn't require great amount of input output pins as more pins are useless in easy project. And the microcontroller board with less amount of memory doesn't realize our requirements. It is often used for stand-alone project, or it is used together with other microcontroller boards.

2.3.Vibration Sensor:

Vibration sensor is a sort of sensor used in for various different project works and other applications. It is used in application such as gauging the vehicle speed, or for gauging the power level of an impending earthquake. The various sensor operating conditions are concerned with very high temperature, other magnetic fields, the range of vibration, the range of frequency, the electromagnetic compatibility (EMC) and the electrostatic discharge (ESD) conditions and the quality of signal needed to necessitate the specific requirement for a variety of sensors.

It operates on the principle of electro-mechanics and vibration velocity sensors operate accordingly with the principle of electrodynamics and they are used during measuring of the load bearing whole vibrations based on piezoelectric effect. The change in the resistance because of the force acting towards it and converting it into 4 - 20 mA. They are measuring the varying differences in the oscillation. piezoelectric sensor helps detecting the vibrations that are created on the surface. We could also have shock sensor for detecting vibrations.

2.4. Flex Sensor 2.2 inch Bend type of Sensor for Hand Gesture Recognition:

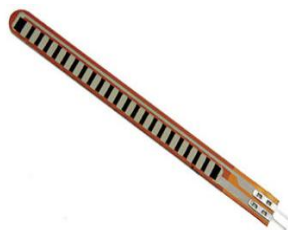


Figure 1. FLEX SENSOR

The flex sensor is a type of bend sensor for hand gesture recognition applications. It is also a type of a variable resistor. The technology of the flex sensors are based on the resistive carbon elements. The sensor helps detecting the gesture of hand through variation in resistance value. Its value of the resistance increases gradually when a body of component bends. Its radius is smaller, so it gives higher resistance value. when a particular finger of the hand bends, it gives the varying signal at particular sensor to the microcontroller.

2.5..Driver Circuit:

The L293 driver circuit module is a type of the monolithic high voltage and high current Darlington transistor arrays. It usually consists of the 7 NPN Darlington pairs that presents the high-voltage outputs with the common-cathode clamp diode for switching of the inductive loads. The ratings of the collector-current segment of 1 Darlington pair is usually 500mA. The pairs of Darlington transistors can be paralleled for the high current capability. Its applications also includes the relay drivers, the hammer drivers , the lamp drivers, the display drivers ,the line drivers, and the logic buffers. The L293D driver circuit module has a 2.7kW series base resistor for each pair of Darlington transistors for operating directly along with TTL or 5V CMOS devices.



Figure 2. DRIVER CIRCUIT

2.6.Heart Beat Sensor:



Figure 3. HEART BEAT SENSOR

Heartbeat Sensor is a type of electronic device which is used for measuring the rate of heart beat. We have to monitor the temperature of the body, rate of heart beat and rate of blood pressure are the basic things that we have to check regularly for monitoring the health of a person. For measuring the body temperature, we would use the thermometers and a sphygmomanometer for monitoring the Arterial Pressure or Blood Pressure. The rate of heartbeat can be monitored by two ways: by manually checking the pulse at the wrists or the neck and the another way is by using a Heartbeat Sensor.

2.7..Respiratory Sensor:



Figure 4. Respiratory Sensor

The respiration sensing sensor is a sensitive girth type of sensor usually worn by using an easily fitting, highly durable and elastic woven band that is fixed with a length adjusting webbing belt. It helps detecting the chest or the abdominal expansion or abdominal contraction and helps giving outputs of the respiratory waveforms. The respiratory sensor can also be used along with any other sampling rate, it can also be connected to any other input

of any other encoder (except the channel-A of the ProComp 2). Usually, it is connected by the input signal with the lower sampling rate. The respiratory sensing sensor is very sensitive to the stretch of the lungs. When it is strapped around a person's chest or the abdomen, it would help in conversion of the expansion and contraction of the chest rib cage or upper abdominal region, to a rise and fall of the waveform signal in the screen. For patient's comfortness, the elastic strapped segment often stretches when the abdomen region expands during breathing of the lungs.

2.8. Gsm Module:



Figure 5. GSM MODULE

SIM900A Modem is made with the Dual Band GSM based SIM900A modem series from the SIMCOM. It operates on the frequency range of 900MHz. SIM900A could also help search these 2 bands automatically. The frequency band could also be settled by the AT Commands. The baud transfer rate is also configurable from the range of 1200-115200 through the AT command. SIM900A is very compact and it is a wireless module. The Modem is a type of interface, which allow people to connect the PC as well as the microcontroller with the RS232 Chip (MAX232). It is very suitable for the SMS, the Voice as well as the DATA transferable applications in the M2M interface. The onboard Regulated Power supply in the modem helps allowing the people for connecting the wide range of unregulated power supply. By using these type of modems, people could use services like audio calls, read and send SMS, also helps attending the incoming calls and etc. through very simple AT commands. SIM 900A GSM Modem has the serial outputs and the TTL outputs.

2.9.GPS:



Figure 6.GPS

We used the GPS module that is solely based by the model of Ublox NEO-6M. This model unit operates and gives the possible good positioning information and also it include a larger built-in 25 x 25mm active GPS antenna with the UART TTL socket. The battery is included for the purpose of obtaining a GPS lock faster.

UBLOX NEO-6M GPS Module have the power storage battery for power backup purposes and EEPROM for the purpose of storing configuration settings. The antenna is faced towards the sky for the best performance and it is connected with the help of UFL cables which is very useful for mounting the GPS. This helps making itself powerful for the usage in cars and other applications. The Ublox GPS module has the serial TTL type of outputs, it has about 4 pins: TX, RX, VCC, and GND.

3.Working Model Of Handgesture Controlled Wheel-Chair Robotic System:

LCD display is used as the interface for finding the current working condition of the wheel-chair robotic system. It acts as the interface of interaction between the user and the machine. Flex Sensor 2.2" Bend Sensor used for Hand Gesture Recognition of the wheelchair system. This hand gesture controlling flex sensor is attached to the gloves of our hand. when we move our finger, it gives signal to the flex sensor of particular glove finger. Emergency communication system works with the help of GPS and GSM module. we have to program what message we have to send and, to which number like hospital doctor, close family members along with the position of location with our GPS system.

Health monitoring system consist of respiratory sensor and the heartbeat sensor, which helps in the continuous monitoring of a person. Every person has particular frequency of intaking air inside the body (i.e) breathing rate.

we can set the breathing rate to the respiratory sensor, During any irregularities in the breathing, health monitoring reports to the microcontroller, it uses the GSM module to send emergency alerts. Heart beat sensor also regulates the heartbeat of a person ,and during any heart problem like heart attack ,it acts quickly in giving emergency alert message to the hospital and close family members.

- First we have to give power supply to the smart hand gesture controlled wheel chair robotic system.
- We have to wear the Hand gesture controlling sensor embedded gloves in the one hand of our body.
- We have to enable the gsm module, gsm module takes some time to activate the sim card . This sim card helps in sending the emergency alerts.
- When the power supply is given to the atmega 2560 microcontroller, it activates the wheelchair robotic system. we have to upload the software embedded c coding to microcontroller, it saves the program in the microcontroller memory. It runs the program continuously to run the hand gesture controlled robotic system with health monitoring and emergency aid.
- When we move our first finger of our hand, the flex sensor of first finger finds the sensor value is varying than normal sensor value. It gives signal to the microcontroller and it gives signal to dc driver circuit .It gives 5V to all the motors and the voltage flow is given in forward direction for motor input pins m1,m2,m3 and m4 .It moves the wheel chair in forward direction and displays “forward” in LCD display.
- When we move our second finger of our hand, the flex sensor of second finger finds the sensor value is varying than normal sensor value. It gives signal to the microcontroller and it gives signal to dc driver circuit .It gives 5V to all the motors and the voltage flow is given in backward direction for motor input pins m1,m2,m3 and m4. It moves the wheel chair in backward direction and displays “Backward” in LCD display.
- When we move our third finger of our hand, the flex sensor of third finger finds the sensor value is varying than normal sensor value. It gives signal to the microcontroller and it gives signal to dc driver circuit .It gives 5V to the first motor and the voltage flow is given in forward direction for first motor pins m1 and m2. It moves the wheel chair in right direction and displays “Right” in LCD display.
- When we move our fourth finger of our hand, the flex sensor of fourth finger finds the sensor value is varying than normal sensor value. It gives signal to the microcontroller and it gives signal to dc driver circuit .It gives 5V to the second motors and the voltage flow is given in backward direction for second motor input pins m3 and m4. It moves the wheel chair in left direction and displays “Left” in LCD display.
- Health monitoring system consists of respiratory sensor and heart beat sensor. when the heartbeat is irregular or the breathing rate is irregular, the system detects and switch the buzzer to alert nearby people and send emergency alerts using GSM module to hospital and close family members.
- Emergency brake switch is provided for emergency stop. when we have to stop the system movement suddenly, then we have to switch the emergency brake switch.

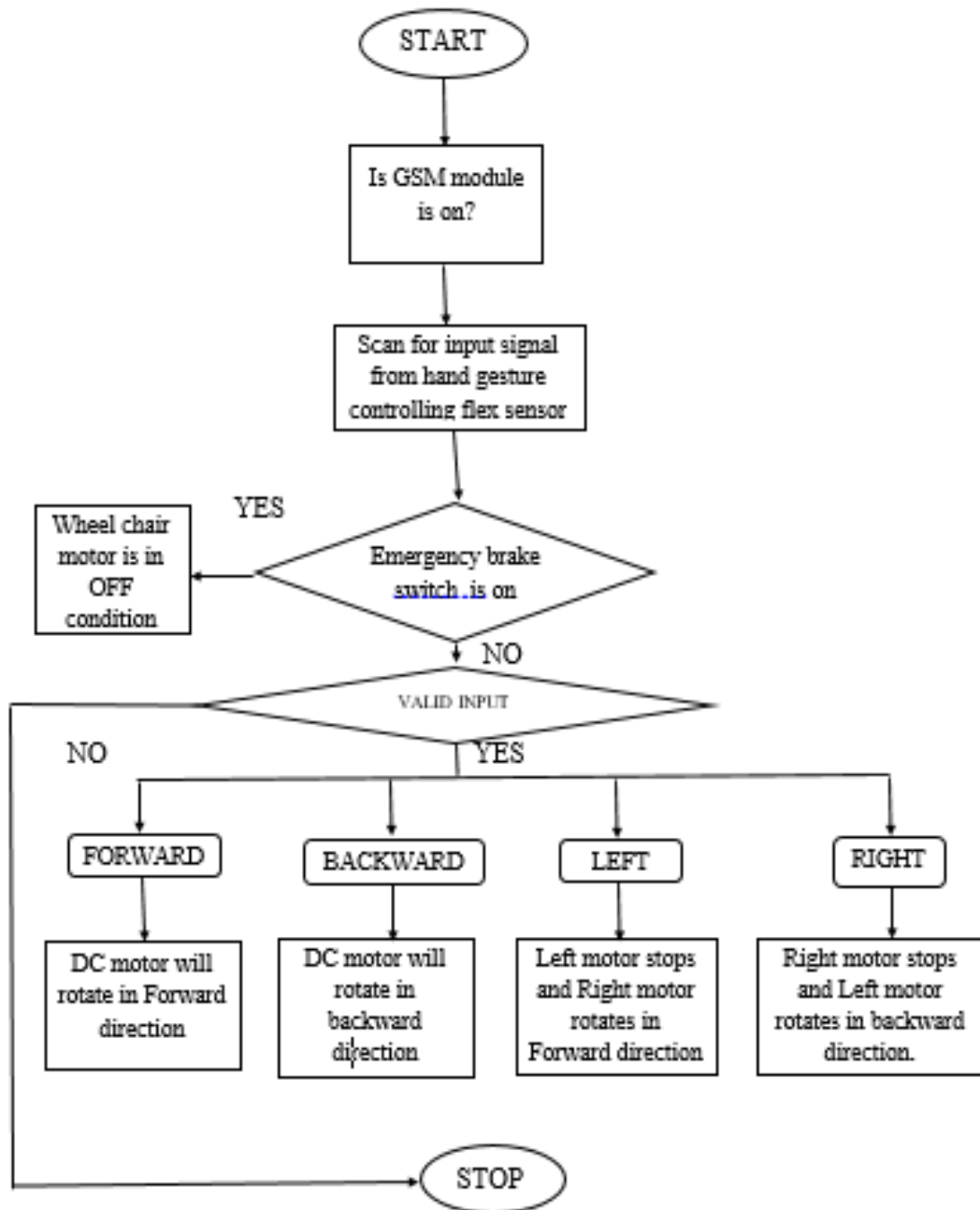


Figure 7.system flow chart

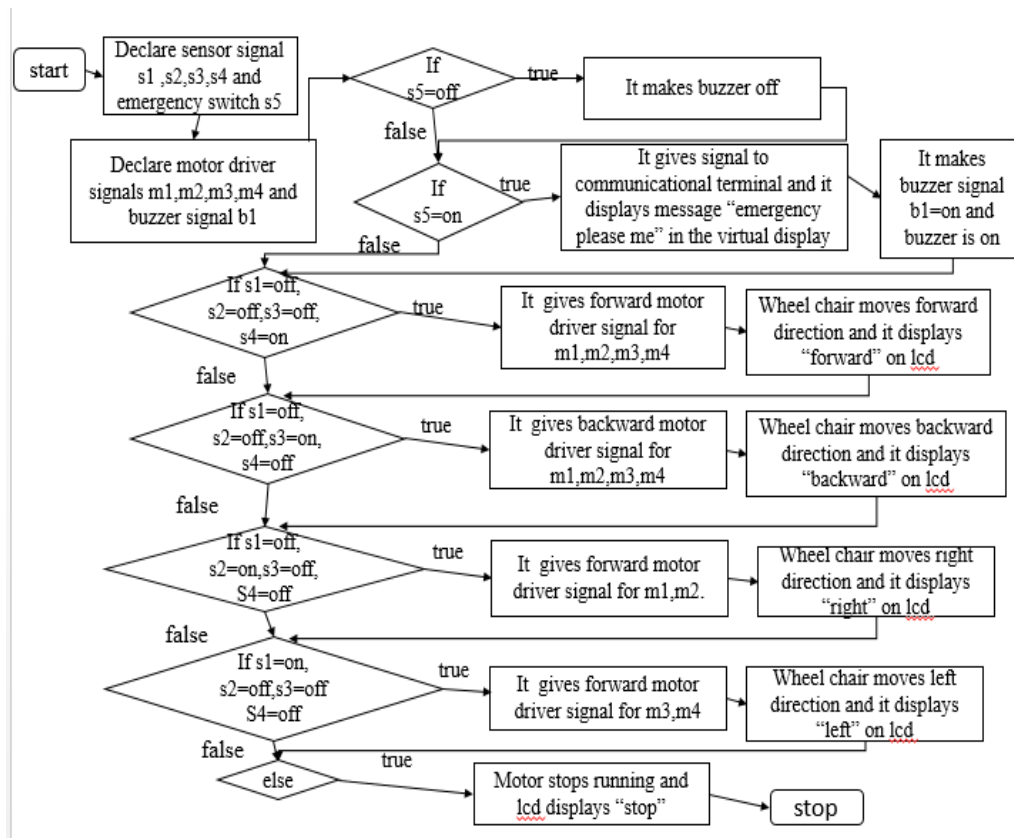


Figure 8. embedded c coding flow chart



Figure 10. 2.2 inch bend type flex sensor embedded gloves for hand gesture control.

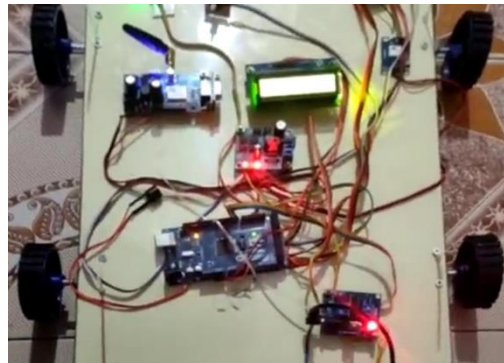


Figure 9. Hand gesture controlled wheelchair with health monitoring and emergency communication aid.

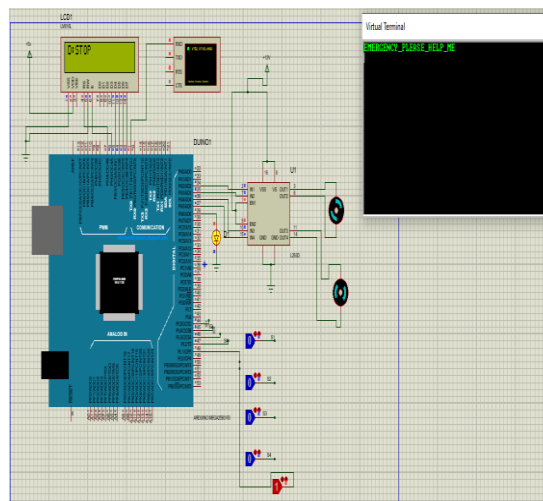


Figure 11. Software designing and testing of hand gesture controlled wheelchair.

4. Experimental Results:

The proposed prototype work is the designing of the wheelchair robotic system controlled by the hand gesture. The accuracy of the system is tested during 3 time periods-i)Hand gesture controlled wheelchair movement during normal conditions. ii) Hand gesture controlled wheelchair movement during health monitoring period. iii) Hand gesture controlled wheelchair movement during emergency communication aid period. The wheelchair system is tested upto 5 times of trails for proper movement of wheelchair during various conditions. The result shows

100% accuracy in the wheelchair movement during normal period, health monitoring period and the emergency communication aiding period.

Hand gesture controlled wheelchair movement during normal condition.	Experimental trails					Total response
	1	2	3	4	5	
Forward	1	1	1	1	1	5
Backward	1	1	1	1	1	5
Left	1	1	1	1	1	5
Right	1	1	1	1	1	5
Stop	1	1	1	1	1	5

Table 1.Hand gesture controlled wheelchair movement during normal conditions.

Hand gesture controlled wheelchair movement along with health monitoring system	Experimental trails					
	1	2	3	4	5	Total response
Forward	1	1	1	1	1	5
Backward	1	1	1	1	1	5
Left	1	1	1	1	1	5
Right	1	1	1	1	1	5
Stop	1	1	1	1	1	5

Table 2. Hand gesture controlled wheelchair movement during health monitoring period.

Hand gesture controlled wheelchair movement during emergency communication aid	Experimental trails					
	1	2	3	4	5	Total response
Forward	1	1	1	1	1	5
Backward	1	1	1	1	1	5
Left	1	1	1	1	1	5
Right	1	1	1	1	1	5
Stop	1	1	1	1	1	5

Table 3. Hand gesture controlled wheelchair movement during emergency communication aid period.

5.Conclusions:

This work explains about the designing, modeling and construction of the wheelchair with the help of the hand gesture sensing flex sensor. The circuit design works properly for the movement of wheelchair by using the hand gesture commands

In this project work, we also tested a simulated review of the whole systems, the key techniques, and the evaluation issues of Hand gesture-controlled mobile robots along with emergency alerting system in a simulated system.

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