

Low Cost Smart wheelchair to support paraplegic patients

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Abstract- The term "paraplegia" describes paralysis that affects the lower body. It could result from a persistent illness or an accident. Wheelchairs with intelligence play a significant role in helping the disabled. Patients with paraplegia have problems getting around since using a standard wheelchair can occasionally be challenging and require excessive manual effort. This study develops a traditional wheelchair that uses a smart glove to assist people with disabilities. The smart glove to regulate the wheelchair's movement uses two flex sensors. It has an LCD that shows the conditions of the patients who are also mute. The wheelchair is equipped with a control mechanism to guarantee that it always moves in a straight manner. When encountering any difficulties, the wheelchair track is adjusted using the control system. The chair was equipped with a Telemedicine System to monitor the patient's vital signs as an added function. The chair is kept at a safe distance using an ultrasonic added to avoid running into any objects.

Keywords- paraplegic, Flex Sensor, Ultrasonic Sensor, telemedicine, Motor driver MDD10A

I. INTRODUCTION

For paraplegic persons, conventional wheelchairs can occasionally be challenging and draining. They may effortlessly and independently move in any direction with the assistance of this intelligent wheelchair. Patients with paraplegia (who are unable to move their lower bodies) can use it. Although they can use their hands, it can occasionally be challenging and too much work. Therefore, a smart wheelchair is created to streamline this process in order to fix the problem. An excellent hand-glove is included with the wheelchair. This intelligent hand-glove is linked to flex sensors that allow the wheelchair's motors to be controlled by just bending a few selected fingers.

Mute paraplegic patients may use the wheelchair as well since it has an LCD that allows the user to gesture to indicate fundamental demands. The use of ultrasonic technology makes it possible for the wheelchair to automatically detect impediments and apply a short break if something unexpectedly blocks its path. a Telemedicine system is used to track the patient's health while a control system is used to adjust the chair's movement. The low-cost design is the main advantage.

The paper utilizes a hand-glove system and is equipped with an ultrasonic safety sensor to help prevent collisions with objects. A telemedicine system is added to monitor the patient's oxygen levels and heart rate.

The intelligent wheelchair is designed so that the patient can operate it with little effort, and it guards against collisions with objects if they speak incorrectly. A control system to correct the chair's movement and a telemedicine system to keep track of the patient's health are both included with the chair. The low-cost design is the main advantage.

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The following is the goal that will be attained by this work:

1. Providing affordable robotic wheelchairs to people with physical disabilities.
2. Chair track correction without patient involvement

An Internet of Things-based Flex Controlled Robotic Wheelchair for the Disabled [1]. Quadriplegia is a term used to describe a condition in which the torso and limbs are completely or partially paralyzed. An innovation that intends to

enhance the activities of people with mobility restrictions is the smart wheelchair. For those who are unable to maneuver a wheelchair with their hands alone, this research offers a solution. This study presents a novel Internet of Things-enabled smart wheelchair design (IoT). Three options are suggested so the patient can move about freely and transmit data to the cloud and those nearby. The development of an accelerometer-based hand glove enables wheelchair movement in the chosen plane. The sufferer can let those nearby know what they require by using hand signals and RF transmission. The third option provides cloud-based data that a doctor can use for diagnosis.

This endeavor produces a Snappy Wheelchair [2] that will benefit those with physical disabilities. It is controlled by two separate systems: a joystick control system and a flex sensor control system. With the Flex Sensor Control System, a disabled person who can only move two fingers of their entire body can also operate the Snappy Wheelchair. Anyone who can move his or her hand or a single leg can operate the joystick control device on the Snappy Wheelchair. By pressing the controlling switch to transition from one controlling system to another, a person can also have two controlling systems active at once.

This paper is structured as follows; the framework, including the proposed structure, experimental dataset, assessment criteria, outcomes, results and analysis, is discussed in section three. In sections four, the telemedicine strategy is presented; the motor driver is illustrated in section five. Finally, the conclusion is given in section six.

II. PROPOSED STRUCTURE

When designing the wheelchair, we kept the following in mind:

- Make wheelchairs user-friendly and versatile.
- Make the system inexpensive to use.
- High productivity with minimal upkeep.

Data glove is which collects data from resistors that gauge the user's finger flexion. A commercially available controller with five flex sensors on each finger served as the data glove. One of the most important strengths of this work is the use of only two fingers of the patient, which means the use of two flex sensors only.

The block diagram of the proposed structure is illustrated in figure 1

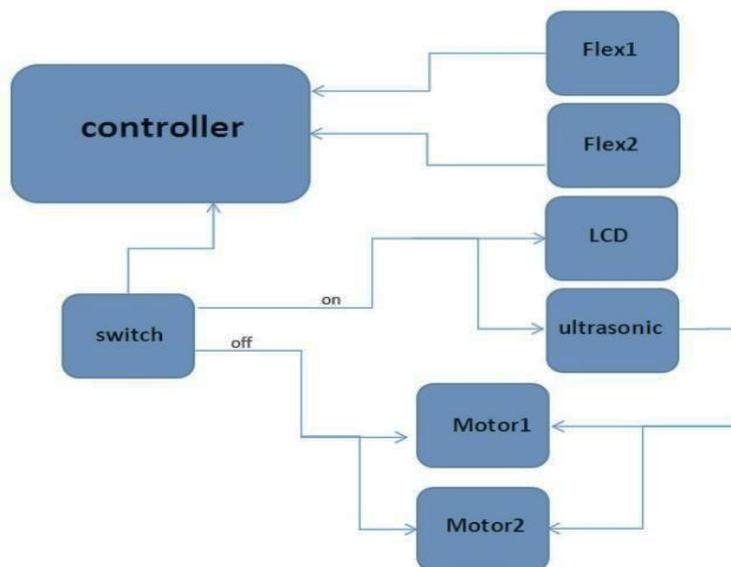


Figure 1: The Block diagram of the smart glove system

A Flex sensor is an electronic device that can be considered as a variable resistor upon bending. It can also be called a bend sensor as it has a bending nature.

The quantity of resistance is exactly proportional to the bending angle of the sensor. It is in a normal state if it is straight; if it is bent, the resistance will rise.

As shown in figure 3, it is a voltage divider circuit. The pull-up resistor is the flex resistance value (which is variable) and the pull-down resistor is the 47kΩ (which is constant).



Figure 2: flex sensor

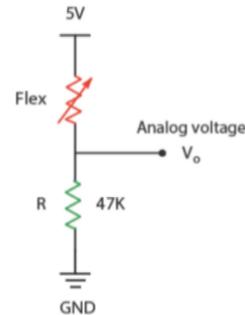


Figure 3: flex voltage divider

The output voltage is the multiplication of the Vcc value and constant resistance value divided by the summation of the constant resistance and the flex variable resistance. By putting flex resistance on one side of the equation, the variable flex resistance could be calculated.

As shown in figure 4, the value of the flex sensor increases as the flex is bent it. At an angle of 45°, the resistance value becomes 62.5kΩ. At an angle of 90°, the resistance value becomes 100kΩ.

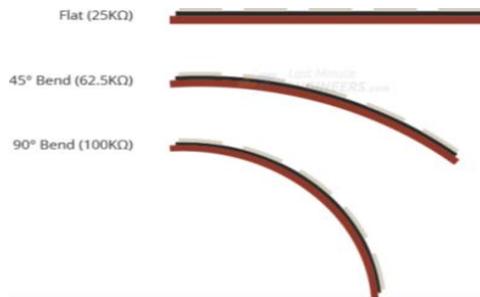


Figure 4: Flex sensor bending angles

A flex sensor is placed on the index finger of each hand, when the resistance is 100kΩ that means that the finger is bent. Using a switch, to section the circuit into two cases distinguishing between them by the switch status

The first case (closed switch):

- 1-If the user moved his right index finger the left motor will connect which will make the chair turn slowly and on a relatively long radius to the right.
- 2- If the user moved his left index finger the right motor will be connected which will make the chair turn to the left.
- 3-If the user moved both fingers at the same time both motors will be connected which will allow the chair to move forward.

The second case (open switch):

- 1-If the user moved his right index finger, LCD will show that he feels an emergency.
- 2-If he moved his left index finger, the LCD will show that he is hungry.
- 3-If he moved the two fingers together, the chair will move backward.

TABLE I. SWITCH ON AND SWITCH OFF MODES

Mode	$R1 > 100\text{ k}\Omega$ & $R2 < 100\text{ k}\Omega$	$R1 < 100\text{ k}\Omega$ & $R2 > 100\text{ k}\Omega$	$R1 > 100\text{ k}\Omega$ & $R2 > 100\text{ k}\Omega$
Switch on	Pain on LCD	Emergency on LCD	Move Backward
Switch off	Move to the right	Move to the left	Move forward

Flex sensor shown in figure 5 has 2 pins, one is connected with 5v and the other is connected to an analog Arduino pin and a pull-down resistor is connected and then grounded. Flex sensors are resistors so it doesn't matter which pin you connect whatever with. Two flex sensors are connected, one with Arduino pin A2 and the other with Arduino pin A3. This circuit depicts a voltage divider.

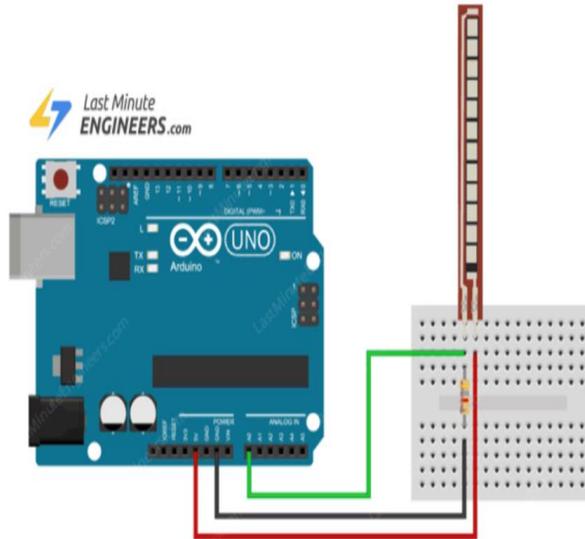


Figure 5: Flex sensor connection with Arduino

The flex sensor is an analog signal. On Proteus, it deals with flex sensor as a digital signal, so the simulation did not work until the code was changed to check if the simulation worked. After that, implementation with hardware was done with the first code (practical case).

Motors can't be connected like how they are connected on Proteus simulation. In real life, Arduino can deliver only a few tens of milli-amperes, but a motor needs higher current to run. In addition, motor produces back emf.

The solution to this problem is use L293D IC as it has an H-Bridge and can run 2 DC motors and control their direction of rotation. It handles back emf too.

Vee needed to be connected with a variable resistor (potentiometer) to adjust the contrast of LCD

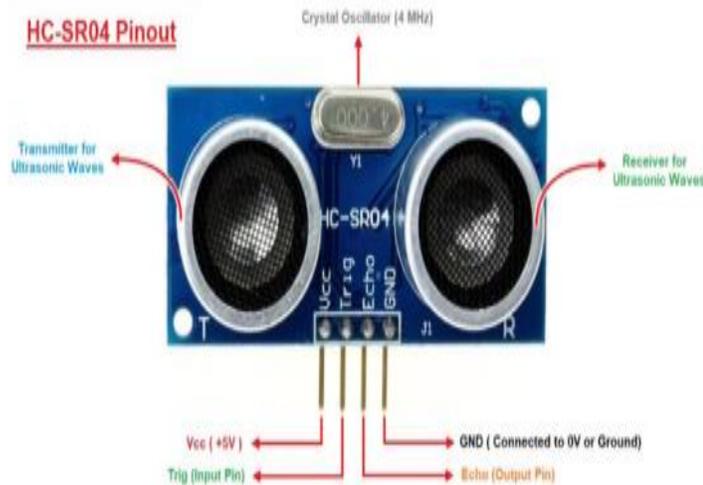


Figure 6: Ultrasonic Sensor [3].

There are four pins on the sensor. VCC and GND are connected to the Arduino's 5V and GND pins, respectively, while Trig and Echo are connected to any digital Arduino pin. We send the ultrasonic wave from the transmitter using the Trig pin, and we listen for the reflected signal using the Echo pin.

Ultrasonic Transmitter in figure 6 sends out ultrasonic sound pulses at a frequency of 40 kHz.

Ultrasonic Receiver – The receiver listens to the pulses that are transmitted. If it receives them, it generates an output pulse whose width is used to calculate the pulse's travel distance.

It emits a 40 000 Hz ultrasonic that travels through the air and bounces back to the module if it comes into contact with an object or impediment. You may compute the distance by taking into account the travel time and the sound's speed.

III. TELEMEDICINE

A healthcare system was implemented on the wheelchair to help monitor the vitals of the patient. This system will help the doctor or the family to check the health of the patient and alarm them if there is anything abnormal.

The oxygen rate and pulse rate are considered to be the most crucial measurements, according to the study. The MAX30102 oximeter in figure 7 was selected to measure the oxygen and pulse rates.

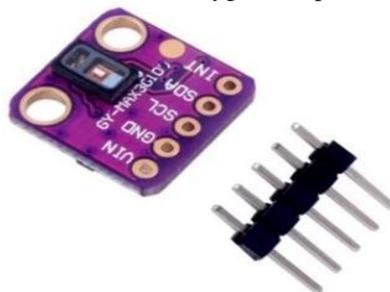


Figure 7: MAX30102 pulse oximeter sensor [4]

A9G GSM and GPS module in figure 8 were used to send messages to the doctor if there is anything abnormal in the sensor's readings and it also can send the location of the patient as the module is provided with a GPS antenna. If the doctor wants to check the reading, he can send a message to the module and the module will reply with the current reading. As illustrated in figure 9. The patient can be located to send the ambulance and provide the required support as illustrated in figure 10.



Figure 8: A9G GSM and GPS module [5]



Figure 9: Messages sent by the doctor and the replies sent by the module with heart rate and the location

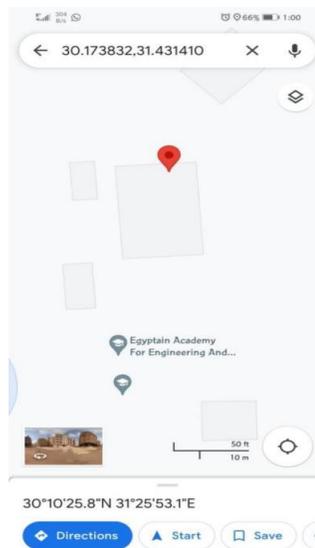


Figure 10: Searching the location sent by the module to the doctor

Also, when the heart rate is abnormal the module sends an emergency message to the number written in the code as illustrated in figure 11.

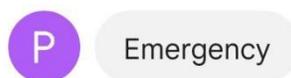


Figure 11: The message sent by the module when the heart rate was abnormal

IV. MOTOR DRIVER

A Cytron Dual Channel DC is used as a motor driver to interface between the motors and control circuits. The motor driver converts a low-current signal to a higher-current signal to drive a motor [6].

The motor driver illustrated in figure 12 is a dual channel version of MD10C. It drives 2 brushed DC motors with high currents up to 10A each, continually. It has a locked antiphase and sign-magnitude PWM control. The system uses all solid-state components, which results in fast response times and eliminated wear of relays.

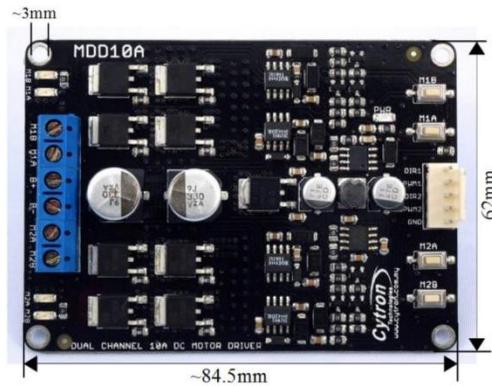


Figure 12: Dual channel 10A dc motor driver

Two batteries illustrated in figure 13 were used, each battery has a 12-voltage supply. These batteries are connected in series so their total is 24 volts. We need 24 volts so the two motors can move successfully. The maximum DC is 2 amperes and its volt is 24v.



Figure 13: The used DC motor

The motor driver can take voltage from 7v up to 30 v. The motor driver consists of 2 channels; channel 1 and channel 2. Each channel has A and B. A is connected to the positive terminal of the motor and B is connected to the negative terminal of the motor[7].

TABLE I. CONNECTION OF MOTOR AND POWER SUPPLY WITH A MOTOR DRIVER

Pin No	Pin Name	Description
1	Motor 1 Output B	Connect to motor 1 terminal B
2	Motor 1 Output A	Connect to motor 1 terminal A
3	Power +	Positive Supply
4	Power -	Negative Supply
5	Motor 2 Output A	Connect to motor 2 terminal A
6	Motor 2 Output B	Connect to motor 2 terminal B

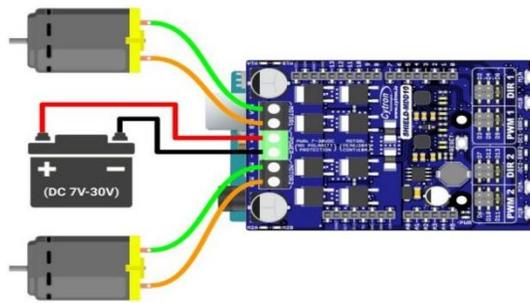


Figure 14 Connection between Arduino and motor driver

TABLE II. THE CONNECTION BETWEEN ARDUINO AND THE MOTOR DRIVER

Pin No	Pin Name	Description
1	Ground	Ground of Arduino
2	Pulse width modulation 2	Pin 7
3	Direction 2	Pin 19
4	Pulse width modulation 1	Pin 6
5	Direction 2	Pin 18

The wheelchair movements:

In the forward case, the first motor's direction is LOW and its PWM is HIGH. The second motor's direction is LOW and its PWM is HIGH.

In the backward case, the first motor's direction is HIGH and its PWM is HIGH. The second motor's direction is HIGH and its PWM is HIGH.

In the right case, the first motor's direction is LOW and its PWM is HIGH. The second motor's PWM is LOW.

In the left case, the first motor's PWM is LOW. The second motor's direction is LOW and its PWM is HIGH.

In the stop case, the PWM of the first motor is LOW and the PWM of the second motor is LOW also.



Figure 15 Smart Wheelchair.

By comparing the proposed model with the existing works, we find that the proposed model is equipped with a control circuit that corrects the path of the chair without patient intervention, as shown in figure 16 [8].

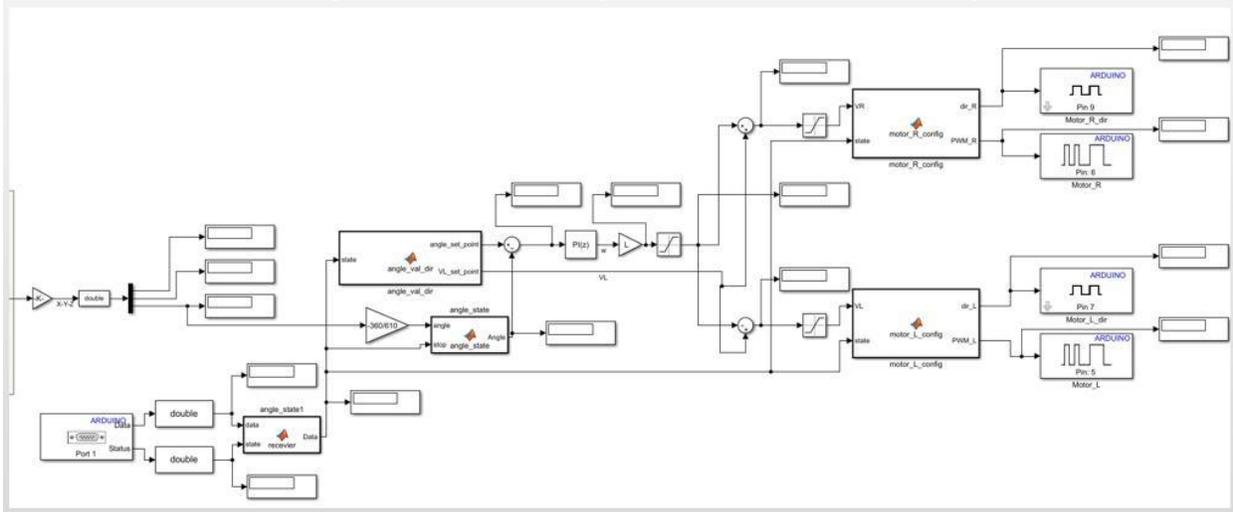


Figure 16 control circuit.

According to Amazon, electric wheelchairs range in price from 18,000 to over 24,000 Egyptian pounds [6]. The price of our created system is only 16,000 Egyptian pounds. Therefore, it is inexpensive cost [9].

V. CONCLUSION

A hand glove device with flex sensors controls the suggested wheelchair. By just moving their finger across the LCD, users may see their fundamental necessities. The patient is given the security he need by the addition of an ultrasonic sensor. The oxygen and pulse rates are also measured using a telemedicine system. When a sensor's readings are abnormal, a GSM and GPS module is attached to send messages to the doctor. The module also has a GPS antenna, so it may send the patient's location. The patient can move more easily thanks to the addition of all these characteristics. Because the flex sensor is more durable than other methods that provide the same goals, the wheelchair is less expensive, safer, and projected to last longer.

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