Design and Development of Human Assisted wheelchair using Internet of things

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Abstract:

Around the world, millions of people are suffering either from a short-term or a long-term disabilities due to congenital disorder, age-related or by an injury. In many of the cases mentioned above, walking is difficult or impossible for such cases wheelchairs are the only alternative way for mobility. Manual wheelchairs are used when the patients disability does not affect the physical movement of the wheelchair. However, in severe cases such as paralysis or accidental cases, it would be impossible to use wheelchair on their own. In such cases, wheelchair users have to rely on someone else to control the wheelchair. Many multi-national companies around the globe are investing in research and designing of smart wheelchairs. In this paper we have integrated our smart wheelchair in such a way that the user can control it by using 4 different ways. Our paper evaluates currently available technologies and we have also discussed the future scope of the project.

IndexTerms: IOT enabled Smart wheelchair, Temperature and humidity sensor, Arduino, Physically Disabled, Buzzer, Light dependent resistor, Ultrasonic Sensor.

Introduction:

The NSO, a branch of the Ministry of Statistics and Programme Implementation, has conducted a Survey to find the number of disability, It was revealed that the total percentage of people with disability in the population was 2.2 percent which is nearly 2.68 CR people and it keeps on increasing daily [1]. Around twenty million people depend on wheelchairs for their daily tasks. There are many people with severe disability who cannot use manual wheelchair such as Quadriplegia, elderly problems, spinal cord injuries, blindness or mental disability. Patients using manual wheelchair and has severe disability has to rely on someone to push the wheelchair [4]-[7]. So in order to reduce the dependency we use "smart wheelchairs". A smart wheelchair is a modified manual wheelchair that is equipped with a variety of sensors to make the physical movement as low as possible. Its main purpose is to reduce the physical intervention of user for moving the wheelchair.

Day by Day the technology keeps getting better and the prices of the smart components are becoming cheaper and accessible to everyone, so we have decided to make an IoT-based smart wheelchair as cheaper as possible. With the input from different people, we tried to include different ways to control the wheelchair. One of those ways is by using an android app either voice-controlled or by sending an instruction to the Bluetooth module present in the wheelchair and there is a joystick which can be used to operate left, right, forward, backward, and stop movements [19]. To make controlling even easier, we decided to include a gesture-controlled input with the help of an accelerometer so just by the movement or positioning of the hand, the wheelchair can be moved in any direction. Now with the Hand Gesture, and voice control within Wheelchair, the disabled person can move independently without any external help [9].

Components required:

1) Arduino Uno:

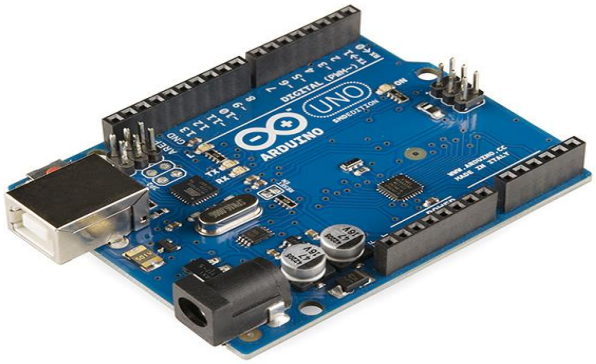

fig 1 Arduino Uno

In this project, we have used Arduino Uno which has on board

- power supply
- 16MHZ crystal oscillator
- An Atmel microcontroller chip.
- USB port to communicate with PC.

It also has six analog pins and fourteen digital input and output pins, energy jack for vigor connection. Arduino is open-source hardware that means, anyone can get the details of its design and they can modify it to make their own one themself.

The Arduino IDE is a platform which is used to write and integrate the code with Arduino. The platform is very easy to use and arduino has its own library files which are used to integrate the Arduino with different sensors, actuators….etc. We mostly use embedded c and c++ to code in this platform [22].

2) Motor driver:

fig 2 L293D IC

L293D is a 16-Pin Motor driver chip. It is mainly used to operate motors in different directions with a l293d we can run 2 motors at a time. By using l293d we can drive motors of up to 36v. It can easily be controlled by Microcontrollers like Arm, PIC, and Arduino.

L293d works on the principle of H-Bridge circuit which is capable of running motors both in the clockwise and anti-clockwise direction.

3) Ultrasonic Sensor:

. fig 3 Ultrasonic sensor .

Ultrasonic is a sensor that calculates the distance between the object and sensor. This is done by calculating the time by ultrasonic waves to reach the object. The ultrasonic waves travels at 330 m/s and they travel at frequency too high that we cannot hear. It consists of two main components:

- The transmitter
- 2) The receiver

HC-SR04 is the physical name of the ultrasonic sensor. The operating voltage of the ultrasonic sensor is +5V and theoretical it can measure the distance of about 2cm to 450cm [14]. Distance between the object and the sensor will be measured by using formula

Distance = 1/2 *Speed*Time (1)

Here the speed of sound is 344 m/s.

4) Bluetooth:

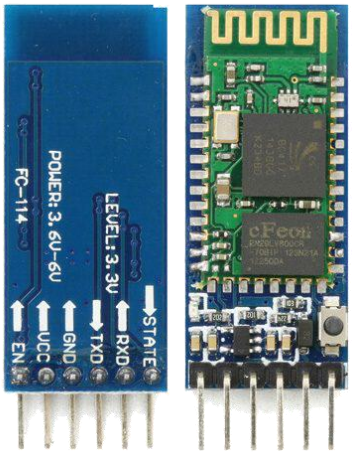

fig 4 hc-05 Module

The hc-05 is a Bluetooth module that helps the microcontrollers to communicate wirelessly. This module is used as a means of communication between microcontrollers like PIC, Arduino... etc. Any device that has Bluetooth modules such as mobile phones, computers can send or receive data. There are many android applications that make this process a lot easier. The module can be interfaced with any microcontroller that supports usart protocol [8]. It works in 2 different modes,

- Command mode: It is used for changing the default settings such as baud rate, changing name ….etc.
- Data mode: Data mode is used to send and receive data

5) Accelerometer:

fig 5 Accelerometer

It is a small, thin in size, extremely low power consumption, 3-axis accelerometer with good accuracy. It is used to direct the Arduino which guides the motor driver and motors and makes motion possible.

Accelerometer module (ADXL345) consists of 8 pins. Interfacing the ADXL345 module with a microcontroller is very simple task. Connect the Vcc (voltage) and Gnd (ground) pin to the 5V and GND pin of the Arduino uno. Connect the Scl and Sda pins of device to the Scl and Sda pins of Arduino Uno.

6) Joystick module:

fig 6 Joystick

We have used a Joystick Module with Arduino to control the movement of the motor. Integration of the joystick module is very easy just connect the axis Pins VRx and VRy to the ADC Pins of the Arduino uno. If in case a switch is needed then connect it to the digital Pin of the Arduino uno.

Methodology:

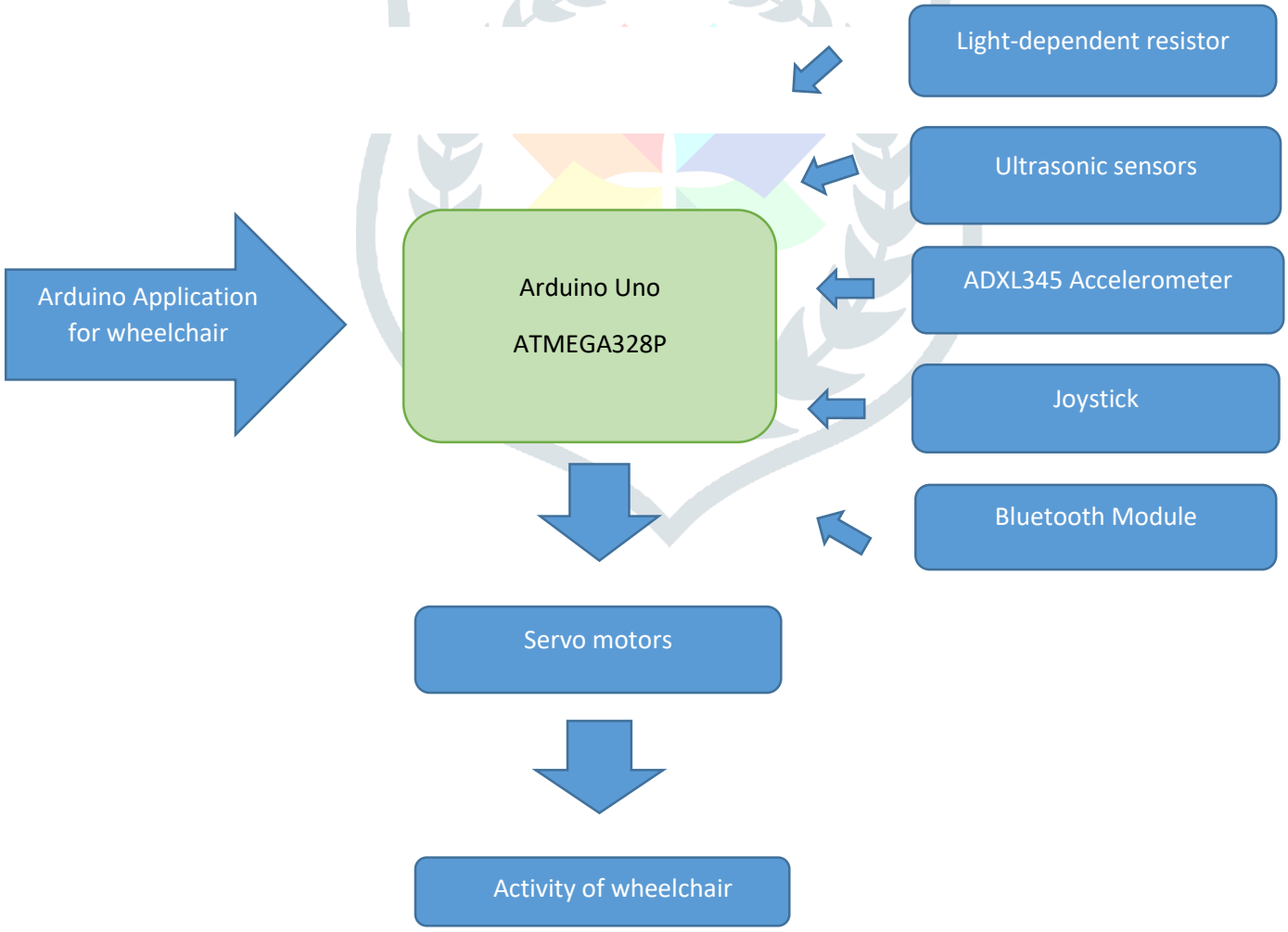

fig 7 Block diagram of smart wheelchair system

The above Figure(Fig 7) describes how the circuit is going to work. Arduino takes input from multiple ultrasonic sensors which are on the forward and backward side of the wheelchair and checks if there is any obstacle. If there is an obstacle, then the wheelchair would stop immediately, and to get the patient alerted, the buzzer would be on and wouldn't be offed until the obstacle is avoided [12].

In the circuit we have connected an LDR, it detects the absence of light in the room and turns on the bulb. When light is falling upon the resistor its value will be more than 700, but when there is no light then its value will be less than 700. So by using these values we can turn the bulb ON & Off.

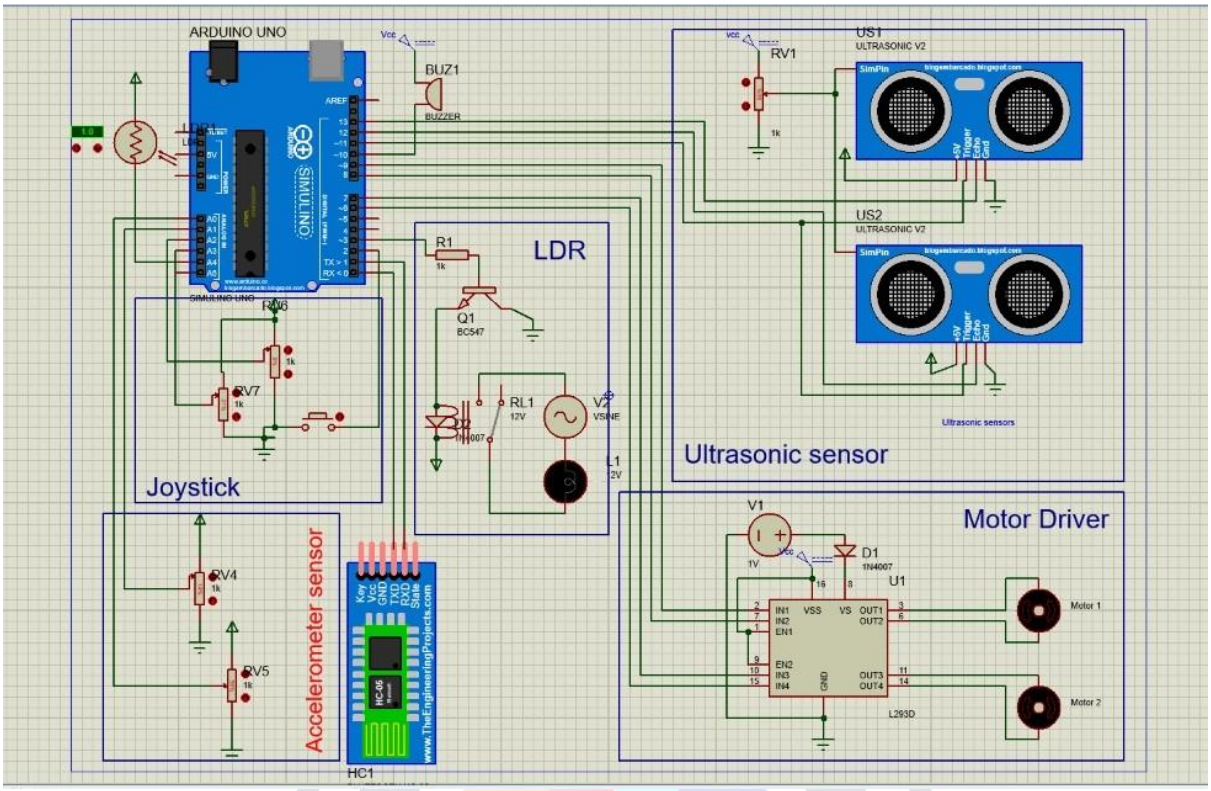

fig 8 Circuit diagram of smart wheelchair system

Figure 8 displays the complete circuit diagram of wheelchair which we have made in the proteus designing software.

The movement of the wheelchair depends on the inputs of these components

- Accelerometer: When we tilt the accelerometer it measures the static acceleration of gravity in 3 axis such as x, y, and z. so when we tilt the accelerometer to a particular side the output values of the x, y, and z-axis changes accordingly. The readings of x, y, and z are different when the accelerometer is tilted to left, right, forward, and backward. So we note down those unique values and store them in a variable [19].

  So when the real-time values are equal to these stored values we would know which side the accelerometer is tilted to and we can move the motors accordingly.

- Joystick: Joystick modules are just like an accelerometer but instead of 3 axis measurements like an accelerometer, joysticks measure only 2 axis x and y. Similar to the accelerometer, Each direction output range is fixed. We need to store the values in variables, and when the real-time values equal those values we would know in which direction the joystick has been moved [10].

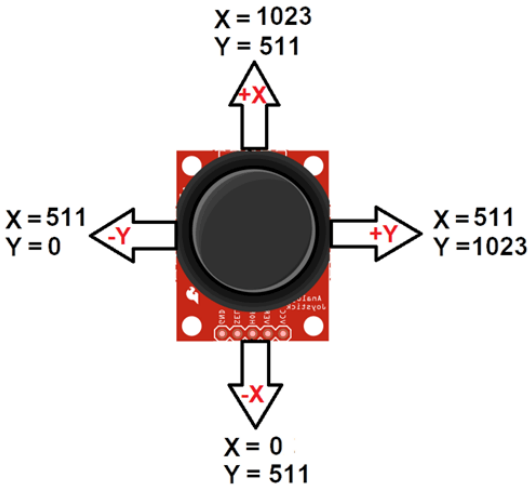

fig 9 Joystick working

Figure 9 mentions the default values when the joystick is tilted in a certain position.

- Bluetooth: Bluetooth can control a wheelchair by 2 different inputs by the user
  1) voice commands
  2) Text messages

  Both of these require an android application to send voice or command. When we send the command the Bluetooth forwards it to the Arduino and we will save the command in a variable. For example
  If the received command is "FORWARD", both the motors will move forward, else if it is "LEFT" then we will stop the left motor and start the right motor…. Similarly, instead of voice, we can send a message like "FORWARD" through the mobile phone, and the wheelchair moves similar to the message received [8].

All these inputs are sent from these sensors to the Arduino uno serially and based upon the input, the motors are moved accordingly.

Conclusion:

This project aims at expanding the development of the IOT based smart wheelchair. In this we have integrated the wheelchair with lots of sensors, which are capable of controlling the wheelchair by using different means of inputs such as gesture control, Voice control, and Joystick. We can even make more implementation such as brain signal readers or eye gestures in this project so that it can be even used by the paralyzed people [3].

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