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Voice Controlled Wheelchair

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Abstract: *This project is designed to control a robotic wheelchair by voice commands for remote operation. An ARM series microcontroller is used together with an Android Application for the desired operation. The Android Application is connected to the Bluetooth module (HC-05) present on the Robot via Bluetooth. The commands are sent to the robot using push buttons or voice commands present on the android application. At the receiving end two dc servo motors are interfaced to the microcontroller where they are used for the movement of the wheelchair. The RF transmitter of the Bluetooth can take either switch press or voice commands which are converted to encoded digital data for the advantage of adequate range (up to 100 meters) from the robot. The receiver decodes the data before feeding it to another microcontroller to drive DC motors via motor driver IC for necessary work. This technology has an advantage over long communication range as compared to RF technology. Further the project can be developed using IoT technology where a user can control the robot from any corner of the world.*

Keywords: Assistive technology, Voice-controlled wheelchair, Speech recognition, Mobility, Independence, User testing

I. INTRODUCTION

This project banks on two major concepts namely robotics and voice recognition technology. Robotics as a discipline has seen unparalleled development since the early 1960s. It finds application in industries, manufacturing, bio engineering, space exploration and recreational activities like drones. Whereas speech recognition technology has also seen rapid development in the recent time. Models which might require 'training' to better adapt to the voice of the user resulting in increased accuracy. While those which do not require training are called speaker independent system. The voice commands can be a fixed set of commands (as in this project) while more advanced ones come with natural speech recognition which can process complete sentences or phrases in multiple languages and accent of the speaker.
Like any other robotic application this project also has three major dimensions –
(a) Mechanical Construction
(b) Electrical Circuitry
(c) Computer Programme.
The mechanical construction of the project involves the frame of the wheelchair and two DC motors which drive the wheelchair. The electronic circuitry comprises of the Bluetooth module which facilitates the communication, Arduino Uno which interfaces with the motor driver also a part of the circuitry. The third is the computer programme written in IDE (Arduino) which acts the driver code for the wheelchair. The driver code is installed on the arduino which process the command received, interacts accordingly with the motor driver which makes the wheelchair move.

1.1 Problem Definition

To Design and develop a prototype model of showing the concept of automatic wheelchair with ignition switch which will show the working of application of automation. Also to fabricate the model of the same which would able to show the characteristics of systems and working according to need.

1.2 Motivation

Today in biomedical sector, a wheelchair is an important device for physically handicapped and aged person. We are trying to construct a voice controlled wheelchair which will recognize and follows natural language voice instruction and will move respectively.

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1.3 Objectives

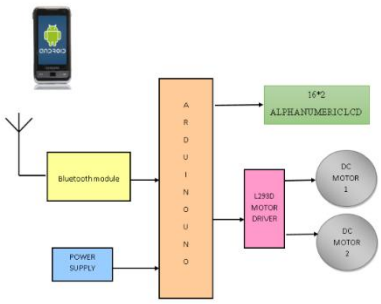
- In order to fulfil the needs of present automatic wheelchair with ignition switch, some improvement must be made base on the problems statement:
- To design and develop automatic wheelchair with ignition switch.
- To minimize human effort.
- To save time
- Easy to operate.

II. LITERATURE REVIEW

Previously a many projects have ventured into the realm of wheelchair which communicates with its operator using voice in one way or the other. These projects function around the basic tenet of voice recognition or speech to text, the difference arises in the implementation driving code, sensor or mechanical part used. Some also include additional features like obstacle detection, conformation on receiving command, automatic breaking and speed limiting system. The purpose is to make innovation in the field of wheelchair automation so that it caters to multi-dimensional requirements from critical applications space exploration and military use to humanitarian innovation to help those with disabilities to drive themselves. Some the projects might require 'training' to better adapt to the voice of the user resulting in increased accuracy. While those which do not require training are called speaker independent system. The voice commands can be a fixed set of commands (as in this project) while more advanced ones come with natural speech recognition which can process complete sentences or phrases in multiple languages and accent of the speaker.
The following project might be considered for further reading:
[1] A.N Khan, K. Priya, S. Kumar-"Implementation of Voice Controlled Robotic vehicle with Automatic Braking and Obstacle Avoidance". In INROADS Vol. 7 (Special Issue), 2018
[2] Prof. B. Jolad, M. Arora, R. Ganu, C. Bhatia -"Voice Controlled Robotic vehicle". In IRJET Volume: 04 Issue: 06, June-2017
[3] Dr. M. Narayana, A. Alishety, H. Chapala -"Voice Controlled Robot using Android Application". In International Journal of Engineering Innovation and Research Volume: 04 Issue: 02

III. METHODOLOGY

3.1 Block Diagram



Block diagram of Electrical Architecture of the Voice Controlled Wheelchair

The above diagram shows the electrical arrangement of the components required in the making of Voice Controlled Wheelchair.

3.2 Working

The system has two parts, namely; hardware and software. The hardware architecture consists of an embedded system that is based on Arduino Uno board, a Bluetooth Module, Motor Driver and an Android phone. The Bluetooth Module provides the communication media between the user through the android phone and the system by means of voice command given to the android phone. The user speaks the desired command to the "BT Voice Control for Arduino voice (AMR Voice Application)" software application installed in the android phone that is connected through

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Bluetooth with Bluetooth Module HC-05. The voice command is converted to an array of string and the string is passed to Arduino Uno connected to it. Once the Bluetooth Module receives the message, the command sent will be extracted and executed by the microcontroller attached to it and depending on the commands fed to the Motor Driver, the motors will function accordingly. The system will interpret the commands and control the wheelchair accordingly via android application.

III. METHODOLOGY

The different directions of motions possible are: forward, backward, left, right and stop. In achieving the task, the controller is loaded with program using the Arduino programming language and arduino development environment.

First make sure Bluetooth module is paired with the android mobile. The default password for pairing is "1234" or "0000".

When the user says "GO", AMR Voice application sends the data in form of string "*GO#" to Bluetooth module connected to the circuit. When microcontroller detects "GO", the motor attached to the wheelchair moves FORWORD.

When the user says "BACK" AMR Voice application sends the data in form of string "*BACK#" to Bluetooth module connected to the circuit.

When microcontroller detects "BACK", the motor attached to the wheelchair moves REVERSE.

When the user says "LEFT" AMR Voice application sends the data in form of string in form of string "*LEFT#" to Bluetooth module connected to the circuit. When microcontroller detects "LEFT" the moves the motor attached to the wheelchair LEFT side.

When the user says "RIGHT" AMR Voice application sends the data in form of string "*RIGHT#" to Bluetooth module connected to the circuit. When microcontroller detects "RIGHT" the moves the motor attached to the wheelchair RIGHT side.

When the user says "STOP" button which is in the Centre of remote the AMR Voice application sends the data in form of string "*STOP#" to the Bluetooth module connected to the circuit. When microcontroller detects "STOP" the wheelchair gets stopped.

Click on "DISCONNECT" icon to disconnect the paired Bluetooth module.

Software Specifications

ARDUINO SOFTWARE IS USED

How to start with Arduino software:

Get an Arduino board and USB cable

In this tutorial, we assume you're using an Arduino or Genuino Uno or an Arduino or GenuingMega2560.If you are using a retired board as Arduino Duemilanove, Nano or Diecimila please refer to the driver installation instructions end of this document. If you have another board, read the corresponding page linked in the main getting started page.

Connect the board

The USB connection with the PC is necessary to program the board and not just to power it up. The Uno and Mega automatically draw power from either the USB or an external power supply. Connect the board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

Install the board drivers

If you used the Installer, Windows - from XP up to 10 - will install drivers automatically as soon as you connect your board.

If you downloaded and expanded the Zip package or, for some reason, the board wasn't properly recognized, please follow the procedure below.

Click on the Start Menu, and open up the Control Panel.

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While in the Control Panel, navigate to System and Security. Next, click on System. Once the System window is up, open the Device Manager.

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Look under Ports (COM & LPT). You should see an open port named "Arduino UNO (COMxx)". If there is no COM & LPT section, look under "Other Devices" for "Unknown Device".
Right click on the "Arduino UNO (COmxx)" port and choose the "Update Driver Software" option.
Next, choose the "Browse my computer for Driver software" option.
Finally, navigate to and select the driver file named "arduino.inf", located in the "Drivers" folder of the Arduino Software download (not the "FTDI USB Drivers" sub-directory). If you are using an old version of the IDE (1.0.3 or older), choose the Uno driver file named "Arduino UNO.inf"
Windows will finish up the driver installation from there.

Launch the Arduino Software (IDE)
Double-click the Arduino icon (arduino.exe) created by the installation process. (Note: if the Arduino Software loads in the wrong language, you can change it in the preferences dialog
Open the blink example
Open the LED blink example sketch: File > Examples >01.Basics > Blink.
Click on the Start Menu, and open up the Control Panel.
While in the Control Panel, navigate to System and Security. Next, click on System. Once the System window is up, open the Device Manager.
Look under Ports (COM & LPT). You should see an open port named "Arduino UNO (COMxx)". If there is no COM & LPT section, look under "Other Devices" for "Unknown Device".
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Open the blink example
Open the LED blink example sketch: File > Examples >01.Basics > Blink.
Select your board
You'll need to select the entry in the Tools > Board menu that corresponds to your Arduino or Genuino board
Select your serial port
Select the serial device of the board from the Tools | Serial Port menu. This is likely to be COM3 or higher (COM1 andCOM2 are usually reserved for hardware serial ports). To find out, you can disconnect your board and re-open the menu; the entry that disappears should be the Arduino or Genuino board. Reconnect the board and select that serial port.

Upload the program
Now, simply click the "Upload" button in the environment. Wait a few seconds - you should see the RX and TX leds on the board flashing. If the upload is successful, the message "Done uploading." will appear in the status bar.
A few seconds after the upload finishes, you should see the pin 13 (L) LED on the board start to blink (in orange). If it does, congratulations! You've gotten Arduino or Genuino up-and-running.

Download and install the Arduino Software (IDE)
Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually.

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When the download finishes, proceed with the installation and please allow the driver installation process.
Choose the components to install
Choose the installation directory (we suggest to keep the default one)
The process will extract and install all the required files to execute properly the Arduino Software (IDE)

Connect the board
The USB connection with the PC is necessary to program the board and not just to power it up. The Uno and Mega automatically draw power from either the USB or an external power supply. Connect the board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

Install the board drivers
If you used the Installer, Windows - from XP up to 10 - will install drivers automatically as soon as you connect your board.
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Windows will finish up the driver installation from there.

IV. CALCULATION

Motor selection for wheels
Given,
Diameter for wheels=60mm
TORQUE REQUIRED TO RUN=
Torque = mass * radius of wheel
=2*9.81*30
=0.2943 Nm
=2.94 kgcm
Then we have to find motor of 5.88 Nm torque and rpm 30
We are using two motors for wheels .so that total torque is divided by these two motors.\
So torque required for 1 motor is 2.94kgcm
Therefore, we are selecting motor with 3 kgcm torque.
Power output of DC motor is =voltage *current
Power output of DC motor is =12*0.3
Power output of DC motor is =3.6 watt
Power=2*pi*N*0.2943/60
3.6=2*pi*N*0.2943/60
N=117 rpm

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This is the maximum rpm value.
We are selecting motor with 30rpm

Code for Circuit

```
// Include Libraries
#include "Arduino.h"
#include "BTHC05.h"
#include "DCMDriverL293D.h"
#include "LiquidCrystal.h"
// Pin Definitions
#define BTHC05_PIN_TXD          11
#define BTHC05_PIN_RXD          10
#define DCMOTORDRIVERA_PIN_ENABLE1      5
#define DCMOTORDRIVERA_PIN_IN1    2
#define DCMOTORDRIVERA_PIN_IN2    3
#define DCMOTORDRIVERA_PIN_ENABLE2      6
#define DCMOTORDRIVERA_PIN_IN3    4
#define DCMOTORDRIVERA_PIN_IN4    7
#define LCD_PIN_RS      A4
#define LCD_PIN_E       A3
#define LCD_PIN_DB4     8
#define LCD_PIN_DB5     9
#define LCD_PIN_DB6     12
#define LCD_PIN_DB7     13
// Global variables and defines
// object initialization
BTHC05 bthc05(BTHC05_PIN_RXD,BTHC05_PIN_TXD);
DCMDriverL293D
dcMotorDriverA(DCMOTORDRIVERA_PIN_ENABLE1,DCMOTORDRIVERA_PIN_IN1,DCMOTORDRIVERA_
PIN_IN2,DCMOTORDRIVERA_PIN_ENABLE2,DCMOTORDRIVERA_PIN_IN3,DCMOTORDRIVERA_PIN_IN
4);
LiquidCrystal lcd(LCD_PIN_RS,LCD_PIN_E,LCD_PIN_DB4,LCD_PIN_DB5,LCD_PIN_DB6,LCD_PIN_DB7);
// define vars for testing menu
const int timeout = 10000;       //define timeout of 10 sec
char menuOption = 0;
long time0;

// Setup the essentials for your circuit to work. It runs first every time your circuit is powered with electricity.
void setup()
{
  // Setup Serial which is useful for debugging
  // Use the Serial Monitor to view printed messages
  Serial.begin(9600);
  while (!Serial) ; // wait for serial port to connect. Needed for native USB
  Serial.println("start");

  bthc05.begin(9600);
  //This example uses HC-05 Bluetooth to communicate with an Android device.
```

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```
//Download bluetooth terminal from google play store, https://play.google.com/store/apps/details?id=Qwerty.BluetoothTerminal&hl=en
//Pair and connect to 'HC-05', the default password for connection is '1234'.
//You should see this message from your arduino on your android device
bthc05.println("Bluetooth On....");
// set up the LCD's number of columns and rows
lcd.begin(16, 2);
menuOption = menu();
}
// Main logic of your circuit. It defines the interaction between the components you selected. After setup, it runs over and over again, in an eternal loop.
void loop()
{

if(menuOption == '1') {
// HC - 05 Bluetooth Serial Module - Test Code
String bthc05Str = "";
//Receive String from bluetooth device
if (bthc05.available())
{
//Read a complete line from bluetooth terminal
bthc05Str = bthc05.readStringUntil('\n');
// Print raw data to serial monitor
Serial.print("BT Raw Data: ");
Serial.println(bthc05Str);
}
//Send sensor data to Bluetooth device
bthc05.println("PUT YOUR SENSOR DATA HERE");
}
else if(menuOption == '2') {
// L293D Motor Driver with Dual Hobby DC Motors - Test Code
//Start both motors. note that rotation direction is determined by the motors connection to the driver.
//You can change the speed by setting a value between 0-255, and set the direction by changing between 1 and 0.
dcMotorDriverA.setMotorA(200,1);
dcMotorDriverA.setMotorB(200,0);
delay(2000);
//Stop both motors
dcMotorDriverA.stopMotors();
delay(2000);
}
else if(menuOption == '3') {
// LCD 16x2 - Test Code
// Print a message to the LCD.
lcd.setCursor(0, 0);
lcd.print("Circuito Rocks !");
// Turn off the display:
lcd.noDisplay();
delay(500);
// Turn on the display:
```

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```
    lcd.display();
    delay(500);
    }
     if (millis() - time0 > timeout)
    {
       menuOption = menu();
    }
}
// Menu function for selecting the components to be tested
// Follow serial monitor for instrcutions
char menu()
{Serial.println(F("\nWhich component would you like to test?"));
    Serial.println(F("(1) HC - 05 Bluetooth Serial Module"));
    Serial.println(F("(2) L293D Motor Driver with Dual Hobby DC Motors"));
    Serial.println(F("(3) LCD 16x2"));
    Serial.println(F("(menu) send anything else or press on board reset button\n"));
    while (!Serial.available());

    // Read data from serial monitor if received
    while (Serial.available())
    {
       char c = Serial.read();
       if (isAlphaNumeric(c))
       {  if(c == '1')
                              Serial.println(F("Now Testing HC - 05 Bluetooth Serial Module"));
                  else if(c == '2')
                              Serial.println(F("Now Testing L293D Motor Driver with Dual Hobby DC Motors"));
                  else if(c == '3')
                              Serial.println(F("Now Testing LCD 16x2"));
          else
          {
             Serial.println(F("illegal input!"));
             return 0;
          }
          time0 = millis();
          return c;
       }
    }
}
```

V. CONCLUSION

Design and develop of voice command operated wheelchair is implemented. A power-assist automatic wheelchair prototype that effectively meets the various transportation needs of individuals with hemiplegia or physical disabilities will be designed, manufactured, and tested. Intricate design detail and execution resulted in a visually simplistic design that promotes low cost and low maintenance. The modular aspect of the components allows the system to be retrofit to automatic wheelchairs with only minimal modifications.

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2) Rohit Gurunath Jadhav, Exam Seat No.: B190400874
3) Omkar Manikrao Bade, Exam Seat No.: B190400813

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