Smart Navigation of Wheelchair using Human Machine Interface

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***Abstract* — This manuscript deals with smart navigation of wheelchair using human machine interface. In day to day life, physically challenged people are facing many problems especially to move around. This project was made especially to handle such problem faced by physically challenged people. To implement the manuscript, microcontroller ATMEGA328 was used to control the motor coupled to the wheel of the wheelchair which was controlled by the voice command from the android mobile phone through a bluetooth module. Apart from moving the motor using voice command, prototype also have ultrasonic sensor which senses the obstacle on the way and will control the direction of the wheel accordingly. Apart from physically challenged people, aged people will also get benefited with this prototype.**

Keywords—Bluetooth module; ATMEGA328; Ultrasonic sensor; DC Motor

I. INTRODUCTION

Many people who are physically handicapped and those who are aged feels uncomfortable to move around without the help of other people. In order to encourage them and to make them to feel comfortable to move around without the help of anyone, smart navigation of human machine interface prototype was developed. It uses microcontroller ATmega328 to control the movement of the wheelchair based on the voice command interfaced with a bluetooth module. Programming with ATmega328 was simple compare with other microcontrollers used in [1]. Ultrasonic sensor was used to sense the obstacle and will direct the wheel according to the control command from the microcontroller. In [2][3], joy stick was used to operate the wheelchair which needs to be operated manually. Here such manual operation can be avoided by simply using voice command. In earlier research [4], Infrared sensor was used. But the limitation of IR sensor is that it cannot be used in sun because of ambient light interference etc. Ultrasonic sensor [5] works on sound waves so no problem in detecting obstacle in any case. Range of ultrasonic sensor was perfect and is very accurate. A Prototype was implement in this manuscript to overcome the difficulties faced in the earlier research.

II. BLOCK DIAGRAM OF HUMAN MACHINE PROTOTYPE

Fig.1 represents the block diagram of smart navigation of Wheelchair using Human Machine Interface. Here android mobile and bluetooth module was interfaced by an application. On getting the voice command, Bluetooth device will send the command to the microcontroller. Based on the program controller will send the signal to the driver IC and it will direct the motor based upon the voice command and the control specified in the microcontroller program. Supply for DC motor was supplied from battery. Apart from voice control, ultrasonic sensor is used to detect the obstacle on its way.

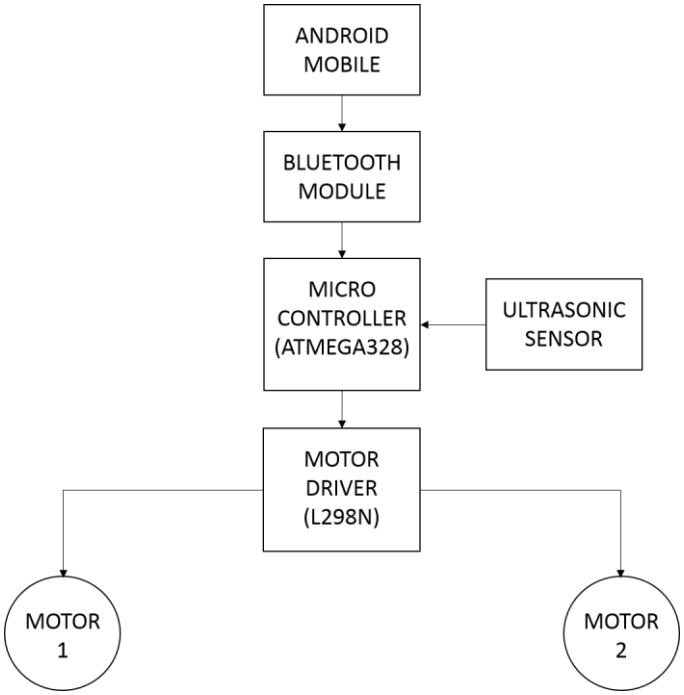


Fig. 1. Block Diagram of Smart Navigation of wheelchair using Human-Machine Interface

A. *Android Mobile and Bluetooth Module:*

By using an application called voice control BOT, voice command was recognized by an android phone. Bluetooth device was used to interface voice command recognized by the mobile phone with the microcontroller to provide information regarding the direction of the motor.

B. *Ultrasonic Sensor(HC-SR04):*

Ultrasonic sensor was used to detect the obstacle on the path of the wheelchair. A short ultrasonic pulse is transmitted at the time 0, reflected by an object. The sensor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is

called cycle period. The recommend cycle period should be no less than 50ms. If a 10µs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40kHz ultrasonic signal and detect the echo back. If no obstacle is detected, the output pin will give a 38ms high level signal.

This sensor was provided with 5 volt dc supply. Apart from supply and ground terminal, it will have 2 other terminal called trigger and echo. On getting the triggering pulse from the microcontroller, waves will be generated from the sensor. Whenever the waves sticks the object and send back to the sensor in the form of echo. Speed of response of the sensor in the form of echo and time taken for the response will decide the distance of the object. Distance of the object from the sensor is given by

Distance = Speed of sound * Time taken (1)

Based upon the response from the sensor, microcontroller will control the wheel direction.

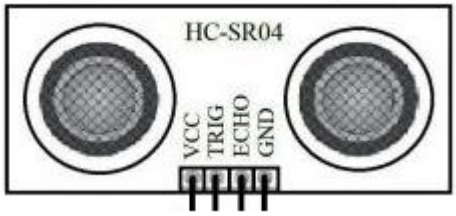


Fig.2 Ultrasonic Sensor

C. DC Motor:

12 V, 150 rpm, high torque DC gear motor providing 20000gm-cm torque was used to drive the wheelchair. The motor generates a low RPM which is very ideal for making gripper to pick and place heavy objects with greater accuracy.

D. Motor Driver IC(L298N)

L298N is a dual H-Bridge Motor driver IC. It is integrated monolithic circuit in a 15- lead Multiwatt. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. Pin configuration of L298N was shown in Fig.3

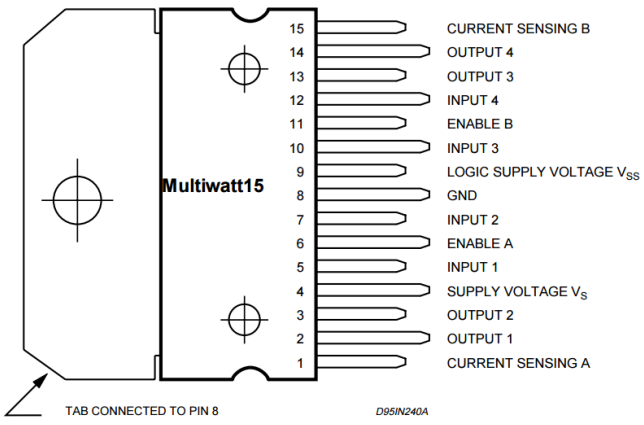


Fig.3 Pin configuration of L298N

It consist of 4 input pins(INPUT 1, INPUT 2, INPUT 3, INPUT 4), 4 output pins(OUTPUT 1, OUTPUT 2, OUTPUT 3, OUTPUT 4) and 2 enable pins(ENABLE A, ENABLE B). 4 input pins and 2 enable pins are connected to the microcontroller. Based upon voice command, corresponding enable pin will get enabled which in turn will make the motor to operate in direction programmed in the microcontroller according to the voice command.

E. Microcontroller(ATMEGA328)

ATmega328 is commonly used nowadays where a simple, low powered, low-cost microcontroller are needed. Because of the above reason microcontroller ATmega328 was used. It was programmed to control the motor operation based on the voice command signal from the bluetooth module. Output of the bluetooth device will be in the form of binary numbers. Based upon the input values from the bluetooth device, microcontroller was programmed accordingly so that wheelchair will navigate with the help of Motor driver IC L298N.

Apart from controlling the motor direction, it also give control signal to ultrasonic sensor. Thereby, the sensor will be able to detect the obstacle on the path of the wheel chair.

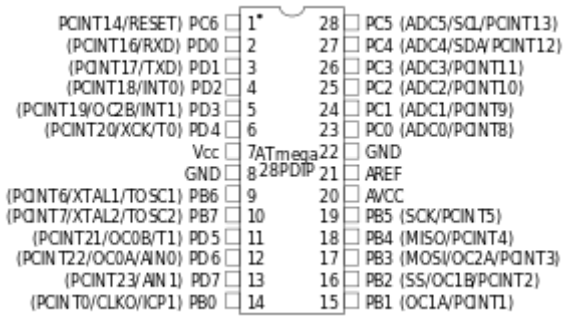


Fig.4 Pin configuration of ATmega28

F. Overall Block Diagram:

Working of each and every components was discussed already. This circuit is all about the hardware part of entire prototype.

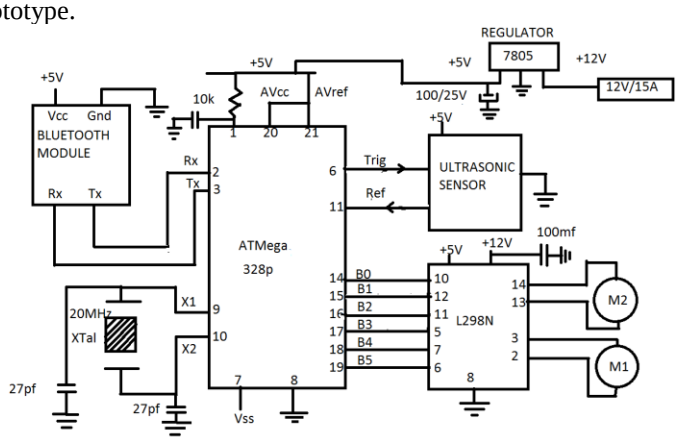
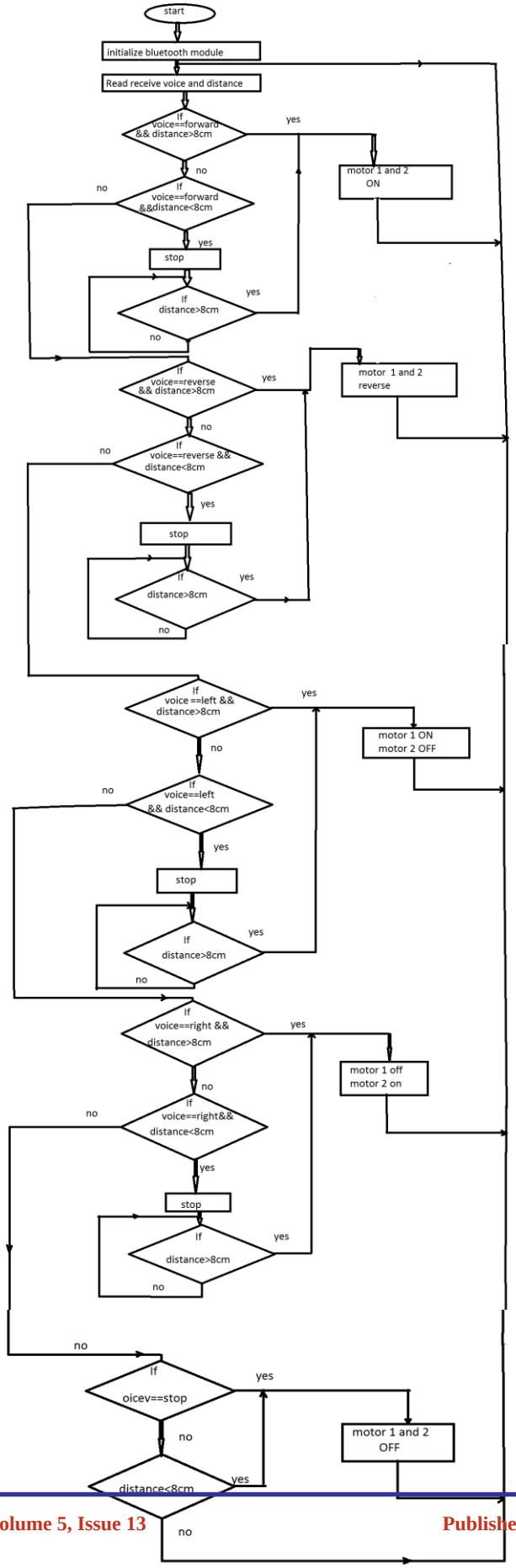


Fig.5 Overall Block Diagram of the prototype.

III. SOFTWARE DESCRIPTION

A. *Flowchart for microcontroller operation:*



Microcontroller was programmed by Arduino programming. Bluetooth module was first initialized, then voi

ce and distance was read by the controller. If voice command is forward and distance between the object and the wheelchair is greater than 8 cm, motor1 and motor 2 will be turned on by enabling the corresponding pins in the driver IC. If not, the motors will stop until the distance is greater than 8cm. Procedure will be repeated for other direction by enabling the corresponding pin by using the logic given in the Table.1.

Motor was operated under the control of microcontroller with the help of voice command whose logic was given in the table below

Voice Command	Motor 1	Motor 2	Direction
Forward (or) Go	On	On	Forward(CW)
Left	Off	On	Left (CW)
Right	On	Off	Right(CW)
Reverse	On	On	Reverse(CCW)
Stop	Off	Off	Stop

Table 1. Logic for motor operation using microcontroller

IV. HARDWARE IMPLEMENTATION

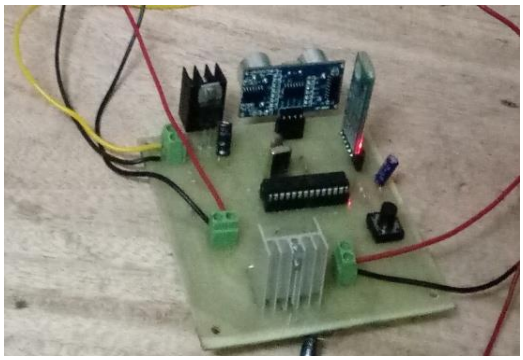


Fig.6 PCB with ultrasonic sensor, driver IC and Microcontroller

Fig.7 Complete setup of the Prototype

Fig.8 Forward Motion of the prototype

Fig.9 Reverse Motion of the prototype

Fig.10 Left side motion of the prototype

Fig.11 Right side motion of the prototype

V. CONCLUSION

The paper has been successfully designed and tested. It has been mainly designed in order to reduce human effort in driving a wheelchair. Many existing systems has discussed about the wheelchairs and has proposed many methods for reducing their efforts. But still there is a difficulty in moving a wheelchair manually. So, in order to avoid that difficulty, instead of controlling the wheelchair electrically or by gestures, our project succeeded in moving the wheelchair using voice commands. When the voice commands are given by the disabled person sitting on the wheelchair, using Bluetooth module and an android mobile voice commands was interfaced to the microcontroller, and according to those commands the motors will move which in turn moves the wheel chair.

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