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Voice Controlled Automated Wheelchair

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Abstract
A wheelchair is a device used for mobility by people for whom walking is difficult, due to illness or Disability. Many individuals have problems to use the manual conventional wheelchair and find the manoeuvring and steering of the conventional wheelchair to be strenuous finding themselves dependent on others to push them. Motorized or powered wheelchair fails to find their place in developing countries such as India due to lack of awareness and are also not commercially viable. This project aims to design a voice controlled motorized wheelchair with alert mechanism and obstacle avoidance sub-systems. It would enable a disabled person to move around independently, while using a voice recognition system and a touch pad that is interfaced with motors. The prototype of this wheelchair is built using Programmable Interface Controller 16F877A. Sensors are mounted on the wheelchair for obstacle avoidance along with GSM based alert mechanism that would come in aid of the user in case of an emergency. The Wheelchair has been designed to be cost effective so that if our project is commercialized disabled users in developing countries as well as across the globe will benefit from it.
Key Words—Motorized, Voice recognition system, GSM, Sensors

I. INTRODUCTION

Disabled people need the aid of certain artificial means to move around. These means have to be increasingly sophisticated, taking advantage of technological evolution to facilitate the integration of disabled people into the working world. The needs of individuals with disabilities can be satisfied with traditional manual or power wheelchair however a large segment of disable people find it impossible to use wheelchairs independently .The type of artificial aid needed by disabled person depends to a large extent on the level of his or her incapacity. If the user is capable of controlling his head or his hands, the ideal solution is the use of a joystick.

When there is a high level of incapacity, solutions are basically centered on the use of other means, such as voice commands or eye movements. Only in extreme cases is there a need for the chair to cover distances in an autonomous manner, without the need for any intervention on part of the user Many disabled people lack the dexterity to control a joystick. The idea of controlling wheelchair using voice commands is simpler, cost effective and suits a large part of the disabled community. Controlling the wheelchair using a touch pad can be used as a suitable back up for the voice recognition system.

Situations may arise when a user may need the immediate attention of his caretaker or a family member a sophisticated alert mechanism using GSM may be used for this purpose. Obstacle avoidance can be achieved using IR or Ultrasonic sensors to enhance the functioning of the voice controlled wheelchair

II. SYSTEM REQUIREMENTS & TECHNOLOGIES USED

This paper describes the research that is carried out in an attempt to develop an automated wheelchair. In the design of the wheelchair many factors need to be taken into consideration it should be strong enough to hold the weight of the user, it should also respond rapidly and efficiently to the commands given by the user. Compatible motors and microprocessors are selected in order to make all components work effectively. The microcontroller is the heart of the proposed system that controls the wheelchair, the voice commands of the user are processed by the voice

recognition system and propelling of the wheelchair depends on the motor control and drive system

The different technologies that are used in the design of the automated wheelchair are:

2.1 Voice recognition system HM2007

HM2007 is a single chip CMOS voice recognition circuit with the on-chip analog front end, voice analysis, recognition process and control function. It has 8 bit data out which when combined with any microcontroller an intelligent recognition system can be built.

Training:

To train the circuit begin by pressing the word number you want to train on the keypad. For example press the number “1” to train word number 1.

When you press the number on the keypad the LED will turn off (Status). The number is displayed on the digital display. Next press the “Train” key for training. When the train key is pressed it signals the system to listen for a training word and the LED turns back ON, now speak the word you want the circuit to recognize into the microphone clearly. The LED should blink OFF momentarily, this signals that the word has been accepted. Continue training new words using the above mention procedure.

Testing the recognition:

Repeat a train word into the microphone. The number of the word should be displayed on the digital display. For instance if the word ”Forward” was trained as word number 1 saying the word forward into the microphone will cause the number 1 to be displayed.

Error Codes:

The system provides following error codes:

55= Word too long

66=Word too short

77=No match found

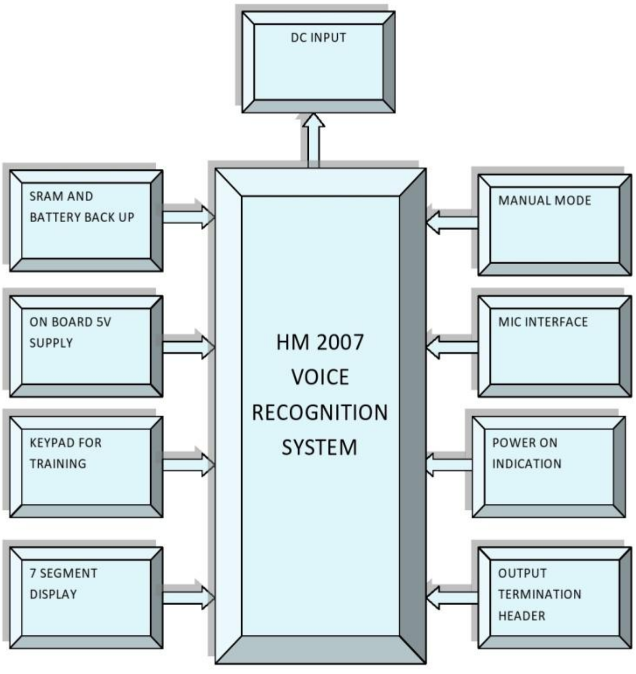

Fig 1: HM2007 Speech Recognition kit

2.2 Microcontroller (PIC)

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology. PIC stands for Peripheral Interface Controller.

Main features are used in proposed wheelchair are, Operating speed: clock input (20MHz), Operating voltage range (2-5.56) volts, High sink current (25mA),10 bit multichannel A/D converter, Universal synchronous Asynchronous Receiver transmitter (USART).

2.3 GSM based Alert mechanism (SIM300)

Designed for global market, SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz . Advantage of using this modem will be that we can use its RS232 port to communicate and develop embedded applications. Applications like SMS control, data transfer, remote control and logging can be developed easily.

2.4 Ultrasonic sensor

This sensor is a high performance ultrasonic range finder. It is compact and measures an amazingly wide range from 2cm to 4m. This ranger is a perfect for any robotic application, or any other projects requiring accurate ranging information. This sensor can be connected directly to the digital I/O lines of a microcontroller and distance can be measured in time required for travelling of sound signal using simple formula as below:

Distance = (Echo pulse width high time * Sound Velocity (340M/S)/2)

2.5 Touchpad

A resistive touch screen is operated by resistance sensitive system between two layers such as film or glass. Two pieces of transparent materials with conductive coating are placed in the same direction as two electrodes face each other. The touch screen is activated when these transparent conductive layers are pressed to contact each other with a finger or a pen. The one of these conductive layers functions as an X-coordinates electric circuits and the other as a Y-coordinates circuits

These coordinates will be used to decide the regions on the touch screen for controlling the movement of the wheelchair. This acts as an alternative to voice recognition system.

2.4 Motor driver (Dual Dc motor driver 20A)

This driver provides raw power and simple connectivity to robotics applications. It is ideal for application where two motors require up to 20 Amperes of current during start-up and during normal operations. It comes with a simple TTL/CMOS based interface that can connect directly to the IOs of an MCU. It has a breaking feature that can guarantee immediate halt on the shaft of motors in most high power applications and also includes protection circuitry to avoid any electrical fluctuations affecting the normal operation of an MCU.

2.5 Motors (DC motors) and Lead Acid Battery

Dc motors have a two wire connection, all the power from the driver is supplied over these two wires. The speed of DC motors is controlled by using a technique called Pulse width modulation or simply PWM. The torque of the motor is about 25 Kg-cm and speed requirement is about 20 to 30 rpm.Lead Acid battery is used as a power supply, with
Ratings: 12 Volts, 7.2Ah.

III. SYSTEM STRUCTURE

The block diagram of the entire system is as follows:

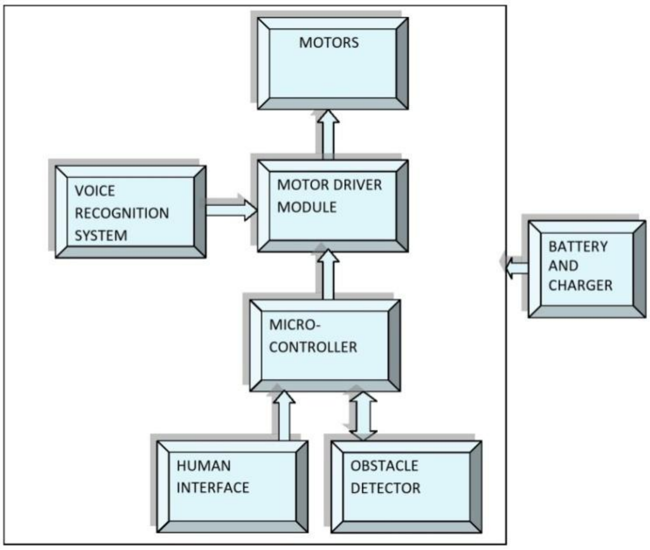

Fig 2: Block Diagram of entire system

The Digital output obtained from HM2007 speech Recognition kit will be used as the input to Microcontroller PIC 16F877A. One of the Port will be used as the input port which will accept digital output from the speech recognition module.
The Microcontroller will now use these digital inputs to rotate the two DC motors in clockwise, anticlockwise or to stop the motors which will accordingly move the wheelchair in forward, backward and in sideways direction.
Human interface (alert mechanism) block involves communication of the patient in danger with the caretaker via GSM module.
And the obstacle detector automatically halts the wheelchair if any obstacle is present in front of it by giving digital inputs to the microcontroller which stops the motors.

IV. RESULTS

Implementation of the proposed project is in progress. Till now following results have been obtained:

4.1 Speech Recognition Output:

The Speech Recognition module was trained for following words and corresponding digital outputs were obtained.
Digital outputs of the trained words

Table1:
Trained words with their digital outputs

Sr. no.	Trained Words	Digital output obtained
1	Forward	01
2	Back	02
3	Right	03
4	Left side	04
5	Please Stop	05

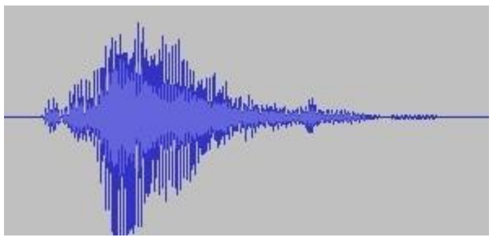

Fig 3: Analog input (“RIGHT”) to HM2007

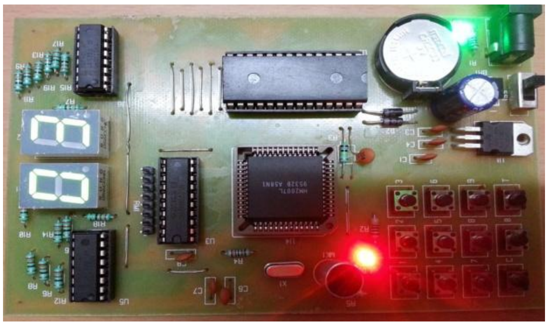

Fig 4: Output (03) for the trained word “RIGHT”.

The above figures Fig 6 and 7.show the analog input for trained word “RIGHT” that results in number “03” being displayed on the voice recognition system .

4.2 Output of motor driver and Motion of Wheelchair:

The output of Speech Recognition Module was processed in the Microcontroller and corresponding input was given to motor drivers from microcontroller to drive the appropriate motor. Input to motor drivers and motion of wheelchair is given by the following table.

Table2:
Output of motor driver and motion of the wheelchair

Input to Motor 1 Driver		Input to Motor 2 Driver		Sense of rotation of motors		Motion of wheelchair
Dir Pin	Brk Pin	Dir Pin	Brk Pin	M1	M2	
0	0	0	0	C	C	Forward
1	0	1	0	AC	AC	Back
0	0	0	1	Stop	C	Right
0	1	0	0	C	Stop	Left side
0	1	0	1	Stop	Stop	Stop

**C-Clockwise, AC- Anticlockwise, M-Motor
Dir-Direction, Brk-Break.

Voice recognition module simulated using switches in Proteus:

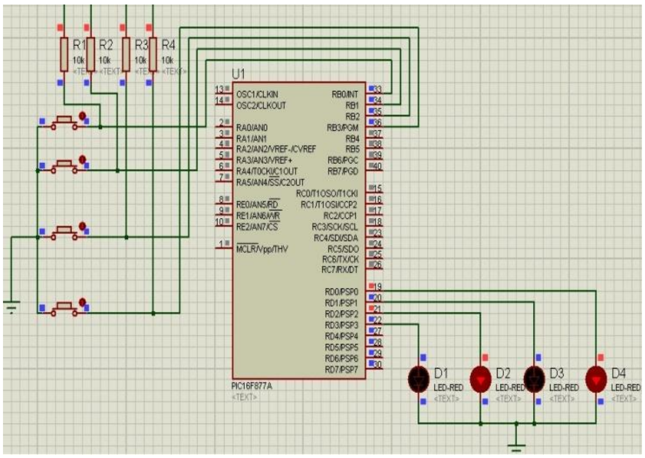

Fig 5: Output (0101) of Microcontroller for the “stop” command.

4.3 Output of GSM module:

The Program for Transmitting Alert message was implemented and the simulation result of same is shown below:

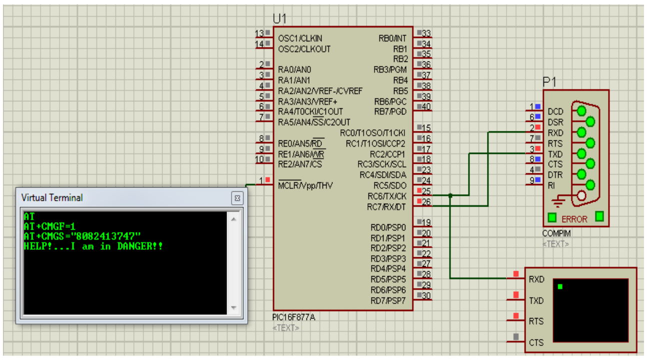

Fig 6: Output of GSM module

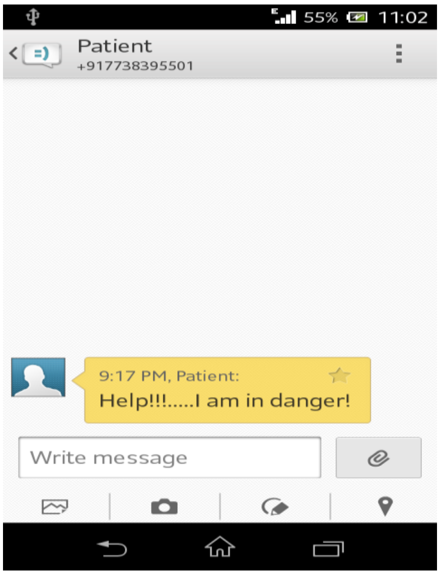

Fig 7: sent message via GSM module

4.3 Obstacle Avoidance Sensor

Obstacle avoidance system made use of Ultrasonic sensors to detect obstacle at a range of 15 to 20 cm.

The working of ultrasonic sensors is as follows:

i. First of all a 10us trigger input has to be given to the pin named "Trig" on the sensor. This starts one cycle of range conversion and sends 8 bursts of sound waves from the transmitter.
ii. As soon as the signals are transmitted the "Echo" pin goes to high level and remains in high level until the same sound waves are received by the receiver.
iii. If the received sound waves are same as what the same sensor transmitted then the Echo pin goes to low level.
iv. If no object is detected within 5M after 30ms the Echo signal will automatically go to low level.

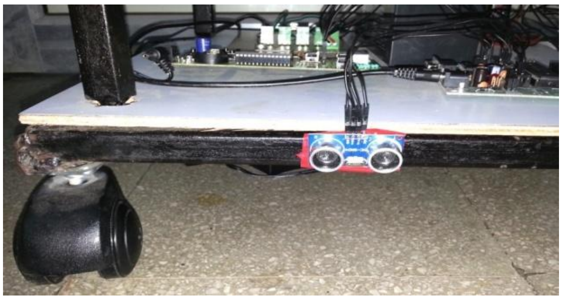

Fig 8: Ultrasonic Sensor mounted at the base

Fig 9: Complete wheelchair with circuits, motors and power supply

V. CONCLUSIONS

The objective was to design an automated wheelchair that is equipped with sensors, GSM based alert mechanism and driven by voice commands the system once fully functional will enable the user to man oeuvre the wheelchair independently in turn simplifying the life of physically challenged individuals. The voice recognition is used for controlling the motion of a wheelchair that can be unique concept which would stand apart from the manual or motorized wheelchairs. The use of this new technology in conjunction with a mechanical system in order to simplify everyday life would spark interest in a technologically growing modern society.

The successful implementation of the voice recognition system and GSM based alert mechanism has been achieved, the voice recognition system worked for most of the commands. Only when a word was not properly enunciated, the system failed to recognize it. However a touch pad that can drive the wheelchair can be useful in such cases and also when the user is not severely disabled. The prototype hardware complete with the voice recognition system, microcontroller, motors and drivers was tested for different voice commands, thus completing the major part of driving the wheelchair using voice commands. The obstacle avoidance system was implemented using ultrasonic sensors that stopped the movement of the wheelchair on the detection of the obstacle at a range of 15-20 cm. The alert mechanism was tested and was found to be successful in sending alert/emergency messages to the caretaker or family member of the wheelchair user thus proving to be a unique facet in the proposed wheelchair

Future work needs to be done on using touch pad as an efficient counterpart to voice recognition system to drive the wheelchair.

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