ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 5, May 2015

A Multifunctional Smart Wheelchair

Mr. Khagendra Joshi, Mr. Virendra Gupta,Ms. Monika Gosavi,Mr. Sandip Wagh

***Abstract*— A fully dedicated wheel chair to the biomedical sector with its smart features is presented in this paper. This wheel chair is a boon to all those people who are suffering from various ailments which makes them disable or immovable, and make them dependent on others for their movement. Persons with different symptom combination can get benefit out of it at different level. Some wheel chair users find manual or powered wheel chairs difficult or impossible to operate. Therefore many scientists are working to develop smart wheel chairs for their ease. This multi-control smart wheel chair incorporates smart features like obstacle detection, line following, voice control, temperature monitoring and Heart rate monitoring. The smart wheel chair control unit consists of integration of AVR microcontroller ATmega328 with Bluetooth module, GSM module SIM900, ultrasonic and infrared sensors, temperature sensor LM35 and motor driving circuit for controlling motor's speed.**

***Index Terms*— AVR microcontroller ATmega328, Bluetooth module HC-05,Smart wheel chair, ultrasonic sensor, infrared sensor, voice control, temperature sensor LM35,GSM module SIM900,PDI,Arduino, MD10C, HC-SR04.**

I. INTRODUCTION

According to the World Health Organization's report on disability, currently about 15 percent of world population lives with some type of disability of whom 2-4 percent experience significant difficulties in functioning[2]. The global disability prevalence is higher than previous WHO estimates, which date from the 1970s and suggested a figure of around 10 percent. This global estimate for disability is on the rise due to population ageing and the rapid spread of chronic diseases, as well as improvements in the methodologies used to measure disability [2]. About 80 percent of the disable people live in developing countries as declared by the United Nation Development Program (UNDP).According to study report of census 2011 of India, the majority of population by the type of disability in seeing, hearing, speech, movement, mental retardation, multiple disabilities etc lies in movement which is about 20.5 percent [1]. Psychologically, reduction in the mobility can lead to feelings of emotional loss, reduced self-esteem, isolation, stress, and fear of abandonment.

Multiple sclerosis and arthritis patients have severe disabilities and cannot drive joystick operated wheel chairs .The proposed wheel chair has been specially made for the purpose of eliminating high cost and to provide multi-controls. As a voice controlled wheel chair cannot be operated properly in noisy environment, this wheel chair can be utilized well in hospitals where there is no such noise. Here the voice recognition part includes a android smart phone along with a Bluetooth module. Its line follower circuit and obstacle detection circuit will help a patient to move to any section of hospital by just following the track and if any obstacle comes it will stop. The GSM module will provide patient monitoring. If the patient's body temperature goes above a particular threshold, a alert message notifying the temperature of patient will be sent on the registered number of the concerned doctor and thus emergency service can be provided to the respective patient. So such a smart wheel chair with such multi-controls thus can bring transition and thus happiness in the life of disable people.

II. PROPOSED WHEEL CHAIR SYSTEM

Figure 1, shows the block diagram which includes ATmega328 microcontroller which is controlling all the modules connected to it. Here a smart phone with voice control android application is used to communicate with the Bluetooth module. The data received by the Bluetooth module from android smart phone is fed as input to the controller. The controller acts accordingly on the DC motors of the wheel chair. The wheel chair can be made to move in all the four directions using the android phone. In achieving the task the controller is loaded with program written using Embedded 'C' Languages in Arduino software which is an open source. The temperature sensor used here is LM35 which is interfaced with microcontroller, measures temperature of patient in degree Celsius and thus together with the GSM module forms a patient monitoring system. As there are two motors so we used two separate motor drivers, one for each. Along with this we have used 24V battery as power source. Here the motor drivers used, are controlling the speed of the motors with the help of PWM. The individual block explanation of the system is described below:

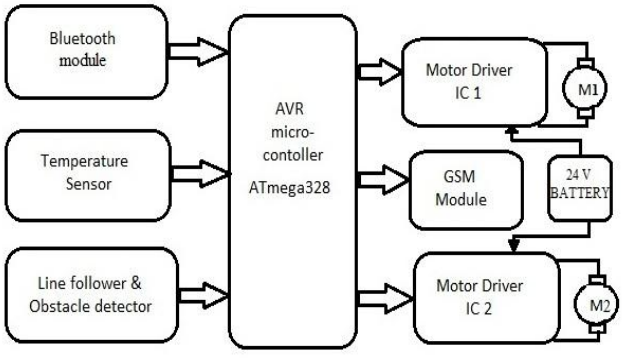

Figure 1: Block Diagram of the Proposed Model

A. AVR ATmega328

It is the heart of our wheel chair control system. All the different types of module used in the smart system are

controlled by this AVR. It is a high performance, low power Atmel 8-bit Advanced RISC microcontroller. Here we are using a 28 pin PDIP package with 23 I/O lines. It has 131 Powerful Instructions, 32K Bytes of In-System Self-Programmable Flash program memory, 1K Bytes EEPROM, 2K Bytes Internal SRAM, 32 x 8 General Purpose Working Registers, Six PWM Channels, 6-channel 10-bit ADC. Its working temperature range is from -40°C to 85°C [10]. Its special features include Power on Reset and Programmable Brown out Detection, Internal Calibrated Oscillator, External and Internal Interrupt Sources, Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby.

The microcontroller on the board is programmed using the arduino programming language and arduino development environment. Arduino programming provides a number of libraries to make programming easier. The simplest of these are functions to control and read the I/O pins [4].

B. Temperature Sensor

Here we are using LM35 as a temperature sensor. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It has Linear + 10.0 mV/°C scale factor.

C.GSM Module

Here we are using SIM900 for patient monitoring. SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration it occupies less space. This module carries a SIM card holder where a SIM is to be placed for communication. It has an adjustable baud rate from 1200 bps to 115200 bps[13]. Its Built in RS232 level converter makes interfacing with microcontrollers easy. Here we are using standard AT commands to control it.

D. Bluetooth module HC05

Here we are using a Bluetooth module HC-05 along with an android phone as a voice recognition system. Its frequency range is from 2.4GHz to 2.48GHz [11].This module also works using standard AT commands. By using these AT commands we can set parameter like baud rate and can also set a particular port as input or output. HC Serial Bluetooth product consists of Bluetooth serial

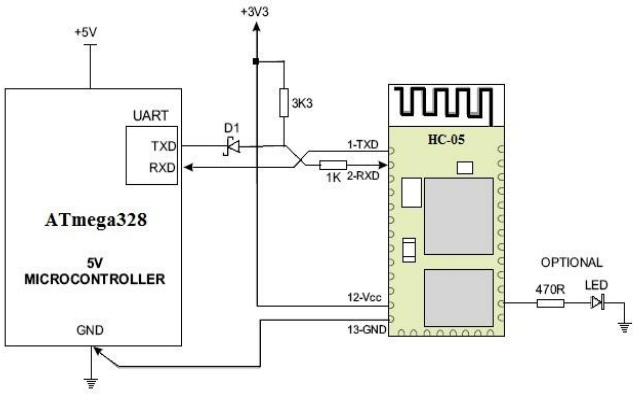

Figure 2: Bluetooth HC05 interfacing with ATmega328

interface module and Bluetooth adapter. Bluetooth serial module is used for converting serial port to Bluetooth. Figure 2, shows the interfacing of HC05 with microcontroller ATmega328 [4].

This module has two modes: master and slaver device. The device named after even number is defined to be master or slaver when out of factory and can't changed to the other mode. But for the device named after odd number, users can set the work mode (master or slave) of the device by AT commands [4].

Their connection can be built once the pair is made. This Bluetooth connection is equivalently like a serial port line connection including RXD, TXD signals. Bluetooth serial module's operation doesn't need drive, and can communicate with the other Bluetooth device. But communication between two Bluetooth modules requires two conditions:

i) The communication must be between master and Slave.

ii) The password must be correct.

E. Line follower

The line follower circuit is designed, to move the wheel chair in a predefined path which is a black strip. In this circuit we are using four infrared sensors S1, S2, S3 and S4 which are fixed at the bottom of the wheel chair. Some of the valid conditions are given below:

In the Table 1, '0' and '1' represents the position of the sensors above the black strip. Here'0' means no light is reflected back to the sensors and '1' means light is Fully reflected back to the sensors and hence their status decides the movement of wheel chair in a particular direction. Table 1, shows some of the valid conditions.

F. Obstacle Detector

The obstacle detection is performed by a HC-SR04 Ultrasonic sensor which is fixed in the front of the wheel chair. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The module includes ultrasonic transmitter, receiver and control circuit.

Table 1: Movement of wheel chair according to sensor's status

S1	S2	S3	S4	MOVE
1	0	0	1	FWD
1	0	0	0	LEFT
1	0	0	1	FWD
0	0	0	1	RGT
1	0	0	1	FWD
0	0	0	0	STOP

The basic principle of work:
(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
(3) If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning[12].

Test distance = (high level time× velocity of sound) / 2 (1)

G. DC Motors

Here we are using 24V, 8A Permanent magnet D.C motor. Permanent Magnet DC motors are useful in a range of applications, from battery powered devices like wheelchairs and power tools, to conveyors and door openers, welding equipment, X-ray and pumping equipment. They are frequently the best solution to motion control and power transmission applications where
compact size, wide operating speed range, ability to adapt to a range of power sources or the safety considerations of low voltage are important. Because of their linear speed-torque curve, they particularly suit adjustable speed and servo control applications where the motor will operate at less than 5000 rpm. In operation with a constant armature voltage, as speed decreases, available torque increases, In Figure 3, as the applied armature voltage increases, the linear speed-torque curves shift upwards. This shows that Speed is proportional to voltage and torque is proportional to current.

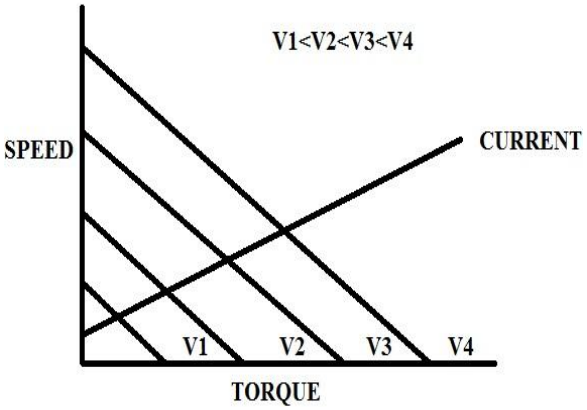

Figure 3: As applied armature voltage increases in a PMDC motor, the linear speed-torque curves shift upwards

Table 2: H-Bridge control of Motor driver circuit

L1	L2	LEFT MOTOR	R1	R2	RIGHT MOTOR
0	0	OFF	0	0	OFF
0	1	∪	0	1	∪
1	0	∩	1	0	∩
1	1	invalid	1	1	invalid

G. Motor driver

As here we are using Permanent magnet D.C motor with a current requirement of 8 ampere so we used here MD10C motor driver which is designed to drive high current brushed DC motor up to 10 ampere. It supports for both locked-antiphase and sign-magnitude PWM signal as well as using full solid state components which result in faster response time and eliminate the wear and tear of the mechanical relay.

It has Bi-directional control for 1 brushed DC motor and supports motor voltage ranges from 3V to 25V.It contains NMOS H-Bridge for better efficiency and heat sink is required. Also supports speed control of PWM frequency up to 10KHz. 4 NMOS transistors acting as switches are used and according to their on-off function the direction of motor is controlled which is explained in Table 2.

III. CONCLUSION

Our proposed wheel chair system thus provides an easily controllable and multiple functionality environments. The reliability and safety of our system is highly improved by incorporating line follower and obstacle detection circuitry which includes infrared and ultrasonic sensors for automatically providing movement along the track and detecting the obstacle in between the track and taking proper action to avoid any mishap. Thus this chair has provided an ease and comfort to all the physically disable people and made them independent and self- reliant.

IV. FUTURE SCOPE

Our wheel chair system has proved usefulness to a disable person in much aspect, still there is room for improvement .We can incorporate interfaces like brain control, eye ball control, gesture control. Presently our system is incapable of climbing stairs, so we can improve in this part too.

V. ACKNOWLEDGEMENT

Authors would like to thank our guides Mr. P.T Shashidharan (Scientist ‘E’) and Mrs. V.S Jahagirdar (S.T.O) for their kind support and guidance without which this work would not be possible.

VI. REFERENCES

[1] Census of India 2011 “Data on Disability”.

[2] World Health Organization "World report on Disability".

[3] M Prathyusha,K.S Roy,Mahaboob Ali Shaik "Voice and touch Screen Based Direction and speed control of wheel chair for Physicallly challenged using Arduino,"IJETT,vol. 4,issue 4, April 2013.

[4] Ritika Pahuja,Narendra Kumar "Android Mobile Phone controlled Bluetooth Robot using 8051,"IJSER vol. 2,issue 7,July 2014.

[5] Nirmal TM "Wheelchair for physically and mentally diasbled persons,"IJEER,vol. 2,Issue 2,pp:(112-118),month:April-June 2014.

[6] G.Kalasamy,A Mohammed Imthiyaz,A manikandan,S.Senthilrani "Microcontroller Based Intelligent wheelchair Design,"IJREAT,volume 2,Issue 2,April-May,2014.

[7] R. C. Simpson. Smart wheelchairs: a literature review. Journal of Rehabilitation Research and Development , 2005.

[8] Sarangi P. Parikh, ValdirGrassi Jr., Vijay Kumar, Jun Okamoto Jr., "Integrating Human Inputs with Autonomous Behaviors on an IntelligentWheelchair Platform", IEEE Computer Society-Vol. No. 22, Issue No. 02, pp. 33-41, march/April 2007.

[9] Description of arduino software is available on the arduino website. [Online]. Available: http://www.arduino.cc.

[10] ATmega328 datasheet pdf available on website: www.atmel.com

[11] Bluetooth module datasheet available on website : http://www.rcscomponents.kiev.ua/datasheets

[12] Details of ultrasonic sensor HC-SR04 available on website: www.micropik.com

[13]Description of GSM module available on website: www.propox.com

First Author

Name: Khagendra Joshi
Education Qualification: Completed B.E in Electronics and telecommunication from VPCOE Baramati affiliated to Pune University and pursuing M.tech in Electronics design and technology from NIELIT Aurangabad.

Second Author

Name: Virendra Gupta
Education Qualification: Completed B.E in Electronics and communication from Shri Vaishnav Institute of Technology And Science Indore affiliated from RGPV Bhopal and pursuing M.tech in Electronics design and technology from NIELIT Aurangabad.

Third author

Name: Monika Gosavi
Education Qualification: Completed B.E. in Electronics and Telecommunication from Jawaharlal Nehru Engineering College Aurangabad affiliated to Dr. B.A.M.U. , Aurangabad and pursuing M.tech in Electronics design and technology from NIELIT Aurangabad.

Fourth author:

Name: Sandip Wagh
Education Qualification: Completed B.E in Electronics and telecommunication from VPCOE Baramati affiliated to Pune University and pursuing M.tech in Electronics design and technology from NIELIT Aurangabad.