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MEMS based Hand Gesture Wheel Chair Movement Control with Emergency Alert

D.Sobya[1], R.Varshni[2], P.Albinia[3]

[1]Assistant Professor, [2, 3] B.Tech,
Department of Electronic and Communication Engineering,Christ Institute of Technology,Pondicherry, India.
[1]sobyadevaraj@gmail.com,[2]varshubaby9693@gmail.com,[3]albiniaphilip1912@gmail.com

ABSTRACT

The objective of this project is to develop a control on wheel chair which helps to the physically disabled persons using their hand movement or their hand gesture recognition through MEMS technology. In this article a fully committed wheel chair to the biomedical sector with its smart features is presented. This wheel chair is useful for disabled persons who are having various ailments which makes them disable or immovable. Persons with different symptom combination can get benefit out of it at different level. Some wheel chair users find difficult or impossible to operate manual or powered wheel chairs. This multi-control smart wheel chair incorporates smart features like obstacle detection, voice control, temperature monitoring and heart rate monitoring. In this research, it is not only monitoring the patient but also to send the emergency alert to the predefined destination. The smart wheel chair control unit consists of integration of AVR microcontroller SST89C52 with MEMS module, GSM module SIM900, ultrasonic and infrared sensors, temperature sensor LM35 and motor driving circuit for controlling motor's speed.

KEYWORDS— Smart Wheel Chair, AVR Microcontroller, MEMS Module, Ultrasonic Sensor, Voice Control.

I. INTRODUCTION

According to the World Health Organizations 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. A wheelchair is a chair fitted with wheels. The device comes in variations allowing either manual propulsion by the seated occupant turning the rear wheels by hand, or electric propulsion by motors. There are often handles behind the seat to allow for different individuals to push. Wheelchairs are used by people for whom walking is difficult or impossible due to illness, injury, or disability. 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. 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. Psychologically, reduction in the mobility can lead to feelings of emotional loss, reduced self-esteem, isolation, stress, and fear of abandonment. 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 an android smart phone along with a Zigbee module. Its line follower circuit and obstacle detection circuit will help a patient to move to any part of hospital by just following the track and if any obstacle comes it will stop and send alert to the predefined registered number of the concern doctor. The GSM module will provide patient monitoring. If the patient's body temperature goes above a particular threshold, an 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. MEMS WHEEL CHAIR SYSTEM

Figure, shows the block diagram which includes SST89C52 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 Zigbee module. The data received by the Zigbee 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 project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. 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:

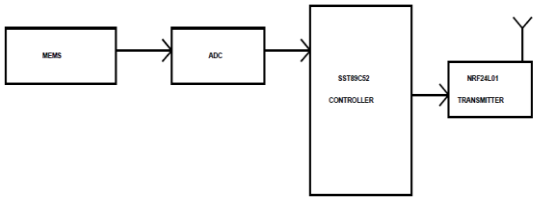

Figure1:Transmitter section:

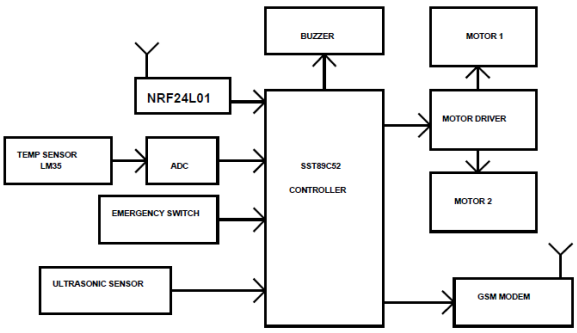

Figure2:Receiver section:

A.AVR SST89C52

It is the heart of our wheel chair 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. AT89C52 has 8KB of Flash programmable and erasable read only memory (PEROM) and 256 bytes of RAM. AT89C52 has an endurance of 1000 Write/Erase cycles which means that it can be erased and programmed to a maximum of 1000 times. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. Here we are using a 40 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. 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.

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 sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 ^{o}C temperature rise in still air. The operating temperature range is from -55°C to 150°C. 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.

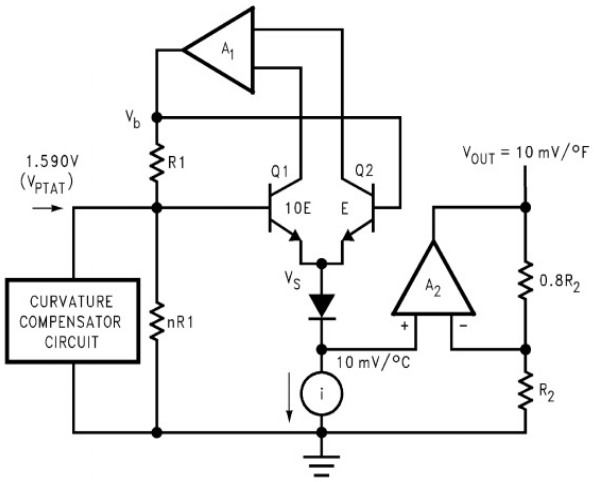

Figure3:Circuit diagram of LM35

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. This means the module supports communication in 900MHz band. GSM Modules are manufactured by connecting a particular GSM modem to a PCB and then giving provisions for RS232 outputs, TTL outputs, Mic and Speaker interfacing provisions etc. 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. MEMS (tilt sensor)

Here we are using MEMS technology Micro-Electro-Mechanical Systems, or **MEMS**, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements that are made using the techniques of micro fabrication. MEMS are an innovative technology that, in one embodiment, generates continued, sustained improvements in, for example, the functionality of small microphones, small cameras, and small electrical signal filters for wireless communication. MEMS sensors are a key technology for the mobile and connected world. Inclinometers, also called tilt sensor, clinometers or slope sensors, are designed to measure the angle of an object with respect to the force of gravity. These tilt or level meters determine the pitch and/or roll angle and output these values via the appropriate electrical interface. MEMS tilt sensor is designed for attachment to structures on either a vertical or horizontal surface and for the subsequent measurement of any tilting that may occur. The sensor itself is MEMS sensors which offer a high range with high sensitivity and accuracy. A tilt sensor can measure the tilting in often two axes of a reference plane in two axes. In contrast, a full motion would use at least three axes and often additional sensors. One way to measure tilt angle with reference to the earth ground plane, is to use an accelerometer. Typical applications can be found in the industry and in game controllers

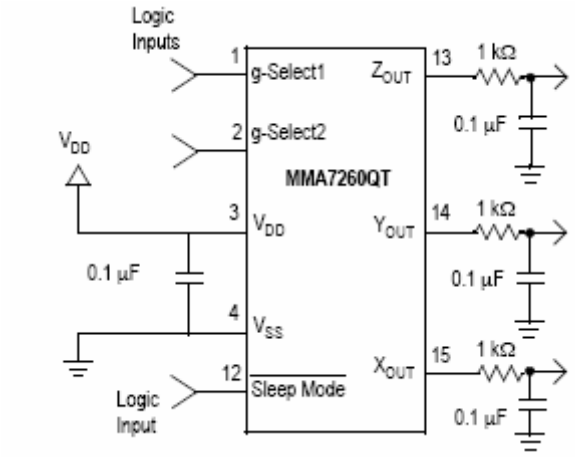

Figure4: Accelerometer with recommended connection diagram

E. NRF24L01 WiFi Transceiver

Nordic recommends its drop-in compatible with nRF24L01 or for a System-on-Chip solution the Nordic nRF24LE1 or nRF24LU1+. The nRF24L01 is a highly integrated, ultra low power (ULP) 2Mbps RF transceiver IC for the 2.4GHz ISM (Industrial, Scientific and Medical) band. The nRF24L01 is a highly integrated, ultra low power (ULP) 2Mbps RF transceiver IC for the 2.4GHz ISM (Industrial, Scientific and Medical) band. These RF modules are very popular among the Arduino tinkerers. The nRF24L01 is used on a wide variety of applications that require wireless control. They are transceivers which this means that each module can transmit and receive data. These modules are very cheap and you can use them with any microcontroller (MCU). With peak RX/TX currents lower than 14mA, a sub µA power down mode, advanced power management, and a 1.9 to 3.6V supply range, the nRF24L01 provides a true ULP solution enabling months to years of battery lifetime when running on coin cells or AA/AAA batteries, .54 pins space, compatible with normal module interface, easy to replace. 51, AVR reference code is available, simply copy and modify. Transfer distance can reach 1000 meters @ 250 Kbps (normally can reach 0.8KM). I will discuss the use of NRF24L01 transceiver module of the models commonly used in wireless communications. You can use it easily to your use of this module is very easy and good range of projects. In addition, the price is also affordable. Low power consumption and 2.4GHz frequency operation also gives us the advantage. The IC can either work in transmit or receive mode. This mode is determined by both the CE pin state, the PWR_UP register, and the PRIM_RX register. The following chart shows the various configurations.

F. Obstacle Detector

Here we are detecting the obstacles and stop the wheel chair by using ABS system. An anti-lock braking system or anti-skid braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. An anti-lock braking system or anti-skid braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding.

It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. It does this at a much faster rate and with better control than many drivers could manage. 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. The basic principle of work:

I. Using IO trigger for at least 10us high level signal,

II. The Module automatically sends eight 40 kHz and detect

whether there is a pulse signal back.

III. If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning[12].

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.

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-anti phase 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.

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

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

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 their on-off function the direction of motor is controlled which is explained in Table.

IV. FUTURE SCOPE

This proposed automatic wheel chair system has proved that it is useful for the disabled persons in much aspect but still there is gap for development. The research may be viable to extend by adding interfaces like brain control, eye ball control, gesture control.

V.CONCLUSION

Based on the above results and discussion the following conclusions were arrived.

- Our proposed automated wheel chair system provides an easy controllable and multiple functionality environments.
- The reliability and safety of our system is highly improved by introducing the new system with obstacle detection circuitry.
- This method includes ultrasonic sensors to automatically provide the movement along with the track.
- Also it detects the obstacle in between the track and taking proper action to avoid any mishap using MEMS.
- Thus this chair has provided an ease and comfort to all the physically disabled people and made them independent and self- reliant.

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