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Wireless Multifunctional Wheelchair

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ABSTRACT

Wireless Multifunctional Wheelchair helps the disabled persons to move independently with less effort, and contact others in case of emergency. For a normal wheelchair it is very difficult to control the motion of the wheelchair without others help for disabled persons. This paper enhances the functionality of the normal wheelchair and provides a cost effective solution. This smart robotic wheelchair has a great significance in life of a disabled person. With several merits, a wheelchair becomes a dilemma for a disabled person when comes to self propulsion. This paper describes an economical solution of robot control systems. The presented wheelchair control system can be used for different sophisticated robotic applications. The automatic robotic wheelchair comprises of the features like sensing hindrances and circuitry to avoid colliding to obstacle and emergency messaging. Implementing embedded systems solution on self-propelled wheelchair enhances upgradability. This paper briefs a multifunctional wheelchair for disabled mob using, touch screen, ultrasonic sensor and GSM system interfaced throughArduinomicrocontroller which ultimately abolishes switching technology and thus optimizing hardware cost.

KEYWORDS: Smart Robotic Wheelchair, GSM System, Optimizing Hardware Cost, Arduino Microcontroller

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INTRODUCTION

Overview

An Embedded system is a combination of software and hardware to perform a dedicated task. Adding embedded system greatly enhances the functionality of a device. The basic wheelchair is a manual one and requires another person's assistance. Without another person's support it is very difficult for a paralyzed patient or physically challenged individual to take care of himself and move from one place to another place. In addition to that absence of breaking system also will be disadvantageous as the individual may not be able to control the speed of his wheelchair. So, adding embedded to this wheelchair improves the functionality like self-propulsion, obstacle avoidance, and emergency texting. Thus there will be no need for other person to push the wheel chair.

Proposed System

The main parts of the system are wheels. The movement of the wheels is based on the control signals. The control signals make the wheelchair to move forward, backward, right, and left. When the wheelchair is given with no control signal then the wheels' motion is stopped. The system is wireless and the control signals are transmitted wirelessly from transmitter to receiver. In addition to this obstacle avoidance system makes the wheelchair to stop when any obstacle comes closer to the wheelchair. In case of emergency to the person, to cater his needs, emergency messaging system is added.

Body of wheelchair is customized in such a way that joystick for motion control is placed on armrest pad and rest of the circuitry is boxed just underneath the seat and above the cross brace, making the arrangement lucid, steadfast thereby letting users see just the relevant details. By enabling joystick the user can control the mobility of wheel chair with less effort. Along with wheelchair movement it facilitates obstacle avoidance facility and emergency calling which leads a merit for a care taker besides just for the disabled person him/herself. This intelligent system comprises of RF transceiver, GSM module, ultrasonic Hc-sr04, Touch screen and two ATMEGA328 microcontroller units. The work herein is entirely controlled by joystick module with Arduino development board and the commands through RF transmitter are received by the microcontroller at the other side. The command received by the microcontroller further decodes the signal and performs the specific operation in accordance with the option chosen on the Touch module. At times when critical situation arises, the user may need to ping some another person to seek help. This work introduces another

feature of emergency texting wherein texting a particular number user can gain help of any care taker. Thus the proposed system saves human effort, reduces complexity of operation.

Obstacle Avoidance and Emergency Calling Features

For obstacle avoidance, an ultrasonic sensor (HC-SR04) is used. Using the sensor, the distance between the vehicle and the obstacle in front of it is continuously measured. A threshold distance, below which the wheelchair has higher chance of collision, is set. If the vehicle's distance crosses below this threshold distance, then the motion of the vehicle is stopped. Thus the wheelchair can avoid hitting any other obstacles.

For emergency messaging a GSM module is used at the transmitter end. A prefixed message is written in the code for assistance. A button for sending the message is interface with the microcontroller. After pressing the button, the message is sent to the person's care taker. The number will be written in the code.

LITERATURE REVIEW

In this paper the hardware and software for the prototype of a low cost multifunctional wheelchair is developed. The wheelchair body is mounted on two wheels whose motion is controlled using a dual axis joystick. The system consists of two modules, a transmitting module and a receiving module. Two microcontrollers are used at both the ends. The two modules communicate wirelessly using 315 MHz transmitter and receiver modules.

At the transmitter module, the dual axis joystick is interfaced to the micro controller and the commands for the wheelchair movement are coded. These commands are sent to the receiver module at 315 MHz using a RF transmitter with encoder. At the receiver a decoder with receiver which is operating at the same frequency is used. The microcontroller receives the information at the receiving end and controls the wheelchair accordingly.

For driving the motors the output from the motors is not sufficient. So, a motor driver with 12V battery is used for driving the motors. At the same time Ultrasonic sensor calculates the distance between the wheelchair and the obstacle and uses this information in controlling the motion of the wheelchair. When the wheelchair is moving forward, if the distance is less than a specific preset value, the motors stop moving. Then the patient who is controlling the wheelchair has to move the chair in either of the remaining directions, so that the distance in the forward direction will change to a value

more than the preset value and the wheelchair will be free to move in forward direction. This will help in avoiding the accidents due to over speeding or momentary carelessness by the patient.

The main objective of this paper is to make the patient to take care of his movements. But sometimes, during emergency or any other situations, the patient will need some assistance from other persons. So, to cater his needs, an emergency messaging system is included with the wheelchair. This is done using GSM (Global system for mobile communication) technology. SIM300 module which is a triband GSM modem is used for communication. It is interfaced at the transmitter side. The mobile number of the person who takes care of the patient is noted for sending the alerts. Then after the patient has pressed the button, an emergency text message will be delivered to the person's mobile number.

METHODOLOGY

Block Diagram

The hardware consists of two blocks.

(i) Transmitting block

(ii) Receiving block

Transmitting Block Diagram

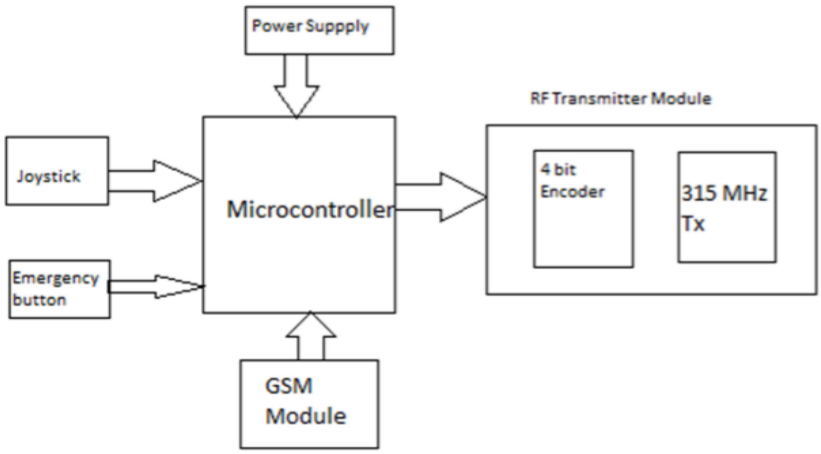


Figure1.Transmitter Block Diagram

Transmitter Block Diagram Description

The main controlling unit of the transmitter part is the ATMEGA328 microcontroller which is mounted on Arduino development board.

The dual axis joystick is used to control the motion. The dual axis joystick has two potentiometers inside it whose value changes on moving the joystick in any direction. Upon interfacing the joystick with Arduino, moving the joystick will produce a change in output voltage at the output pins of the joystick. The two pins are given to the analog input pins of the Arduino. By moving the joystick in four directions, and observing the voltage levels on the serial monitor of the Arduino, four conditions are set for the movement of the wheelchair in forward, backward, left, and right directions. Four digital pins on the Arduino are set to four different values based on the direction of the joystick. The four pins are given to an encoder which encodes them to a single bit. This is given to the RF transmitter which is operating at 315 MHz. This sends the information to the receiver using two digital pins, the GSM module is interfaced with the Arduino. After pressing the emergency button an emergency message will be sent to the preset number.

Receiver Block Diagram

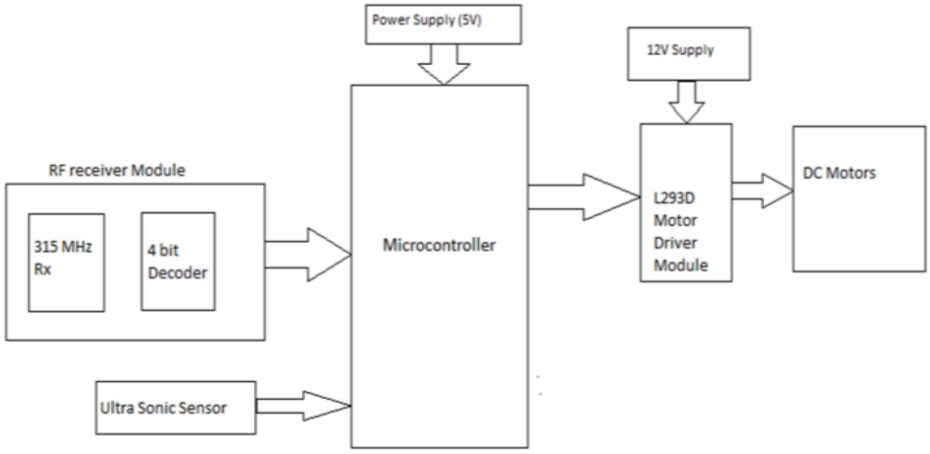


Figure2.Receiver Block Diagram

Receiver Block Diagram Description

The receiver block consists of a ATMEGA328 microcontroller mounted on Arduino board to control the receiving system. The inputs are received from the RF receiver module. The RF receiver module receives the encoded information and this is given to the decoder. The decoder decodes the information into four bits, which is the original information for controlling the wheelchair.

Based on the values of the four bits in the receiver block, the wheelchair is moved in front, back, left, and right directions. This is done by using four digital pins which are given to the motor driver. The motors will run in reverse direction if they are given with opposite polarity. So, in forward direction both the motors are given with same polarity. In reverse direction, the motors are given with

opposite polarity to that of the forward direction. To move in right direction only the left motor is moved in forward direction. To move in left direction, only the right motor is moved in forward direction.

At the same time, using ultrasonic sensor, the distance is calculated. If this distance falls below a specific threshold value while moving in the forward direction, the motors will stop moving. Now, the wheelchair has to turn in direction other than the forward direction, so that the distance will cross above the threshold value, to move forward. The motors are driven by using L293D motor driver module which is powered using a 12V battery**.**

HARDWARE & SOFTWARE REQUIREMENTS

Software Requirements

1. Arduino Compiler

The Arduino IDE is a cross-platform application written in Java, and is derived from the IDE for the Processing programming language and the Wiring project. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. The Arduino IDE comes with a C/C++ library called "Wiring" (from the project of the same name), which makes many common input/output operations much easier. Arduino programs are written in C/C++.

Hardware Requirements

1. Arduino Uno R3
2. GSM SIM300 module
3. Dual Axis Joystick Module
4. Wireless trans receivers
5. Ultrasonic sensor (HC-SR04)
6. Caster Wheel
7. Chassis C6 board
8. DC Motor
9. Motor driver IC

1. Arduino Uno R3

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language and the Arduino development environment. Arduino projects can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing,).

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Figure3.Arduino Uno R3

Features

Microcontroller:	ATmega328
Operating Voltage:	5V
Input Voltage (recommended):	7-12V
Input Voltage (limits):	6-20V
Digital I/O Pins:	14 (of which 6 provide PWM output)
Analog Input Pins:	6
DC Current per I/O Pin:	40 mA

DC Current for 3.3V Pin:	50 Ma
Flash Memory:	32 KB of which 0.5 KB used by bootloader
SRAM:	2 KB (ATmega328)
EEPROM:	1 KB (ATmega328)
Clock Speed:	16 MHz

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM.

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin mode, digital write, digital read functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog write function.
- **LED:** 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog reference function. There are couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analog reference.
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of theATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics:

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not even multiple of the 100 mil spacing of the other pins.

2. GSM

GSM (or Global System for Mobile Communications) was developed in 1990. The first GSM operator has subscribers in 1991, the beginning of 1994 the network based on the standard, already had 1.3 million subscribers, and the end of 1995 their number had increased to 10 million!

There were first generation mobile phones in the 70's, there are 2nd generation mobile phones in the 80's and 90's, and now there are 3rd gen phones which are about to enter the Indian market. GSM is called a 2nd generation, or 2G communications technology.GSMacts as a SMS Receiver and SMS sender. The GSM technical specifications define the different entities that form the GSM network by defining their functions and interface requirements.

Features of GSM

- Single supply voltage 3.2v-4.5v
- Typical power consumption in SLEEP Mode: 2.5mA.
- SIM300 tri-band.

Figure4.Gsm Modem Sim 300

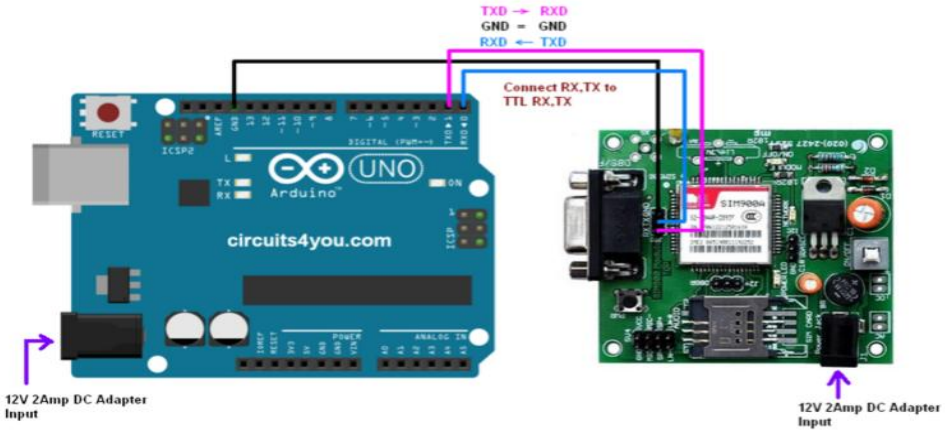


Figure5.GSM AndArduinoInterfacing

3. Dual Axis Joystick Module KY-023

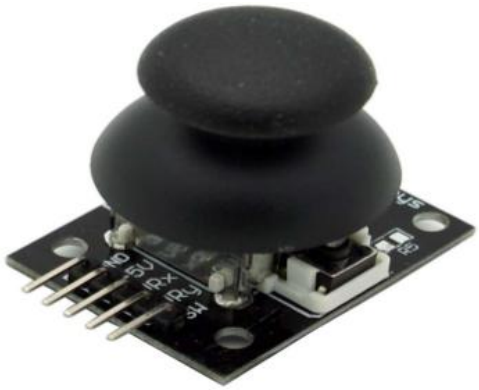


Figure6.Dual Axis Joystick

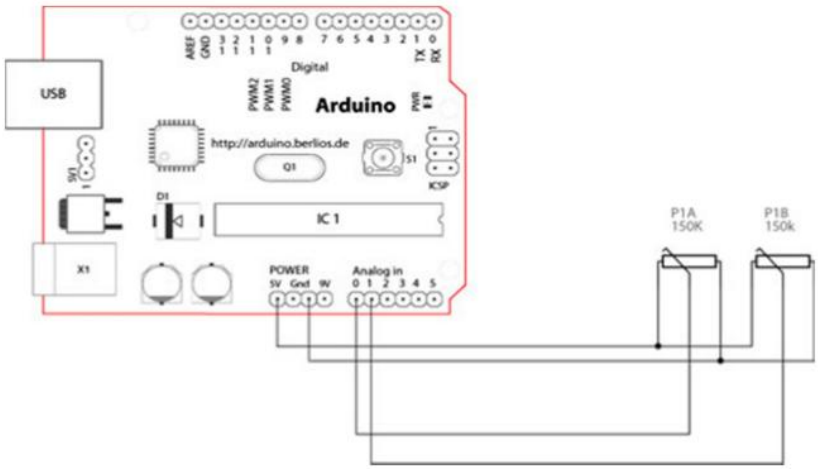


Figure7.Joystick Interfacing With Arduino

Working:

The joystick in the picture is nothing but two potentiometers that allow us to measure the movement of the stick in 2-D. Potentiometers are variable resistors and, in a way, they act as sensors providing us with a variable voltage depending on the rotation of the device around its shaft. The kind of program that we need to monitor the joystick has to make polling to two of the analog pins.

We can send these values back to the computer, but then we face the classic problem that the transmission over the communication port has to be made with 8bit values, while our DAC (Digital to Analog Converter - that is measuring the values from the potentiometers in the joystick) has a resolution of 10bits. In other words this means that our sensors are characterized with a value between 0 and 1024.This joystick module can be used in robotic projects and is very similar to analog joysticks used for gaming. It is made by mounting two potentiometers perpendicular to each other. They are connected to a short stick centered by springs. These two potentiometers enable us to sense dual axis(XY) movement of the stick. It also has a select button which is actuated when the stick is pressed down in the Z direction. This Joystick Module can be easily interfaced with Arduino Boards, Raspberry Pi and Microcontrollers using Analog to Digital Converter.

4.Wireless Transmitter Receiver Modules

A wireless radio frequency (RF) transmitter and receiver can be easily made using HT12D Decoder, HT12E Encoder and ASK RF Module. Wireless transmission can be done by using 433 MHz or 315MHz ASK RF Transmitter and Receiver modules. In these modules digital data is represented by different amplitudes of the carrier wave, hence this modulation is known as Amplitude Shift Keying (ASK).

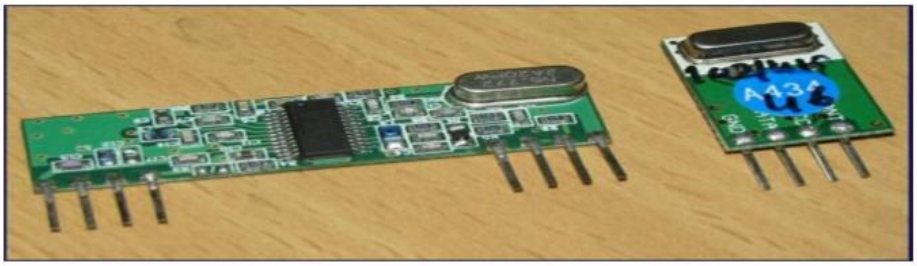


Figure8. RF Transmitter and Receiver Modules

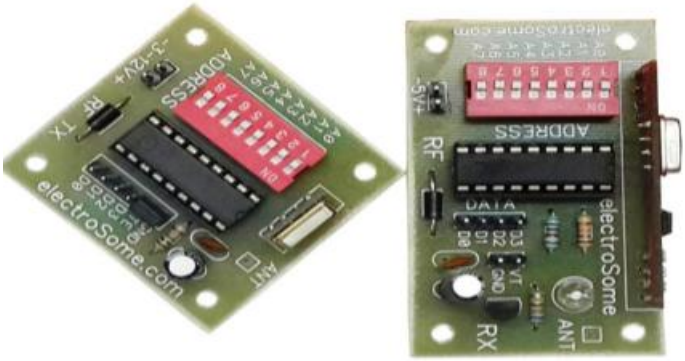


Figure.9 RF modules with encoder and decoder

5. Ultrasonic Sensor

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easyto-use package. From 2cm to 400 cm or 1" to 13 feet. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module. The sensor emits a short 40 KHz ultrasonic burst**.**

Figure10. Ultrasonic Sensor

Schematics

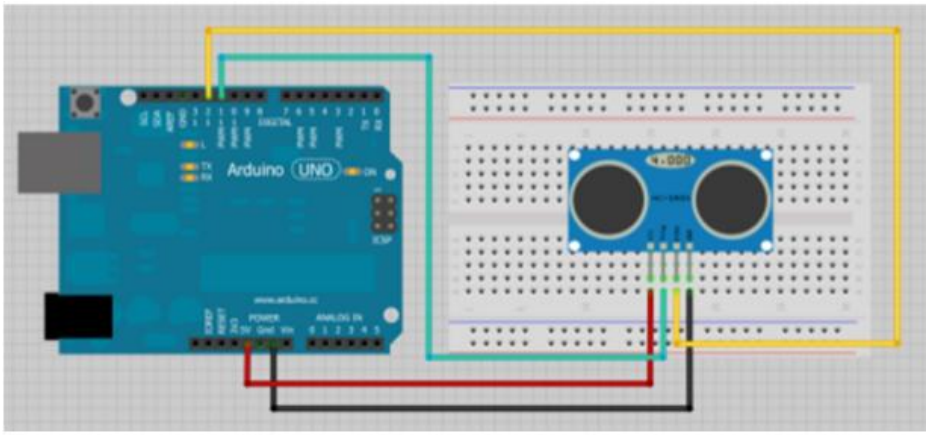


Figure11.Ultrasonic Sensor Interfacing With Arduino

6.Caster Wheel

Figure12. Caster Wheel

This is a big omnidirectional metal ball castor wheel. It is commonly used as support wheel in robots and can be easily mounted to commonly available robot chassis. It has three 120° apart mounting holes having 3mm diameter. It also has a red cap covering the strong metal body.

7. Chassis C6 Board

Figure13. Chassis

8. 12v DC 300 rpm Motor

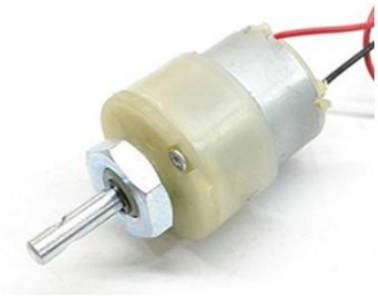


Figure14.DC Motor 1KG/Cm Torque

Features:

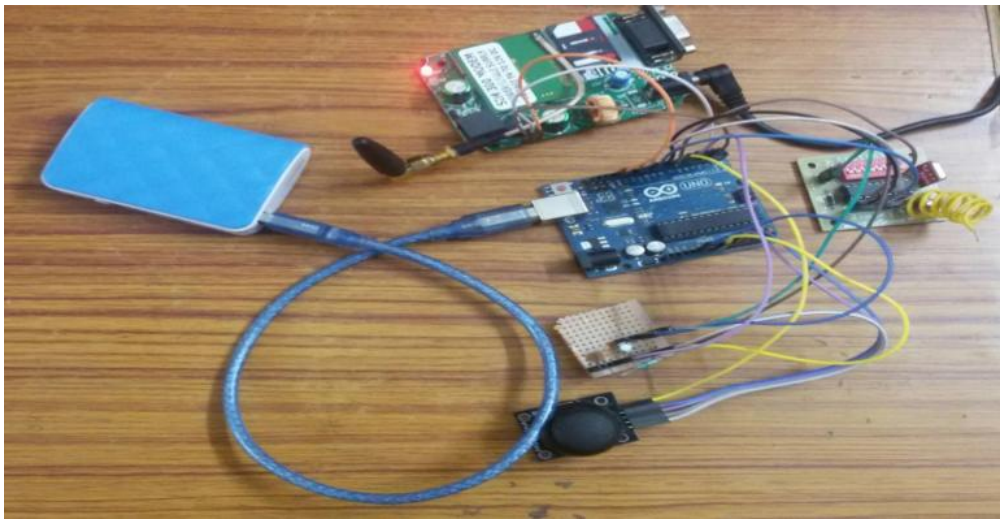
- 300RPM 12V DC motors with Gearbox
- 3000RPM base motor
- 6mm shaft diameter with internal hole
- 125gm weight
- Same size motor available in various rpm
- 0.35kgcm torque
- No-load current = 60 mA (Max), Load current = 300 mA (Max)

9.Motor driver IC - L293D

Features:

- Wide supply-voltage range: 4.5 V to 36 V
- Separate input logic supply
- Internal ESD protection
- High-Noise-Immunity inputs
- Output current 1 A per channel (600 mA for L293D)
- Peak output current 2 A per channel (1.2 mA for L293D)
- Output clamp diodes for inductive transient suppression (L293D)

RESULTS



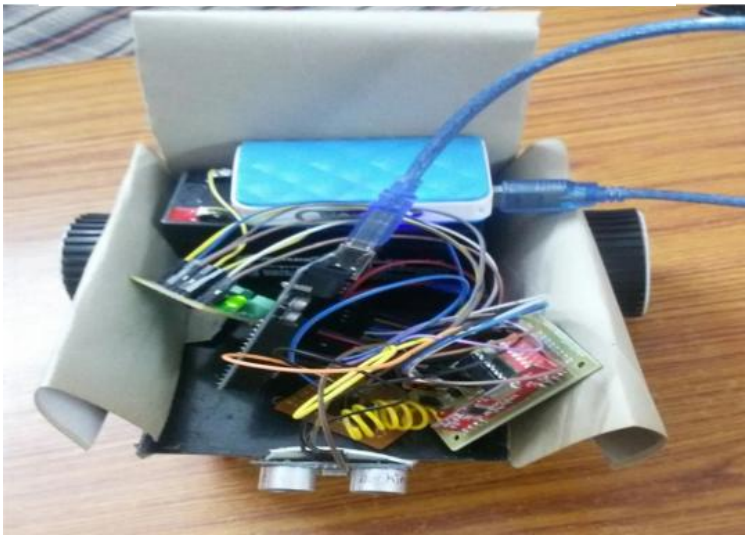


Figure16. Receiver And Wheelchair Circuit

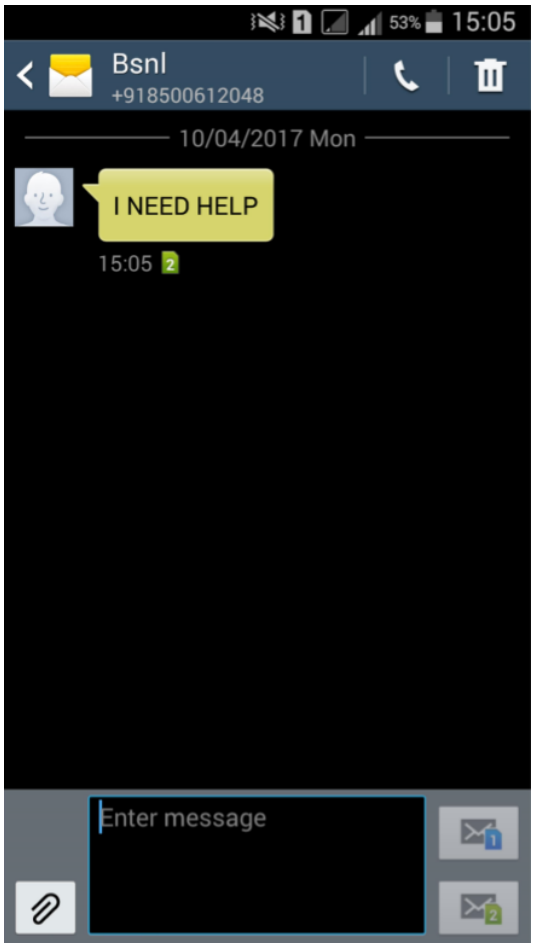


Figure.17EmergencyText Message

CONCLUSION

Wireless multifunctional wheelchair provides a better reliable alternative than selfpropelled wheelchair. Using the joystick, the movement can controlled easily with very less effort from the patient. Obstacle avoidance will prevent any damage that will occur due to over speeding or momentary negligence by the patient who is operating the wheelchair. As the system is built wirelessly complex wiring circuitry is avoided. This makes it easy to comprehend and add additional features or repair the system. By incorporating emergency messaging the patient can contact another person if he/she needs any assistance.

FUTURE SCOPE

- The joystick can be replaced with touchscreen or touchpads to further minimize the physical effort of the patient

- Emergency calling can be incorporated where the patient can interact with other person verbally and takes instructions from other person
- The patient's health condition such as heartbeat, ECG, blood pressure etc., can be measure and sent to doctor who will be in another place by incorporating a WiFi module and thus incorporating Internet of Things (IoT)

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