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Smart Wheelchair for Physically Handicapped Persons

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Abstract - *Now a days, many countries are focusing on smart technology. Our Prime minister of India has also started Smart India and Digital India mission for competing with the other countries of the world. In present time, difficulties are not faced by abled person but are being faced by physically disabled and old aged person. So for their ease of living and getting a better life we came to an idea of smart wheelchair for physically disabled. Smart Wheel Chair is a device which is designed to have self-mobility with the help of the user command, resulting in reduction of the user's human effort and force to drive the wheels for wheelchair. Furthermore it also provides an opportunity for visually or physically impaired persons to move from one place to another. The wheelchair is also provided with obstacle detection system which minimizes the chance of collision while using it. We are trying to provide all the features required in a smart wheelchair at the least price we can for making the disabled person and old aged people's utmost independent on others such as helpers or attendees.*

Key Words: Automatic Braking, Physically Disabled, Smart system, Wheelchair, Hand Inclination, Temperature Detection, Automatic System.

1. INTRODUCTION

Today in market there are many wheelchairs available in the market but they are not embedded with smart systems if they are available then the cost is ranging from 3 lacs to 4 lacs and this price is not affordable for a common man. As the Honorable Prime Minster of India Shri Narendra Modi has started a campaign Shashakt Bharat Abhiyaan for the help of Physically Handicapped persons. As an engineer it becomes our moral responsibility to give something back to the society, so for helping the physically disabled and supporting our nation in the Shashakt Bharat Abhiyaan we came up with an idea of developing a smart wheelchair for physically disabled persons that can give the maximum features at the minimum and affordable price to be used by the common man and can move on his own by the use of this smart wheelchair being independent on anyone. This wheelchair can be guided according to the choice of the user i.e. by the use of IR Remote, Bluetooth or Gyroscope Sensor. The best technology we are providing is the Gyroscope sensor by which the motion can be provided by moving our hand or palm in very small area. This is most reliable and précised sensor for providing motion to the chair. So if a person who's minor part of the body is working he or she can use it with the least efforts and maximum precision and speed control. This device is loaded with many additional features which make it smart. There are features like Automatic Braking, Patient's body temperature Monitoring System, Room Automation System, Battery Power Indicator, Touchpad Based Control, Bluetooth Control, and IR remote based control.

2. RELATED WORK

2.1 Power wheelchair

Presently in market smart wheelchairs are available but are not affordable by common men. They are powered using high power battery and super torque motors so proportionally the cost of the product also increases. The motion provided to the chair is by the use of Joystick and Toggle switch and a person who is 90 – 95 % handicapped cannot drive the wheelchair.[1] So these types of peoples require an attendee or a care taker with them.

2.2 Manual wheelchair

Manual or traditional wheelchair are the type of wheelchair that are mostly used by a layman. A middle class person cannot afford power wheelchair so they use the traditional Manual wheelchair. These chairs are to be manually powered and this creates a big problem for the disabled to locomote from one place to another without a attendee.

So the necessity of superseding the Power and traditional wheelchair uprises for providing more maneuverable motion to the wheelchair by the low cost high functionality smart wheelchair uprises.

3. PROPOSED SYSTEM

Keeping up all the advantages and disadvantages of the present system in mind we are hereby proposing a new advanced smart wheelchair for the physically disabled persons who are not financially sound for purchasing a power or smart wheelchair as the cost is very high.

So we designed a wheelchair which is much more efficient, much smarter, more maneuverable, having précised control for motion, on chair room automation system, control using Bluetooth, IR Receiver and Touchpad. As we are providing many options for a better motion, the type of drive is selected by the user depending upon the choice and requirement of the user. The system proposed is totally

controlled by a microcontroller Arduino MEGA 2560. It is the main and the biggest chip that can be seen in the system. This controller is controlling the motion part and light indication part of the system i.e. the motion by Bluetooth, IR, and touchpad or by gyroscopic sensor. The light indication of the chair is also controlled by Arduino MEGA 2560. The extra features that are affixed on the chair are controlled by the second microcontroller i.e. temperature monitoring system, Automated braking. The system of room automation is done by using very small sized microcontroller i.e. Arduino NANO attached to the Bluetooth and the keypad on the chair which serves the purpose of transmission of the Bluetooth signal to another bluetooth and Arduino PRO MINI attached in the switch board with the relay control circuit for the operation of the devices or equipment connected in the room. Here a four channel relay which is driven by the ULN 2003 driver connected to the microcontroller for the operation.

4. TECHNOLOGY OF THE PROPOSED SYSTEM

In the proposed system mainly four Microcontrollers are used, they are as follows:-

4.1 Arduino MEGA 2560

This is physically the largest controller that can be seen on the system. This is a motherboard developed by the well-known embedded system manufacturer Arduino. The board is based on the microcontroller ATmega 2560 which is manufactured by Atmel in ATmega series. As the crystal frequency available on board is of 16 MHz which gives an ultrahigh speed processing of the programs and analyze the data at a comparatively faster speed for better operation of the connected devices and peripherals. There are total hundred pins on the microcontroller where 62 pins can be used as a general purpose input output (GPIO). This microcontroller is programmed by the use of Arduino IDE (Integrated Development Environment), which is the most compatible language with the hardware.

Microcontroller	: - ATmega2560
Operating Voltage	: - 5V
Input Voltage	: - 7-12V
Input Voltage (Limit)	: - 6-20V
Digital I/O Pins	: - 54 (14 PWM output)
Analog Input Pins	: - 16
DC Current per I/O Pin	: - 40 mA
DC Current for 3.3V Pin	: - 50 mA
Flash Memory	: - 256 KB
SRAM	: - 8 KB
EEPROM	: - 4 KB
Clock Speed	: - 16 MHz

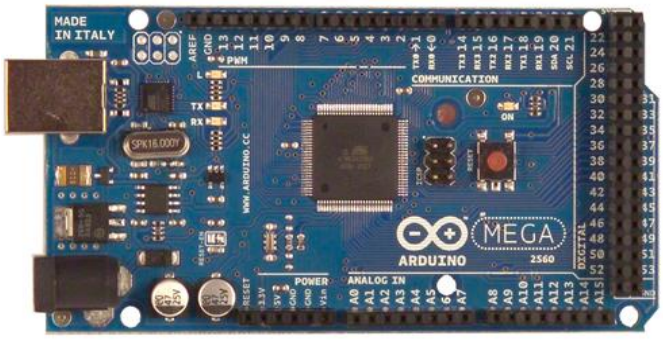

Fig -1: Arduino Mega Development board

4.2 Arduino UNO

This motherboard is developed by Arduino. This board is based on the microcontroller ATmega 328P. The controller is having a frequency of 16 MHz providing a high speed control and better processing of the program. This microcontroller is used for the additional features that are provided on the chair i.e. Automatic Braking and body temperature and monitoring system. This controller is used just for the additional features that are implemented in the device.

Fig -2: Arduino UNO Development board

4.3 Arduino NANO 3.0

This microcontroller is used for the control of keypad and data transmission by HC 05 master Bluetooth Module for the room automation. It is used as, the space requirement is the main constraint of the system.

Fig -3: Arduino NANO Development board

4.4 Arduino PRO MINI

This microcontroller is used as the slave in the room automation system which is connected to the slave Bluetooth and the relay assembly circuit.[2] This circuit is placed in the switch board or just nearer to it. The devices of the room are connected to the relay and the relay is driven by the use of the driver IC ULN 2003 which is controlled microcontroller. So by sitting on the chair the equipment of the whole room can be controlled and that provides an ease of access to the user and adds an additional feature in the wheelchair.

Fig -4: Arduino PRO-MINI development board

5. ADDITIONAL FEATURES

Some additional features like Automated Braking, Temperature detection and Monitoring system, Room automation system, Automatic Battery Level Indicator are provided. Whenever any obstacle comes in front of the device and the user is unknown about that obstacle then the chair will automatically decrease its speed as a notification for informing the user about the upcoming obstacle so that user can either go in the same direction or can change the direction of the chair accordingly. The temperature detection and monitoring system is used to regularly monitor the body temperature of the user and also generates an alarm if the body temperature goes above the nominal body temperature so that the attendee or any other person can know about it.

The room automation control is a system used for the on chair control of the room of the user by the means of Bluetooth and Microcontroller in the room and in the chair and a 4 x 3 keyboard interfaced to the chair.

An Automatic Battery Level Indicator has been attached to it informing user about the power level of battery whenever he or she is going the power level of the battery can be checked. As these features are available in the present wheelchairs but are comparatively much expensive.

5.1 Automated Braking System

In this system an Automatic Braking system as an additional safety feature is added. For that purpose here the concept of distance sensing is implemented by the use of Ultrasonic Sensor. This sensor have three parts.

Fig -5: Ultrasonic Sensors

They are as follows:

1. Transmitter
2. Receiver
3. Control circuit

The transmitter transmits a wave of frequency 40 KHz which when comes in contact with any object it gets reflected and is received by the receiver for analyses. The control circuit consisting of three op-amps for the process of amplification of the received signal.[3] After analyzing the received signal the data is sent to the connected controller and the distance is calculated on the basis of detected distance and accordingly motor is controlled. By this process the brakes to the chair are applied and it stops.

5.2 Body Temperature Monitoring System

The body temperature detection and monitoring system works on the temperature sensor LM 35 which gives an analog output of the temperature to the microcontroller. When the body temperature of the user rises above 98˚ F then there is an alarm in the system to alert the user and the attendee about the increased body temperature of the user.[4] So that proper treatment of the user can be done within time. This features is implemented in the system for the extra safety of the user.

Fig -6: LM-35 Temperature Sensor

5.3 Automatic Battery Level Indicator

This device is used for monitoring the power level of Battery. It is provided as an additional feature in the device. In case if user is going out for some time then he can check the level of battery from the bar graph or the dot display attached with the battery. This provides an additional feature for the user.

5.4 Room Automation System

This adds an additional feature on the wheelchair by the use of this feature the user can access all the devices in the room by use of Bluetooth connectivity. One Bluetooth is attached with microcontroller Arduino PRO MINI with a 4 channel Relay Board of 12V input for control of devices of the room driven by ULN2003 IC. It is installed in the switchboard of the room.

The second Bluetooth is attached with Arduino NANO 3.0 microcontroller with the Keyboard for the operation of Bluetooth HC 05 Master Module for sending the command to the HC 05 Slave Module installed in the Switchboard of the room.

6. SENSOR FOR MOTION OF THE WHEELCHAIR

Our designed wheelchair is provided motion by the use of three technologies. They are

1. Gyroscope Sensor
2. IR based Control
3. Touchpad Control.

A brief explanation of all the system is given as below.

6.1 Gyroscope Sensor

In this system a MPU-6050 Gyro sensor for the main motion of the chair is used. This sensor works on the principle of Gravity. It senses the inclination and accordingly gives output in analog form. The output quantities available from the sensor are Roll, Pitch and Yaw. These quantities are further taken for processing and the motion of the device is controlled by just the movement of the hand of the user. The user has to incline his hand in desired direction and the chair will move accordingly. This system is implemented for the person who cannot operate the joystick control on other wheelchairs or is paralyzed by the whole body having just one arm moving or working. So that they can get ease of access to the device and can move without applying any type of force on the device or by manually powering it.

Fig -7: MPU-6050 Gyroscope MEMS sensor

6.2 Touchpad

The touchpad consists of array of 5 sensors of TCRT 5000. These sensors are used for the purpose of line following and we are using here for designing our touchpad as it will be used to provide motion to the wheelchair in case of failure of the gyroscope sensor[5]. As the chances of failure of gyroscope sensor are very less as compared to other existing system. So this is kept as an auxiliary motion control for the chair.

6.3 IR Remote Based Motion

A TSOP based remote control as an auxiliary motion technique is used. This motion technique can also be used for placing of wheelchair at a different place while sitting on the bed or when the patient is not able to move to place it at a right position in the room.[6] This provides a facility for the user in managing the placing and position of the chair in the user's room. Here we are using TSOP 1738 module for remote sensing.

Table 1: Cost Estimation

Sr. No.	Component	Quantity	Price (INR)
1.	Arduino MEGA 2560	-1-	1400/-
2.	Arduino UNO R3	-1-	900/-
3.	Arduino PRO MINI	-1-	450/-
4.	Arduino NANO	-1-	450/-
5.	Motor Driver L298N	-1-	300/-
6.	DC Geared Motor	-2-	600/-
7.	Gyro Sensor	-1-	400/-
8.	Ultrasonic Sensor	-1-	300/-
9.	Temperature Sensor	-1-	50/-
10.	Bluetooth HC 05	-2-	700/-
11.	IR Receiver Module	-1-	150/-
12.	TCRT 5000 Touchpad Module	-1-	450/-
13.	Four Channel Relay Board	-1-	300/-
14.	Battery Sealed Rechargeable	-1-	650/-
15.	Battery Charger	-1-	150/-
16.	FDTI Bootloader for Pro	-1-	300/-

	mini		
17.	4x4 Numeric Keypad	-1-	215/-
18.	Miscellaneous	-----	1500/-
----	Total Amount	-----	9265/-

7. RESULTS

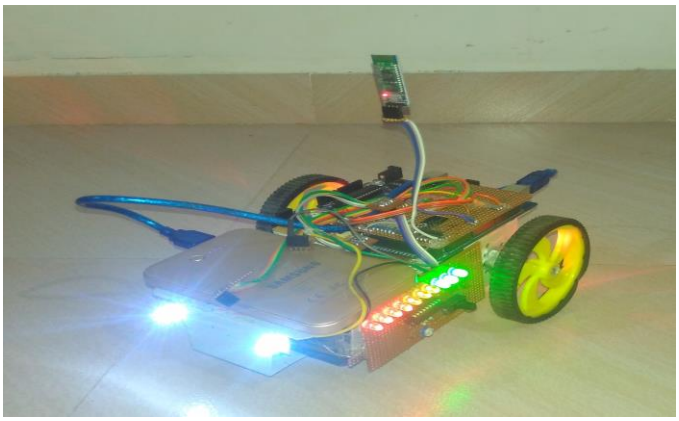

Fig -8: First working prototype of the system

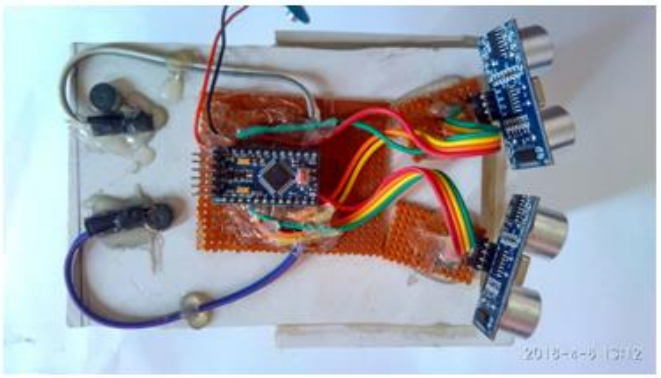

Fig -9: Automated braking circuitry

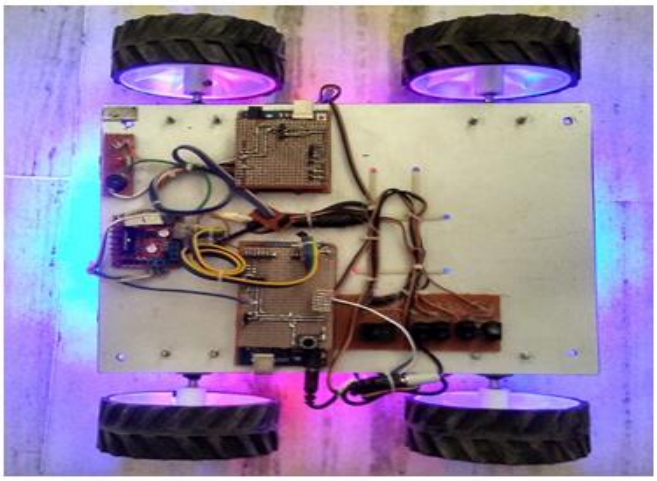

Fig -10: Final working prototype

8. CONCLUSION

Most modern day technologies use sensors such as accelerometer, gyroscope, to take interactive input and in this project also we have tried to make the robot interactive and close to human. Completion of this project needed sheer determination as there were many things that could go wrong. Though some difficulties aroused and many remodeling was needed and the chair had some limitations which we learned while building it, at last the Smart Wheel Chair created very close to the adapted design philosophy.

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BIOGRAPHIES :

Ravi Sharma a student from the department of Electrical Engineering, working in the field of Robotics and Automation and developing different systems which can help the society.

Chinmay Modak a student from the department of Electrical Engineering, a curious techie about the designing of any system.

Lovely Singh a student from the department of Electrical Engineering, a marketing expert being from the field of engineering. The undividable bond of the team