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An Android Based Smart Wheelchair with Health Monitoring using IoT

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ABSTRACT: The module proposed in this paper is an advanced solution for the physically disabled patients to provide them easy mobility with a health monitoring system. The various modes of effortless inputs that we have used in our wheelchair provide a high level of comfort to the user. When considered in context of existing ones, the proposed system stands ahead because of the unique feature of Internet of Things (IoT) that we have embedded in our system. Also, the big need of health monitoring system in the existing ones has overcame in this module. Various safety oriented components such as headlights, emergency lights, buzzer and a panic button will add up to prove the system perfect for daily use. It also includes sensors for monitoring heartbeat, body temperature and humidity which will be a boon for health monitoring department. Safety from each level of perception is maintained and taken care of in this system. Infrared sensors have also been used to avoid the nearing threat or sudden obstacle in the path.

KEYWORDS: Smart Wheelchair, Health Monitoring System, IOT, Android App, Physically Disabled, Temperature & Humidity Sensors, Arduino

I. INTRODUCTION

Disability of a victim can be of any type and can be of sever level. Also, with the increasing population of these people one such proposed system is of high need to the society. Deep down in the severity of this causes it is seen that people who cannot manipulate the wheelchair with their arm due to lack of force or constant attention faces major problems in controlling wheelchair. Following are the variety of such wheelchairs present in the market:

1. Voice Controlled: It can be controlled by verbal command that a user provides and chair moves accordingly.
2. Manual or Self-Moving: A standard version of wheelchair which has got wheels on both side and can be dragged by the user or can be controlled with joystick.
3. Image Acquisition: It uses camera to detect the hand movements and accordingly chair responds.
4. Sensor Controlled: It will use sensors like accelerometer and flux sensor. From stability view it is very good but at the same time it requires high level of accuracy while designing and programming.

On considering all the possibilities that we have listed we have decided to go with manual as well as automated option as it can be operated by all. It gives high level of safety and at the same times comes with useful additional features like night vision and health monitoring system. The proposed system is economical and compact. These features will add up to build a helpful system.

II. IOT ECOSYSTEM

The major sectors that are getting benefited from IoT are government, business and consumers. So as the market is increasing linearly with the time so as technology is also keeping its pace. It is evolving high time essential innovative features like IoT.

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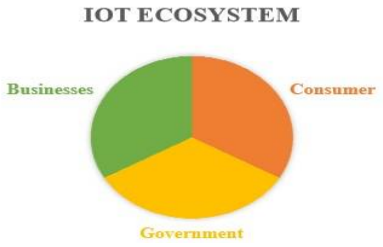

Fig 1: IoT Ecosystem [4]

III. RELATED WORK

In [1] author has discussed about the several applications of IoT in human life and eventually how it will transform the world to a world of Internet which includes giving IP address to each and every physical entity in future. In [2] the author addresses the internet of things and its impact which is the combination of technologies and communication system. In [3] it is viewed that most of current wheelchair systems have embedded computers that have very less computer control and require very precise and low power control from the user.

With all this in mind we have obtained a wheelchair which can be driven autonomously or with the help of mobile phone controls using android applications and with the high percentage of avoiding obstacles.

IV. PROPOSED SYSTEM

The controlling of the wheelchair is done through an android application which is connecting via Bluetooth module and through a manual joystick which is fixed on the hands of the chair, using these two will decrease the dependency of user on another person. We have also equipped our chair with infrared sensors which will help to avoid accidents happening due to obstacles. Sensors will respond to the nearing obstacle and eventually commands will be forwarded to the microcontroller(ATMega328) enabling desired further motion. This system also includes a health monitoring system which monitors health of the user and forward that to the application.

Block diagram below gives the entire information about the proposed system with all the functionalities.

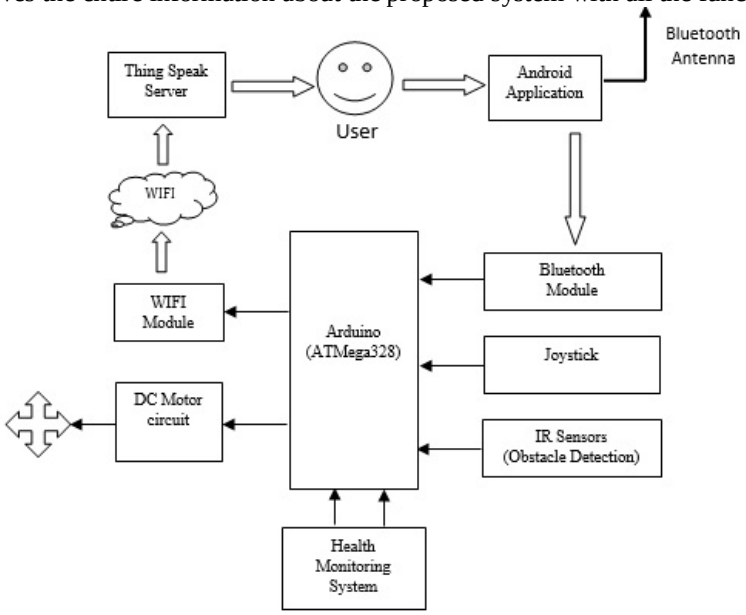

Fig 2: Proposed System

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V. SYSTEM DESIGN

Here, we can understand the hardware and software requirements in the proposed system.

A. Hardware

ATMega328 Microcontroller:

Fig 3: ATMega328 Microcontroller

The Atmel 8-bit AVR RISC-based microcontroller combines 32 kB ISP flash memory with read-while-write capabilities, 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines and 32 general purpose working registers. The device operates between 1.8-5.5 volts. ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models.

LCD Module:

Fig 4: LCD Module

A 16X2 LCD is connected with Arduino at 7,8,9,10,11 and 12 pins to display the reading of various sensors.

WI-FI Module:

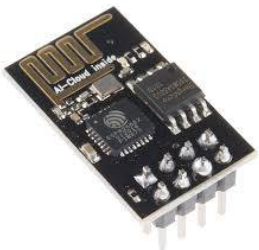

Fig 5: ESP8266

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ESP8266 is an impressive, low cost Wi-Fi module suitable for adding Wi-Fi functionality to an existing microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone Wi-Fi connected device. It requires 3.3 V power. ESP8266 has features like 802.11 b/g/n protocol, Wi-Fi Direct (P2P), soft-AP and Integrated TCP/IP protocol stack.

Joystick:

Fig 6: Joystick Module

A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. We are using dual axis XY joystick biaxial button PS2 module. This module combines two potentiometers and a pushbutton switch into a solid mechanical package with an ergonomic thumb dome. This joystick is perfect for controlling motors, servos, etc. When using the 5V power supply, the default analogue output for X, Y is 2.5V. With the direction of the arrow, the voltage goes up to 5V and the opposite direction it goes down to 0V.

Sensors:

Fig 7: IR Sensor

Sensors are the integral part of the system. Following sensors are also attached to the microcontroller:
IR Sensors: This helps to detect whether there is any obstacle present or not. Sensor detects obstacle by sending continuous signal from transmitter and if there is obstacle then it will stop the wheelchair immediately.
Health Monitoring Sensors: Sensors like Pulse detecting sensors and temperature sensors are used for continuous evaluation of the patient's health and to notify about the same to its guardian through the mobile app.

Motor:

Fig 8: Motor Driver

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Motors are arguably one of the most important parts of a mobile robotics platform. Overpowered motors cause inefficiency and waste the already limited supply of power from the on-board batteries, while undersized motors could be short on torque at critical times. The optimal rotation speed and the available speed range of the motor must also be taken into consideration. Too high of an output rpm from the motor shaft will cause the robot to operate at a fast, uncontrollable speed. Too low of an output and the robot will not be able to attain a suitable speed to meet the user's needs. Therefore, much consideration was put into the selection of the proper motor for the platform. DC motors are commonly used for small jobs and suited the purposes of the platform very well. We are using a 12V DC motor in our wheelchair with L293D motor driver.

Wheels:

Fig 9: Wheel

Wheelchair has four wheels, two rear wheels and two castor wheels, the two caster wheel are fixated in wheelchair base in front, all wheels have the same diameter. The drive wheels are in rear on either side of the base, allowing the chair to turn according to voice command, wheels engage directly to a gear train that transmit torque form motor to wheels by two grooves in each wheel and nut.

B. Software

Arduino:

Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open-source hardware board designed around an 8-bit Atmel AVR microcontroller, though a new model has been designed around a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.
The Arduino board is made up of an Atmel AVR microprocessor, a crystal or oscillator (a crude clock that sends time pulses at a specified frequency to enable it to operate at the correct speed) and a 5V voltage regulator.

To program the Arduino, the Arduino IDE is used which is free software that enables programming in the language that the Arduino understands. In the case of the Arduino, the language is based on C/C++ and can even be extended through C++ libraries.

ThingSpeak:

According to its developers, "Thing Speak" is an open source Internet of Things (IOT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".

Thing Speak has integrated support from the numerical computing software MATLAB from MathWorks allowing Thing Speak users to analyse and visualize uploaded data using Matlab without requiring the purchase of a Matlab license from Mathworks.

VI. WORKING

On finally completing and assembling the modules the main functionality of the system can be explained. Initially the command is given through the mobile phone via android application which reaches the Bluetooth module and it

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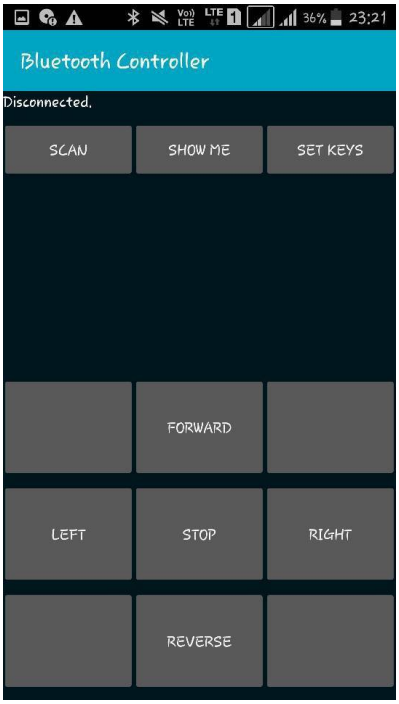
passes the same command to DC motor. On receiving the particular string as a command (left, right, forward or reversed) it will transmit that to ATMega328 microntroller and movement is observed. To back this wireless connectivity a manual provision of joystick is provided to server the same output.

An advance provision of monitoring temperature and humidity of the body and heartbeat rate is also given which is labelled under health monitoring system. This can be observed in real time over Thing Speak servers that can be monitored by the concerned person/guardian at any time any place via an android app.

Below figure shows GUI of the applications that we are using in our system. Figure 10 shows the application that we are using for providing basic directional commands from mobile phone to the system via Bluetooth module. This application uses the internal Bluetooth of the mobile phone. It includes the basic Movement commands like forward, reverse, left, right and stop.

Figure 11 shows the application that we used for monitoring the health of the patient on various parameters. This application shows the reading of heartbeat rate, body temperature and humidity taken from the sensors and transmitted to this application via ThingSpeak server. This is WI-FI based application which is linked to the particular channel of ThingSpeak server.



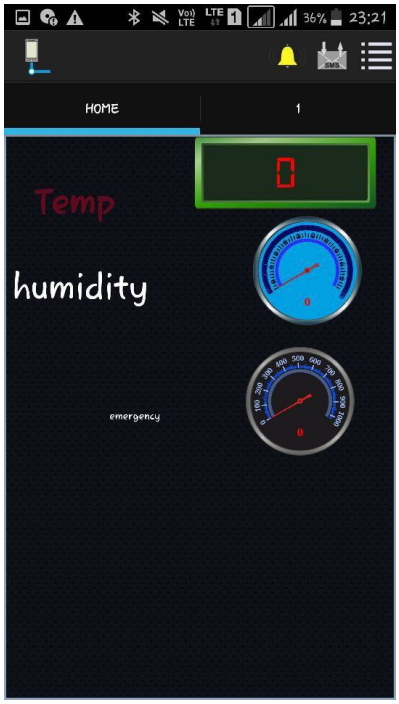


Fig 10: App for Wheelchair's Direction Fig 11: App for Health Monitoring

VII. RESULT & ANALYSIS

An advance provision of monitoring temperature of body, heartbeat rate and sweat is also given which is labelled under health monitoring system. This can be observed in real time over Thing Speak servers that can be monitored by the concerned person/guardian at any time any place.

Below figure shows the reading of body temperature and humidity recorded on Thing Speak server over the Internet in real time. Figure 12 and 13 shows the reading recorded by temperature and humidity sensor respectively.

These reading are transmitted to the ThingSpeak server using Wifi module so that it can be traced to the particular mobile application.

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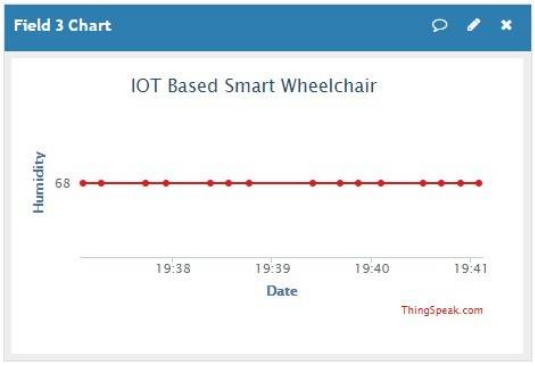

Fig 12: Humidity Readings

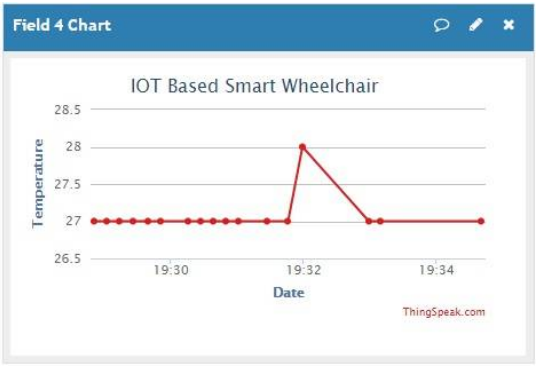

Fig 13: Temperature Readings

Figure 14 shows the final system produced with health monitoring sensors connected to it. On right hand of the chair joystick control, buttons for buzzer and headlight are provided whereas on the left hand side an emergency button is provided which will immediately stop the chair on functioning and inform the guardian about the emergency via mobile app. Under the chair whole circuitry of the system is placed including the power supply and obstacle detecting sensors in all the four directions.

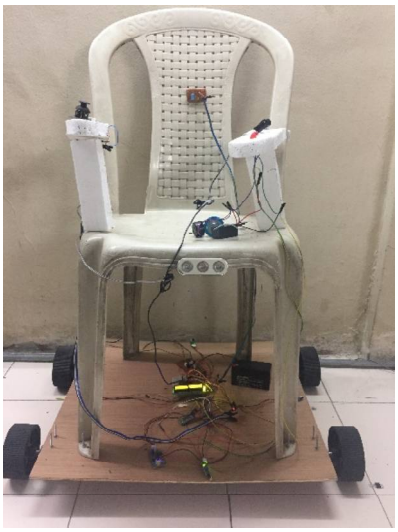

Fig 14: Proposed System

VIII. FUTURE SCOPE

Based on recent advancement in power sources, the diverse varieties of sources are available and one such is solar cell panel which will serve as the alternative source of energy to our primary power supply. To make the system more advance in upcoming era of technology, image processing and artificial intelligence systems can be introduced to the proposed system they together will maximize the performance and expandability of the system. To work over speed related issues/demand gear box will be very best method to increase or decrease the speed as per requirement. Accelerometer is also one such option which can be used to increase the mobility of the person who is not able to use his/her hands.

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IX. ADVANTAGES

This project has following advantages over other existing modules:

1. Easy to drive with negligible efforts.
2. Various modes of driving wheelchair reduce the human intervention to the large extent.
3. Number of sensors are interfaced in the chair which prevent accidents from happening and providing reliable security.
4. Health Monitoring system will be a great benefit to keep an eye on the health status of the user by their guardians in real time.
5. The proposed system is very much economical and highly compact.

X. CONCLUSION

By implementing wireless control and joystick in our chair we have decreased the dependency for the user on another person to a large extent. Health monitoring information will be very helpful for the guardian for keeping an eye on their patient. In the end a very highly reliable system is obtained which will bring a lot of happiness and sense of easy mobility in daily routine of the user.

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BIOGRAPHY

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