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ARM Based Smart & Intelligent Wheel Chair

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ABSTRACT: The aim of this paper is to design smart & intelligent wheel chair for the disabled peoples to make them independent, to build a self confidence & to avoid inconvenience of care taker. The wheelchairs which are operated manually by patients, many problems may occur in controlling the wheel Chair, which may lead to serious consequences.

Hence we proposed a technology which takes the challenge of integrating user friendly technology to establish perfect orientation of the wheel chair in indoor system. This paper describes the wheelchair system with voice control and user friendly touch screen interface. This system is interfaced with GSM and GPRS to locate the destination of disables in case of any emergency. Use of touch-screen enables less muscle movement and less muscular pressure than the self propelled wheelchairs which are being used from ages. Obstacle avoidance facility enables to drive safely in unknown as well as dynamic environments.

KEYWORDS: Easy navigation, Obstacle avoidance, Touch screen, GSM, GPRS, Wheelchairs

I. INTRODUCTION

A With the increase of elderly and disabled people, a wide range of support devices and modern equipment has been developed to help improve their quality of life. Some patients which cannot manipulate the wheelchair with their arms due to a lack of force face major problems such as orientation, mobility, safety. There are various kinds of wheelchair which are being manufactured such as

(1) Manual or self propelled wheelchair-It is normal chair arrangement having wheels which are present on both sides of chair which are dragged by patients manually and Joy-stick operated wheelchair in which joystick is used for operating.

2) Speech Recognition-It recognizes the verbal command given by patient and according to that wheelchair moves.

3) Image acquisition-It uses camera to detect hand movement and according to it movement occurs.

4) Sensor controlled -In this sensors like accelerometer sensor and flex sensor. As a stability point of view it is quite good but it require high accuracy while designing and programming.

Taking all in this in consideration we have decided to do a touch-screen operated wheelchair 1) It is user friendly technology that operates on touch screen 2) less force is required for operation i.e. single finger is enough to operate a wheelchair. As touch screen technology is acquiring highest peak in various scientific as well as commercially developing products, its use in patient friendly devices like wheelchairs may result in improved quality of service.

II. RELATED WORK

In [2] authors used Mems sensor for wheel chair control. Mems sensor is connected to hand on wheelchair. It is a 3 axis accelerometer which gives analog output. The output is fed to ADC which converts it into digital values and gives it to 8051 controller. In [3] system uses GSM and GPRS. GPRS is used for continuous object tracking and GSM is used to send the SMS to the registered number. In [4] system uses voice recognition using MATLAB. Voice recognition system recognizes the voice commands by comparing it with the previously stored data. In [5] wheelchair is designed

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with two modes i) manual mode and ii) voice controlled mode. For manual mode touch pad is used and for voice mode HM 2007 IC is interfaced with controller.

III. PROPOSED SYSTEM

The block diagram of proposed system consists of ARM microcontroller (LPC 2148) interface with accelerometer, touch pad, ultrasonic sensor, voice control model, GSM and GPRS module. The over view of hardware of system and block diagram is shown in figure I.

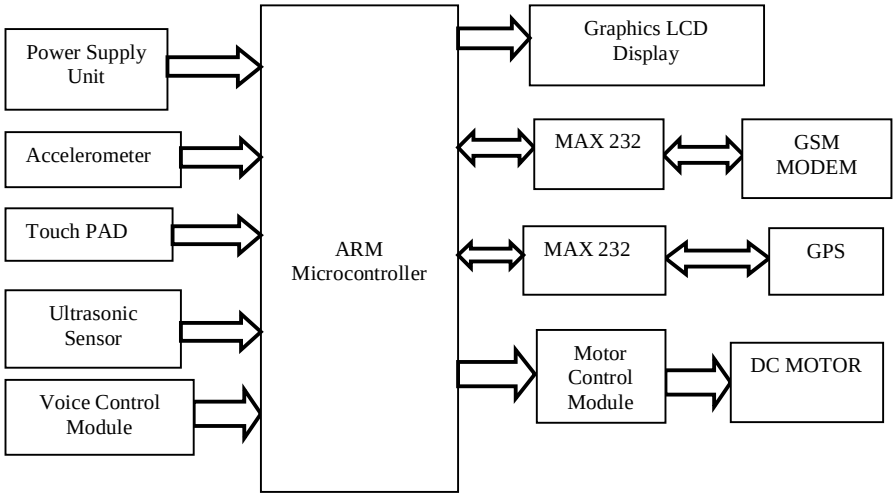

Fig.1. Proposed System

ARM Processor LPC 2148

ARM is a family of instruction set architectures for computer processors based on a reduced instruction set computing (RISC) architecture developed by British company ARM Holdings. A RISC-based computer design approach means ARM processors require significantly fewer transistors than typical processors in average computers. This approach reduces costs, heat and power use. These are desirable traits for light, portable, battery-powered devices—including smart phones, laptops, tablet and notepad computers, and other embedded systems. **LPC2148** is the widely used IC from ARM-7 family. It is manufactured by Philips and it is pre-loaded with many inbuilt peripherals making it more efficient and a reliable option for the beginners as well as high end application developer.

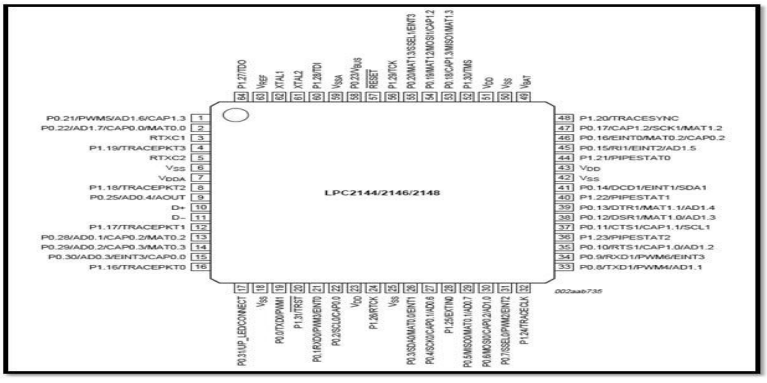

Fig.2. Pin Out of LPC 2148.

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Features

- 8 to 40 kB of on-chip static RAM and 32 to 512 kB of on-chip flash program mem interface/accelerator enables high speed 60 MHz operation.
- In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader softwa sector or full chip erase in 400 ms and programming of 256 bytes in 1ms.
- One or two (**LPC2141/2 vs. LPC2144/6/8**) 10-bit A/D converters provide a tota inputs, with conversion times as low as 2.44 us per channel.
- Single 10-bit D/A converter provide variable analog output.
- Two 32-bit timers/external event counters, PWM unit (six outputs) and watchdog.
- Low power real-time clock with independent power and dedicated 32 kHz clock inpu
- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 SSP with bufferig and variable data length capabilities.
- Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.
- on-chip integrated oscillator operates with an external crystal in range from 1 MHz with an external oscillator up to 50 MHz
- Power saving modes include idle and Power-down.

Power Supply Unit

The main function of power supply unit is to give supply to all electronic components such as ARM processor, LCD, Motor driving unit, GSM & GPS etc. Here we are using +5V regulated voltage supply unit for supplying regulated output. The +5 volt power supply is based on the commercial 7805 voltage regulator IC. This IC produces a steady +5 volt output, accurate to within 5% (0.25 volt). It also contains current –limiting circuitry and thermal overload protection, so that the IC won't be damaged in case of excessive load.

Accelerometer

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

Fig.3. Pin Out of Accelerometer ADXL335

It contains a polysilicon surface-micromachined sensor and signal conditioning circuitry to implement open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration.
The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of the acceleration. The demodulator output is amplified and brought off-chip through a 32 KΩ resistor. The user then sets the signal bandwidth of the device by adding a capacitor. This filtering improves measurement resolution and helps prevent aliasing.

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Ultrasonic Sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

Fig.4. Pin Out of Ultrasonic Sensor

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. 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.

4) Distance can be calculated as follows

$$\text{Distance} = \frac{\text{Speed of sound X time taken}}{2}$$

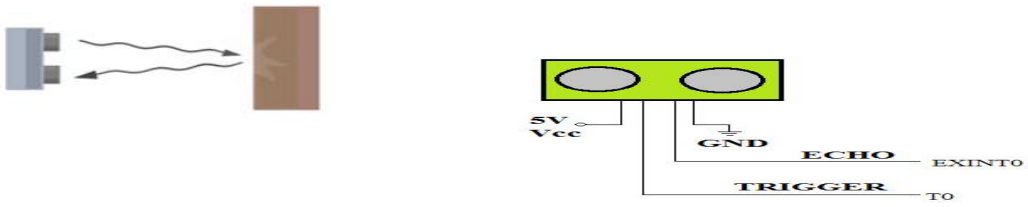

Fig.5. Ultrasonic Sensor

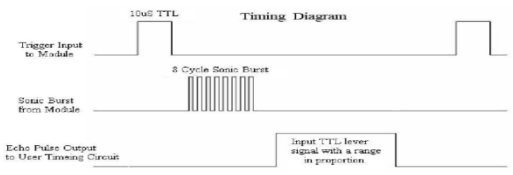

Fig.6. Timing Diagram of Ultrasonic Sensor

GSM MODEM SIM 300

The GSM modem is a specialized type of modem which accepts a SIM card operates on a subscriber's mobile number over a network, just like a cellular phone. It is a cell phone without display. The GSM which is one of the representative wireless networks which has low-power, low-cost and convenience to use. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. Modem sim300 is a triband GSM/GPRS engine that works on EGSM900MHz, DCS1800MHz and PCS1900MHz

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frequencies.GSM Modem is RS232-logic level compatible, i.e., it takes-3v to -15v as logic high and +3v to +15 as logic low.MAX232 is used to convert TTL into RS232 logic level converter used between the microcontroller and the GSM board.

Fig.7. GSM MODEM

Features of GSM

- Single supply voltage 3.2v-4.5v
- Typical power consumption in SLEEP Mode: 2.5mA.
- SIM300 tri-band
- MT, MO, CB, text and PDU mode
- SMS storage: SIM card
- Supported SIM Card: 1.8V, 3V
- Operating frequency: 900 MHz -1800 MHz

GPS

The Global Positioning System (GPS) is a satellite-based navigation system consists of a network of 24 satellites located into orbit. The system provides essential information to military, civil and commercial users around the world and which is freely accessible to anyone with a GPS receiver. GPS works in any weather circumstances at anywhere in the world. Normally no subscription fees or system charges to utilize GPS. A GPS receiver must be locked on to the signal of at least three satellites to estimate 2D position (latitude and longitude) and track movement. With four or more satellites in sight, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the vehicle position has been determined, the GPS unit can determine other information like, speed, distance to destination, time and other. GPS receiver is used for this research work to detect the vehicle location and provide information to responsible person through GSM technology.

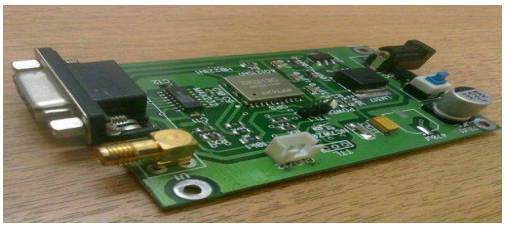

Fig.8. GPS modem

Speech Recognition System based on HM2007

The speech recognition system is a completely assembled and easy to use programmable speech recognition circuit. It has 8 bit data out which can be interfaced with any microcontroller for further development. Some of interfacing applications which can be made are controlling home appliances, robotics movements, Speech Assisted technologies, Speech to text translation, and many more.

Features:

- HM2007 - Self-contained stand alone speech recognition circuit.
- User Programmable through keys.

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- 2 No's of 7-Segment Display (To Display Voice Recognize Commands).
- 4x3 Matrix Key Pads (Train Voice Commands).
- 32K X 8 Non-volatile Memory (Battery Backup)
- 20 or 40 Word vocabulary, Multilingual.
- Power ON status Indication LED.
- 2 No's of Port I/O Connector to interface to control external circuits & appliances.
- MIC Interface

A practical speech recognition System can be constructed using Speech Recognition IC **HM2007** having 48 pin IC which provides speech recognition function. It works in two modes: Manual mode or CPU mode. In both modes, the IC is first trained to recognize words by the user saying each word for corresponding number pressed on the key. The IC stores each word signal in the memory location corresponding to the word. The data output from the IC is interfaced to the Microcontroller from where it is displayed on the LCD.

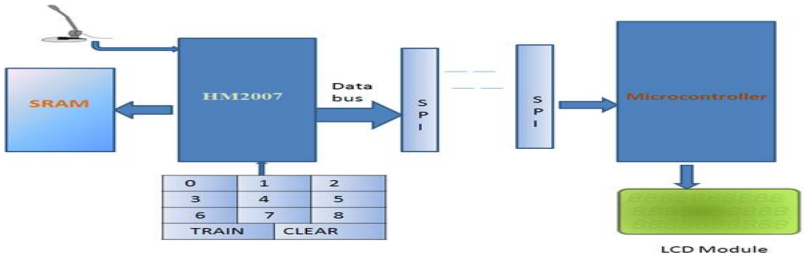

Fig.9. Interfacing of HM2007 with Controller

1. The HM2007 consists of a RDY pin which is an active low pin indicating the IC is ready for training purpose.
2. The Voice input will be given through a microphone connected to the MICIN pin of the IC.
3. The IC is interfaced with a keypad which is used to provide number input corresponding to each word. The IC works in two functions – Clear and Train. When Train key is pressed on the keyboard, the IC begins its training process.
4. The user presses a number key before pressing the 'Train' function key and says the required word to the microphone.
5. The IC sends a high signal to ME (Memory Enable) pin which is connected to corresponding ME pin of SRAM. The 8 bit data signal corresponding to the number pressed is stored in the SRAM (external RAM) through the external bus.
6. After the voice input is detected, RDY pin is at logic high and the IC comes to the recognition state, where it starts the recognition process.
7. The result of the process is given through the data bus with the DEN (Data Enable) pin high.
8.The 8 bit data can be then given to the Microcontroller through a series Interface processor or first latched using latch IC 74HC573.
9. The Microcontroller is interfaced with an LCD and is programmed such that the corresponding word is displayed on the display.

Resistive Touch Screen

A resistive touch screen consists of top and bottom transparent sheets facing each other with a gap between them. The top and bottom sheets are coated with ITO (Indium Tin Oxide). ITO is a transparent conducting material. The top and bottom sheets have uniform as the top sheet gets pressed; the pressed point of the top sheet physically yields and contacts the bottom sheet. As the ITO layers of the top and bottom sheets contact, electricity gets conducted at the contacted point, and the location of the conducted point is detected. Resistance value over its surface.PET film, glass or polycarbonate plastic is most commonly used. The most basic combination is PET film as top sheet and glass as bottom sheet (film/glass structure).

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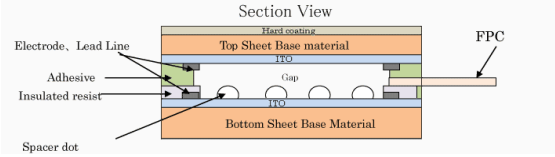

Fig.10. Resistive Touch Plate

DC Motor Drive

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion then you can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver. A simple schematic for interfacing a DC motor using L293D is shown below.

As shown in the circuit, three pins are needed for interfacing a DC motor (A, B, Enable). If we want the o/p to be enabled completely then connect Enable to VCC and only 2 pins needed from controller to make the motor work

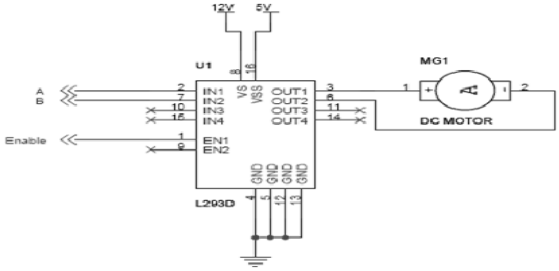

Fig.11. Interfacing of DC Motor with Controller

Table1. Binary Inputs to contol DC Motor

A	B	Description
0	0	Motor stops/breaks
0	1	Motor runs anticlockwise
1	0	Motor runs clockwise
1	1	Motor stops/breaks

Graphics LCD

Graphical LCD liquid crystal display is a display which allows displaying pictures and text. Its construction is similar to the alphanumerical LCD, with a difference that on the graphic display all pixels are divided as one large matrix. If we are dealing with a monochrome LCD, then a pixel is one square segment. Color displays' one pixel is formed of three sub pixels. Each of the three sub pixels lets only one colored light pass (red, green or blue). Since the sub pixels are positioned very close to each other, they seem like one pixel.

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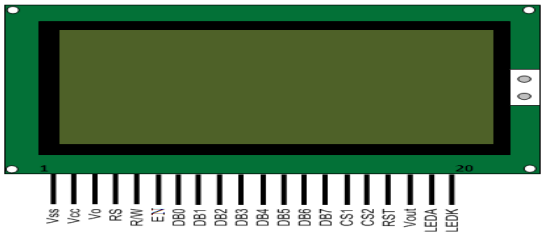

Fig.12. Pin Out of Graphics LCD

Features
• Type: Graphic
• Display format: 128 x 64 dots
• Built-in controller: RA6963
• Duty cycle: 1/64
• +5 V power supply
• N.V. built-in

IV. SYSTEM FLOWCHART

Flowchart of proposed system is given below.

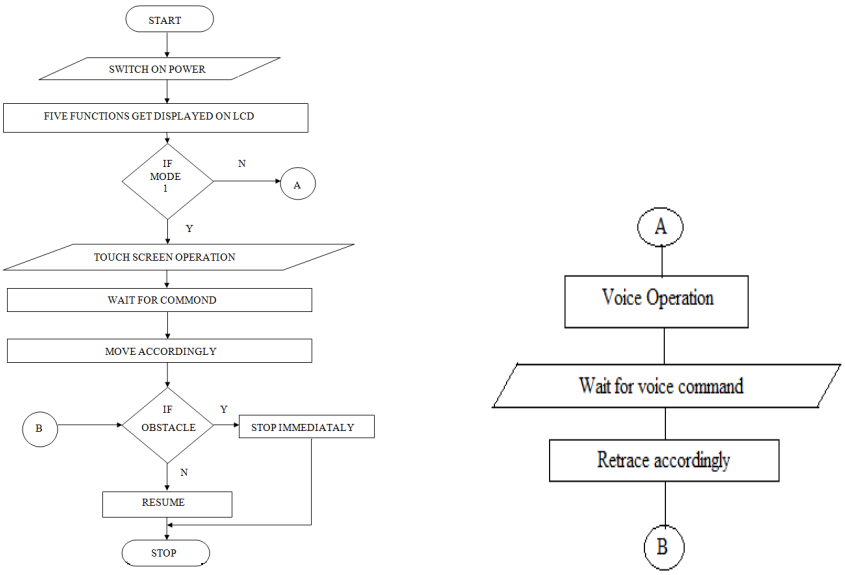

Fig.13. System flowchart

V. CONCLUSION

We are implementing automatic wheelchair which is driven by sensors and has various advantages. It can be operated in three modes i.e. touch screen mode, accelerometer mode and voice recognition mode. Ultrasonic sensor and accelerometer increases accuracy of wheelchair by detecting the obstacle and controlling its speed.
The person with hand disabilities can use voice recognition mode in which run time test words are matched with stored database for the further movement of wheelchair. This Wheelchair will be economical and can affordable to common

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people. In this proposed system two technologies such as GSM and GPRS are added to inform the location of disabled person in case of any inconvenience in this wheelchair.

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