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Improve the Performance of Smart Wheelchair for Multipurpose Applications Based On ARM7

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Abstract: These days, power wheelchairs are available to seniors and the disabled people, and they have expanded the active range of these people. The purpose of our study is to develop a power wheelchair that gives the aged and disabled the same degree of mobility that healthy people enjoy, enabling users to rejoin society fully and heartily. To accomplish this, we adopt a holonomic Omni-directional mechanism that provides three DOF mobility, the same as healthy people have. In addition, we propose a novel steering interface for holonomic Omni-directional power wheelchair that observes user's body action such as tilting an upper body or twisting a waist in order to get user's intention. To design a new wheelchair, we made a large omniwheel and decided measurements of a seat referring to values of standard Japanese physical constitutions. We also made a model of human who ride on wheelchair to analyze a movement of his upper body. The developed wheelchair has high acceleration and speed enough to play a sport such as tennis.

Keywords: Wheelchair, Accelerometer, RFID, Location Tracking, Voice Guidance, Obstacle Avoidance.

I. INTRODUCTION

The rapid growth in the population of senior or disabled people has become a serious social problem. With the disabled population increasing quickly, the assistant systems which specialize for individual situations and purposes of use are highly demanded. Conventionally, these persons have been uniformly regarded as encumbrances who need assistance in various situations. Yet most people in wheelchairs have merely lost a part of normal physical functioning and are still quite capable of playing an active role in society, particularly if their lost abilities can be overcome. This fact shows us that the current situation deprives society of vital human resources while also depriving individuals of dignity, independence and meaning in their lives. Recent technological innovations make it possible for electronically supported devices to overcome the losses of physical functions from which senior and disabled people suffer. Therefore, the establishment of human assist technology for the reentry of senior and disabled people into social activity presents us with an opportunity that we must not pass up.

Chair and wheel were the earliest inventions of man. A wheelchair is a wheeled mobility device designed especially for disabled individuals. The device is propelled either manually (by turning the wheels by the hand) or via various automated systems. Wheelchairs are used by people for whom walking is difficult or impossible due to illness (physiological or physical), injury, or disability. Early wheelchairs were intended only to help a disabled individual to move from one place to another but today the wheelchairs are considered as not only for the transportation purpose but also a way to express users individuality. In India the number of disabled population had a tremendous augment in the past few years. Huge amount of people have congenital disabilities, another few percentages are the victim of accidents and various kind of mobility devices are inevitable part of their life.

A. Wheelchair Invention

The first record of combining wheel to furniture was in Greece in 530 BC. Oldest evidence of wheeled chairs was found in China, and was spoke wheels on chariots in 1300 BC. The first dedicated wheelchair was made for King Phillip II for Spain in 1595. It was not a self -propelled one, a servant's assistance is to be needed for the movement. Self propelled wheels invention was created enormous demand in the market and it was better helping aid for the disabled individuals. Throughout the world, a number of persons lost their limbs in accidents, wars and injuries of spinal cord. These people have to rely on the aid of wheelchairs. There are many wheelchairs available in the market with automatic power supply in the wheels and touchpad/joysticks for the control of navigation. Most of these wheelchairs require manual operation and an extra person to look after the safeguard of the amputee. In most of the cases persons suffering from such disabilities are likely to go under emotional distress state and may take the abnormal decisions which may result fatal. Further the commercially available wheelchairs are expensive and devoid of distinguishing between the user normal psychological states and mentally disturb psychological state as well as between the normal

environment and the continuously changing ambient environment. With advancement of technology the persons can control the wheelchair simply by their voice action, joystick and touchpad.

Fig.1. Wheelchair

The Voice controlled wheelchair is determined by creating speech recognition system utilizing a speech recognition board and a microcontroller can be implemented but the guardian help is still required for the safeguard of the patient. Moreover the amputees or aged persons may or may not be effectively use these systems. There is another big issue of distress state which make the implementation of unusual decisions. Thus, to find out a way to control the wheelchair without involving the hands and imparting a decision making power, could be of a great help to such persons. Here the most perfect solution comes out to be the voice control, physiological state analyzing and environmental state analyzing, self decision making wheelchair. This motivates us to work in the direction of design and implementation of prototype of low cost intelligent wheelchair by distinguishing emotion, illness and environment for elderly and physically challenged. Following are the situation where traditional wheelchairs fail:

1. Handling Joystick/Touchpad: For the persons who suffer from spasms and paralysis of extremities, the joystick or touchpad is a useless so, the voice command system may be the good information transmission means to control the navigation of the wheelchair by such users

2. Emotional Distress/Disease State: Except the normal wheelchair control, the morbidity and the exceptional emotion also need to be considered fully. The wheelchair's operation depends upon the instruction provided by the user. Under the influence of Emotional Distress/Disease state the instruction may result fatal. Thus users need to be continuously monitored for such bad emotions or states.

3. Sudden change in Ambient Environment: The outside environment and the risk cannot be decided completely by the old and the disabled. A sudden introduction of any moving object in path of wheelchair causes sudden decision reaction of the user which in general case is a disable, old person with slow response. In such case Wheelchair's intelligence can lighten user's burden, to provide the safe movement safeguard.

4. Physiological Change in the User Health: While ambulate if any physiological change happens, it could not easily be detected until the user report the problem and doctor diagnose. This may take a long time which may be crucial for the user. Traditional wheelchairs lack such monitoring system.

Design methodology helps to find out the best solution for each design situations. A systematic approach and procedure is to be followed to achieve the suitable solution. It involves the following steps.

- Journals and patent research
- Market study and user (GEMBA) survey
- Bench marking
- QFD matrix
- PDS
- Concept generation and selection
- Final concept refinement
- Physical modeling and validation

II. MODULE DESCRIPTION

A. ARM7 LPC2148 TDMI

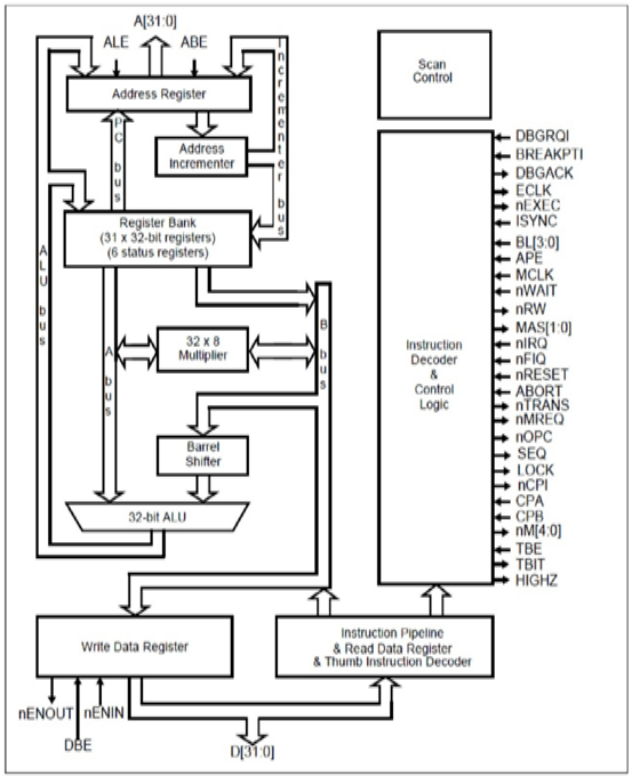

Fig.2. ARM7 TDMI Core Diagram

Over the last few years, the ARM architecture has become the most pervasive 32-bitarchitecture in the world through wide range of ICs available from various IC manufacturers. The ARM processors are embedded in products ranging from cell/mobile phones to automotive braking systems. Worldwide community of ARM partners and third-party vendors has developed among semiconductor and product design companies including hardware engineers, software

developers, and system designers. ARM7 is one of the widely used micro-controller family in embedded system application. This section is humble effort for explaining basic features of ARM-7. The ARM is a family of instruction set architectures for computer processors based on a reduced (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. Here this approach reduces costs, heat and power use. These are desirable traits for portable, light, battery-powered devices—including smart laptops, phones, and tablet.

A simpler design facilitates more efficient multi-core CPUs and higher core counts at lower cost providing higher processing power and improved energy efficiency for servers and supercomputers. It Provides 8kB of on-chip RAM accessible to USB by DMA. One or two (LPC2141/2 vs. LPC2144/6/8) 10-bit A/D converters provide a total of 6/14analog 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 events counter PWM unit and watchdog.
- Low power real-time clock with independent power and dedicated 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550) two Fast I2C-bus, SPI and SSP with buffering and variable data length capabilities.
- Vectored interrupt controller with configurable priorities and vector addresses.
- 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64.
- Nine edge or level sensitive external interrupt pins available.

On-chip integrated oscillator operates with an external crystal in range from 1 MHz to30 MHz and with an external oscillator up to 50 MHz.

B. Power Supply

All electronic circuits works only in low DC voltage, so we need a power supply unit to provide the appropriate voltage supply for their proper functioning .This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation . A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies somewhat, or the load connected to the output dc voltages changes.

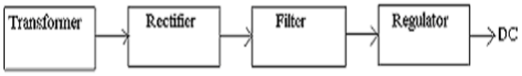

Fig.3. General Block of Power Supply Unit.

1. Transformer

A transformer is a static piece of which electric power in one circuit is transformed into electric power of same frequency in another circuit. It can raise or lower the voltage in the circuit, but with a corresponding decrease or increase in current. It works with the principle of mutual induction. In our project we are using a step down transformer to providing a necessary supply for the electronic circuits. Here we step down a 230volts ac into 12volts ac.

2. Rectifier

A dc level obtained from a sinusoidal input can be improved 100% using a process called full wave rectification. Here in our project for full wave rectification we use bridge rectifier. From the basic bridge configuration we see that two diodes(say D2 & D3) are conducting while the other two diodes (D1 & D4) are in off state during the period t = 0 to T/2.Accordingly for the negative cycle of the input the conducting diodes are D1 & D4 .Thus the polarity across the load is the same. In the bridge rectifier the diodes may be of variable types like 1N4001, 1N4003, 1N4004, 1N4005, IN4007 etc… can be used. But here we use 1N4007, because it can withstand up to 1000v.

3. Filters

In order to obtain a dc voltage of 0 Hz, we have to use a low pass filter. So that a capacitive filter circuit is used where a capacitor is connected at the rectifier output& a dc is obtained across it. The filtered waveform is essentially a dc voltage with negligible ripples & it is ultimately fed to the load.

4. Regulators

The output voltage from the capacitor is more filtered & finally regulated. The voltage regulator is a device, which maintains the output voltage constant irrespective of the change in supply variations, load variations & temperature changes. Here we use fixed voltage regulator namely LM7805. The IC LM7805 is a +5v regulator which is used for microcontroller.

C. Accelerometer

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer.

What are accelerometers useful for?

By measuring the amount of static acceleration due to gravity, you can find out the angle the device is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, you can analyze the way the device is moving. At first, measuring tilt and acceleration doesn't seem all that exciting. However, engineers have come up with many ways to make really useful products with them. An accelerometer can help your project understand its surroundings better. Is it driving uphill? Is it going to fall over when it takes another step? Is it flying horizontally or is it dive bombing your professor? A good programmer can write code to answer all of these questions using the data provided by an accelerometer. An accelerometer can help analyze problems

in a car engine using vibration testing, or you could even use one to make a musical instrument. In the computing world, IBM and Apple have recently started using accelerometers in their laptops to protect hard drives from damage. If you accidentally drop the laptop, the accelerometer detects the sudden freefall, and switches the hard drive off so the heads don't crash on the platters. In a similar fashion, high g accelerometers are the industry standard way of detecting car crashes and deploying airbags at just the right time.

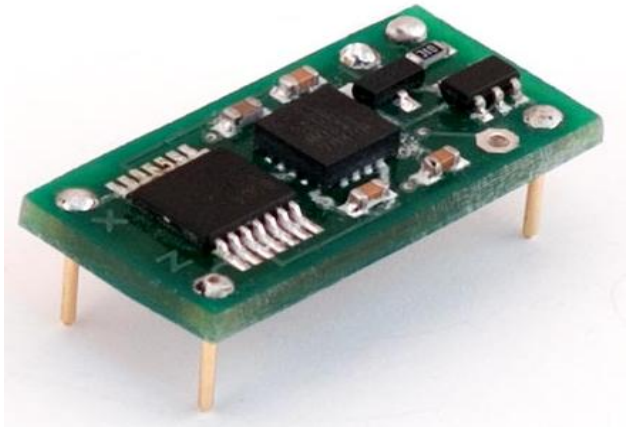

Fig.4. Basic structure of Accelerometer

D. RFID Reader

RFID technology is a simple method of exchanging data between two entities namely a reader/ writer and a tag. This communication allows information about the tag or the element carrying the tag to be determined and in this way it enables processes to be managed more easily. An RFID system comprises a number of elements:

1. RFID reader/writer: The reader write is used to communicate with tags that may pass within range. The RFID reader writer will normally be located in a fixed position and will be used to interrogate an RFID tag. Dependent upon the application and the format of the system and the RFID reader / writer, data may also be written to the RFID tag

2. RFID Tag: RFID tags may also be called RFID transponders and are typically located on items that are mobile. They are small and generally cheap so that they can be attached to low cost (or high cost) items that need to have information associated with them. They are also generally considered as being disposable. The RFID tag contains data that is relayed to the reader, and in some systems it may also be possible to update the data within the tag to indicate that the tag and hence the item has undergone a specific stage in a process, etc.

3. RFID application software: Like all systems these days, RFID systems need application software to run the overall system. With many systems there will be a number of different reader / writers and the data to and from these needs to be coordinated and analyzed. Application software will be required for these. Although each RFID system will vary according to its requirements, these are the main elements which can be found. RFID technology has become widespread in its use. It offers May advantages and RFID is a particularly versatile system, being able to be used in many areas from shops, to manufacturing plants and also for general asset tracking as well as a host of other innovative applications. The use of RFID, Radio Frequency Identification technology has become widespread within many areas of industry. RFID, Radio Frequency Identification provides an ideal technology for tracking assets and identifying them by using a simple low cost antenna attached to the item in question. Alongside RFID provides automatic data collection for which there are now several standards, and this enables RFID technology to be deployed in an effective and known manner. With RFID technology standardized, users are able to rely on the technology to provide the results they need.

4. RFID Benefits

RFID technology provides many benefits for organizations who use the system. RFID provide an easy way in which data can be collected and assets tracked:

- RFID technology provides a low cost form of data collection and asset management.
- RFID technology is widely used and therefore the economies of scale can be utilized to advantage.
- RFID technology enables data collection in environments that are unsuitable for workers as RFID tags can provide data in harsh environments.
- RFID is able to provide many reads and write functions per second, although it is not a very high data rate system, it is sufficient for most data monitoring applications.
- Data on an RFID tag can be altered repeatedly.
- RFID technology can be used with existing systems including bar codes and Wi-Fi

As a result, RFID technology is being used increasingly as organizations need automatic methods of tracking assets and collecting data.

5. RFID Applications

RFID systems can be used in a variety of ways. There are many RFID applications which have gained popularity over the past years:

1. Store product identification - RFID technology can be used within shops and stores as a form of alert for goods that have / have not been paid for.
2. Asset tracking - RFID systems can monitor when RFID tags pass given points and in this way track the assets.
3. Airline baggage identification - airlines need to monitor where baggage is and route it to the required destination. RFID tags can be attached to the bags to automate baggage routing.
4. Parts identification - Data can be written to an RFID tags defining the identity of a part. This can then be used within a manufacturing, stock holding or other process to identify and locate parts.
5. Production control - when items are manufactured they pass through many stages. RFID tags can be attached to items. These can be updated each time the item passes through a stage in production. This will enable the manufacturing system to track all items and know what stage they are at, and any other information such as test failures, etc.

6. Employee access control- many companies today require intelligent access control systems. RFID technology is able to provide control as well as tracking, noting when cards pass particular access points, etc.
7. Supply chain control - with manufacturing working to much tighter timescales with items such as Just-In-Time techniques being involved tracking of the items in a supply chain becomes more critical. RFID tags can be added to items to enable this to be undertaken accurately and more quickly.
8. Vehicle tracking - RFID technology can be used to determine when vehicles have passed particular points and in this way their location can be approximately determined.
9. Livestock identification - RFID tags can be injected into animals, under the skin and this enables accurate determination of which animal is which so that injections, etc can be given to the correct animal.

These represent some of the more standard applications for RFID technology. Many more specialized applications are also in use.

6. Working

In this project we are designing a system to monitor physical parameters of a location like temperature, smoke, rain fall and also the presence of a person say tourist. For this we are using different sensors integrated to an ARM7 micro controller. The data acquired continuously and sent to the remote server using Zigbee module. Presence of a tourist is detected by using the contactless RFID cards allotted to the tourist. Whenever tourist enters in to the location he should show the card at entrance. This can be used as a ticket at the same time the details of the candidate will be sent to the server through Zigbee while the low frequencies of 125 kHz were initially used, systems around the 13.56 license free frequency were also developed. The use of the higher frequency allowed for higher data rates and longer ranges to be achieved. The history of RFID has shown a steady development in RFID technology. Having its routes in the earliest days of electrical science and then radio, RFID history has come out of developments such as radar and IFF. Now RFID is a technology in its own right which is widely used and showing massive benefits to industry and society as a whole

E. Ultrasonic sensor

Fig.5. Basic structure of Ultrasonic sensor.

Ultrasonic sensor provides an easy method of distance measurement. This sensor is perfect for any number of applications that require you to perform measurements between moving or stationary objects. Interfacing to a microcontroller is a snap. A single I/O pin is used to trigger an ultrasonic burst (well above human hearing) and then "listen" for the echo return pulse. The sensor measures the time required for the echo return, and returns this value to the microcontroller as a variable-width pulse via the same I/O pin.

1. Key Features

- Provides precise, non-contact distance measurements within a 2 cm to 3 m range.
- Ultrasonic measurements work in any lighting condition, making this a good choice to supplement infrared object detectors.
- Simple pulse in/pulse out communication requires just one I/O pin.
- Burst indicator LED shows measurement in progress.
- 3-pin header makes it easy to connect to a development board, directly or with an extension cable, no soldering required

2. Application Ideas

- Security systems
- Interactive animated exhibits
- Parking assistant systems
- Robotic navigation

F. Motor Driver

Motor driver L293 will drive two separate DC motor independently. M1_IN1 and M1_IN2 are DC motor1 input and M2_IN1 and M2_IN2 are DC motor2 input all are connected to Microcontroller digital output. Firmware logic will make this output low or high to drive the respective DC motor. When left side IR sensor sense black and right IR sensor sense white, then firmware drive only right side DC motor2, if left side IR sensor sense white and right IR sensor sense black then firmware drive only left side DC motor1. When both left and right IR sensor detects black both motor1 and motor 2 will drive simultaneously, while both left and right IR sensor detects white initially only motor2 will drive for 3 seconds, so it will scan for black area if no detection found firmware drives both motor1 and motor 2 simultaneously and poll for if any black portion is detected.

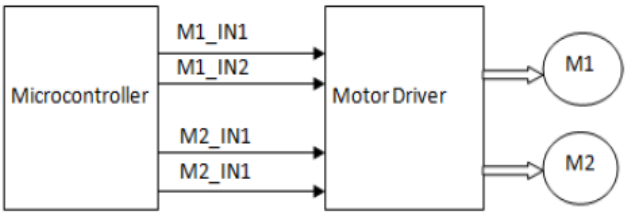

Fig.6. Motor Driver L293L

III. LITURATURE REVIEW

Journal papers and patents explored here are related directly or indirectly to the proposed area of work that is design and development of a Wheelchair cum Stretcher. These papers

are to support and enlighten the whole process of design in the specific area.

A. Wheelchair and Stretcher

A wheelchair is chair with wheels, designed to help the disabled individuals. Stretchers are mobility devices used to transport the patients from one place to other. These both medical mobility aids are used in hospitals and clinics for helping the patients. Stretchers are simple in construction and the patient needs the support of an assistant to transport from one place to other. Whereas wheelchair is designed in such a way that either patient can control the device manually or with the help of someone's assistance. The device consists of proper handle with cushion in hand rest and seating area. The direction movement is a critical part when it comes to emergency situation. Proper selection of caster wheels facilitates to overcome the situations.

B. Selection of Wheelchair

According to selection of an appropriate wheelchair will lead a comfortable living to the user. Performance, safety and dimensions are the three categories which have to be considered while selecting a manual or powered wheelchair. An excellent approach to the wheelchair selection is to set priorities based on user's mobility and seating needs. It is highly recommended that a novice can consult with the rehabilitation specialists in order to select the appropriate wheelchair.

C. Caster Wheel Shimmy

It says self excited vibration is one of the most interesting topics in the field of vibrations and is the science prevailing caster wheel shimmy. Self excited vibration is characterized by vibration that is produced by the motion of the system like wheelchair speed. It can be observed that in most of the cheapest wheelchairs, the design of the casters makes use of a sliding frictional damper in the spindle support to improve the shimmy characteristics. Understanding the theory of damping for the casters show how shimmy prevention works in ultra-light and powered wheelchairs.

D. Smart Power Assisted Wheelchair

All almost 10% of all individual who are legally blind also have a mobility impairment and majority of these individuals are dependent on others mobility. A smart power assistance module (SPAM) for manual wheelchair is being developed to provide independent mobility for this population. The power assist wheelchair that provides for obstacle detection and avoidance for those with visual impairments. The control of the wheelchair will be carried out by the microprocessor and also allow the SPAM to provide a smoother and nuanced control.

E. Wheelchair Configuration

According to rehabilitation is a humanistic profession. Measurement of the user and wheelchair are critical to achieving maximum functional mobility. He says Biomechanics and ergonomics provide the information necessary to understand many aspects of wheelchair use. These factors affect seating comfort and posture, propulsion, efficiency and pain. Proper seating is an important aspect of wheelchair selection, and wheelchair cushions provide pressure relief and some postural support. Electric powered mobility may be the best choice for driving long distance and may be beneficial for people with upper and lower extremity impairments.

F. Patients Transfer System

The proper preparation should be taken before transferring the patient from wheelchair to bed or vice versa. Use of sliding boards will be helpful for paraplegic patients. The best sliding board is made of hard wood, smooth, tapered on ends. Support of two assistance, support straps, belts etc will facilitate easy transfer. The patient should not be slide into chair, lift from the wheelchair and transfer is the optional and safety method for patient transfer.

G. Mechanical Principles for Wheelchair Design

The following mechanical principles will be helpful for a better design. Understanding the centre of gravity location is important in wheelchair design. Weight should be the other important factor for wheelchair design. Reducing weight will results the comfortable use for the user and also lowers material cost. The best strategy is to maximize the strength and minimize the weight of the frame tubing. Calculating the moment of inertia and weight results the best strength and can be used to make the strongest frame at the least weight.

H. Structure of Common Wheelchair

Wheelchair is a wheeled chair consists of various parts and each part with different functions. This is an ergonomically designed medical equipment consists of a foldable frame type mechanism for easy carry. Seating and hand resting position are well designed for a comfortable sitting. Adjustable foot rest with a heel loop on the harpers bracket is provided so that user won't get problems while transportation. Handles are placed in the back rest of wheelchair with suitable grip on that. Push rims are the other features of the wheelchair when into comes to the indoor purpose for the user. The user can be independent by the help of push rim, which may help the user to move from one place to other. Brakes are provided for stopping the wheelchair on both the push rim wheels. Caster wheels are another major part which directs the way and for easy transportation.

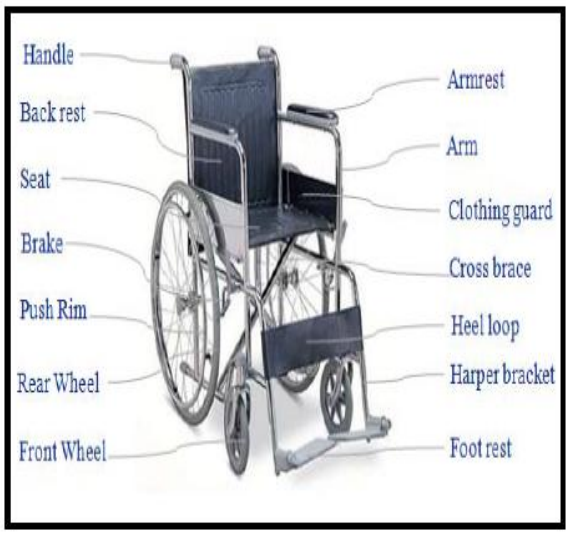

Fig.7 Structure of Wheelchair

IV. SYSTEM DESCRIPTION

The control system of the proposed wheelchair can be divided into various subsystems:

- Navigation subsystem
- Location monitoring subsystem
- Voice guidance subsystem
- Obstacle detection subsystem

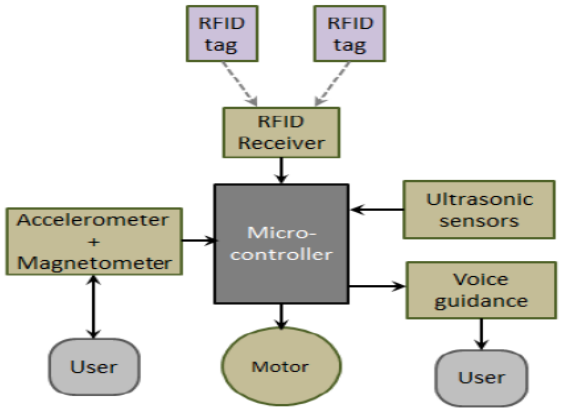

Fig.8. Block diagram of the system

A. Navigation subsystem

This subsystem deals with the navigation of the wheelchair. It is used by the user to move the wheelchair in any desired direction. The subsystem mainly comprises of accelerometer and magnetometer modules. The subsystem consists of a small navigation pad which can be either tied to wrist or to head. On tilting the pad in the desired direction of motion, the chair moves accordingly. The readings of x and y-axis are taken from the accelerometer and are compared against upper and lower limit, if they lie within the threshold, action is performed. This process also prevents motion of the chair due to abrupt high readings obtained from the accelerometer due to its accidental jerking. The table below shows the upper and lower threshold for the readings used in the prototype.

Table I. Accelerometer Readings

X-axis	Y-axis	Direction of motion
X>635	711>Y>-711	Forward
X<-635	711>Y>-711	Backwards
635>X>-635	Y>711	Left turn
635>X>-635	Y<-711	Right turn

The magnetometer is used for direction indication purposes. It is of great help for the visually impaired persons. Geographical north direction is derived from the readings of magnetometer. A vibration pad is attached to the chair. It consists of four vibration motors and a push button, on pressing the button motor lying in the north gets activated and vibrates thereby indicating north direction to the user. Thus user can easily follow the directions and instructions given in the audio clip played by the voice guidance system without any ambiguity.

B. Location monitoring subsystem

This subsystem deals with monitoring of the location of wheelchair in a building. The subsystem is built using active RFID technology. Active RFID tags are placed in the building at locations where voice assistance is vital such as near stairs, doorways or at junctions where different paths lead to different places. RFID receiver is attached to the wheelchair, when the receiver comes in the range of a tag; it gets the unique ID of the tag which is passed on to the microcontroller. Microcontroller compares the ID with a list of pre-stored IDs stored in it and on finding a match it generates control signals for the MP3 player.

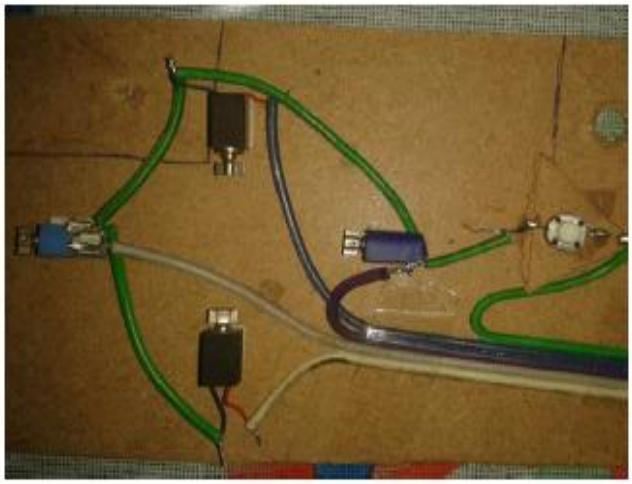

Fig.9. Vibration pad for direction indication.

C. Voice guidance subsystem

Voice guidance system is meant for guiding visually impaired persons. It consists of an MP3 player which is interfaced to the microcontroller. MP3 player has preloaded audio clips. While moving in a building when the wheelchair encounters an RFID tag, its unique ID number is received by microcontroller and it then sends signals to MP3 player to play a particular audio clip which gives the information about the surrounding environment at that place. User listens to the clip through headphones and can easily know where he is and the possible places where he can go.

Fig.10. MP3 player interfaced with microcontroller

D. Obstacle detection subsystem

This subsystem is responsible for the detection of obstacles. It consists of ultrasonic sensors; these sensors emit sound waves whose frequency is well above the perceivable frequency range of the human ears. These sounds waves

when strike an object, gets reflected and are received by the sensor. Thus, by calculating the total time for the waves to return back, distance can be derived. It is given by the relation:

Distance (in cm) = (Travel time * 10-6 * 34300) / 2

In our prototype a limit of 40 cm was set. If any obstacle comes closer than this limit, a buzzer activates and user is warned. However, if obstacle comes closer than 30 cm, chair's movement in that direction is stopped.

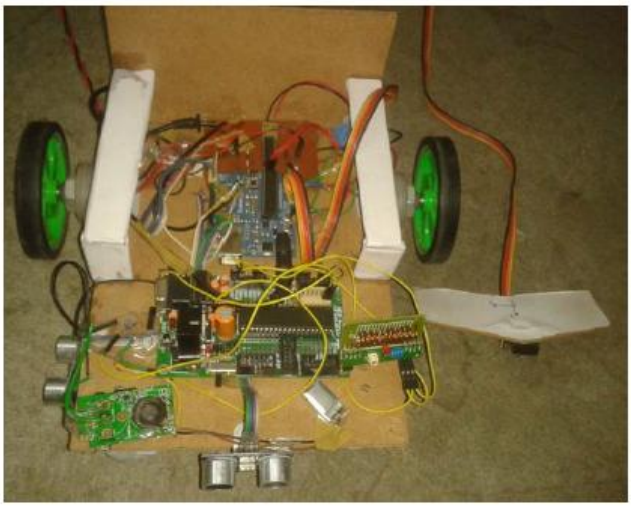

Fig.11. Prototype of our wheelchair

V. CONCLUSION

In this paper, we proposed the novel method to maneuver an Omni-directional power wheelchair by changing user's posture. We also developed interface for measuring the user's posture according to the information from force sensors distributed in the backrest and seat. Some basic driving experiments have been done, which verified the feasibility of the proposed method. Referring to the statistic data of standard Japanese physical constitutions, we designed and developed the Omni-directional power wheelchair having enough performance to use for active applications like a sport. For future work, we will add the dynamic elements, the movement of both arm, the shift of the user's posture into the user's model in order to make judgment standard much more robust. We will do some experiments using the Omni-directional power wheelchair developed for wheelchair tens and evaluate the proposed method.

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