AN INTELLIGENT NAVIGATION SYSTEM FOR THE PHYSICALLY CHALLENGED BASED ON VOICE

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***Abstract* — Intelligent wheelchair plays a more and more important role in modern society. People bound to wheelchairs requires third-party assistance. We propose an intelligent wheelchair without any third-party assistance. This System comprises of a wheelchair, voice module and a navigation module. It is designed for elderly or physically challenged person, who can not control the movement of the wheelchair. The IHNS (Intelligent Home Navigation System) is used for elderly and the physically challenged can go to different rooms within the house like kitchen, bed room, hall room, store room etc by just speaking a word. This paper describes basic components of voice recognition and wheelchair control system. Voice recognition circuit receives the voice and compare with preloaded voice in memory and give to microcontroller to move the wheelchair from one place to other using Motor Driver Circuit and DC motors. According to the received voice, the destination is automatically understood and the wheelchair moves according to the route which is predefined. IHNS is also equipped with obstacle avoidance technique. Voice controlled wheelchair could improve the quality of life and safety of user. Thus the above proposed system provide the Hands-free wheelchair control and also people can move inside the home without any difficulty.**

***Keywords*—** wheelchair, voice, Microphone, obstacle avoidance.

I. INTRODUCTION

In recent years, aging problem has been arising to be among the most serious social issues worldwide, especially in the European and Asian countries, including India and Japan. It is reported in Japan that the population of over 65 years old would reach 3,00,00,000 in 2012 and grow over 30% of total population in 2025. It has been reported that up to 40% of patients found daily steering and manoeuvring tasks to be difficult or impossible, considering that there are 4.3 million users of power mobility in the US alone, the potential for intelligent solutions to assistive mobility is immense.

The National Sample Survey Organization (NSSO) probed into five types of disabilities of the elderly in India. These were visual impairment, hearing problem, difficulty in walking (loco motor problem), problems in speech and senility. 25 percent of the elderly in India suffered from visual impairment, followed by hearing difficulties (14 %) and loco motor disability and senility (each 11 %).

This paper provides an overview of the intelligent wheelchair designed to assist elderly and physically challenged people in day to day life even if they were alone at home. The physically challenged people who use a normal wheelchair for navigation, usually requires an external person to move around. In this busy world, the elderly people may be left alone at home and also may not find an apt person for external help. Here comes the need of an automated home navigation system, which consists of a wheelchair which can be used by the elderly and the physically challenged people without the help of an external person. The proposed IHNS can be operated using voices which is recorded into it.

II. MOTIVATION

Many people suffering from chronic mobility impairments use a powered wheelchair to help them move around their environment. However, there are many factors which may make the use of such wheelchairs difficult or impractical, including fatigue, muscle spasms, or sensory impairments. Wheelchairs are used by people who find themselves unequipped to move without external aid. The special needs of the elderly may differ from that of a physically challenged person or a large individual but they all have “special needs” and often require some assistance to perform their daily routine. Today’s world comprises of a large variety of people.

But in today’s fast world, everyone is busy and there are less people to care for the increasing number of elderly and the physically challenged. Also these people find it tough to even navigate inside the home without external aids. The elderly people find automated wheelchairs as an easy way for locomotion. Having known about these facts, the aim of this project is to bring an automated navigation system which can be used by both the elderly and the physically challenged people in a user-friendly manner using voices for operation.

III. LITERATURE REVIEW

A. Existing System

The idea of a wheeled chair being used to assist the elderly or people with disability. The last fifty years have seen some of the most and the fastest development in wheelchair technology. The first electric wheelchairs were used during World War I for the handicapped, and consisted of an electric motor with a simple single-speed on/off switch applied to the existing manual-style wheelchair. Then the idea of a "smart" wheelchair started to gain support.

Kuno.Y, Murashima.T, Shimada.N, Shirai.Y, presented in Multimedia and Expo, IEEE International Conference on 2000, " Interactive gesture interface for intelligent wheelchairs" whose motion can be controlled by the user's face direction, by which the user can drive it only by looking in the direction they wanted to go.

Pacnik, G. Benkic, K. Brecko, B. presented in Industrial Electronics, ISIE '05 the IEEE International Symposium the idea of "Voice operated intelligent wheelchair – VOIC" which was based on Voice recognition. It does not provide automatic navigation.

Wada, M.; Kameda, F, presented in Industrial Electronics, IECON '09, the 35th Annual Conference of IEEE, "A joystick car drive system with seating in a wheelchair" which was based on the joystick operation in back and forth direction, controls acceleration or deceleration of a wheelchair and movement of the wheelchair to the left and right direction by the turning of a steering wheel.

Then the Last paper was presented by Yi Zhang; Jiao Zhang; Yuan Luo; Complex Medical Engineering (CME), 2011 IEEE/ICME International Conference, "A Novel Intelligent Wheelchair Control System Based On Hand Gesture Recognition" which was based on the hand gesture recognition for those with physical accessibility problem. In this paper, Haar-like features and the AdaBoost learning algorithm are used for hand gesture detection.

Therefore all the systems require certain amount of "manual and maneuvering skills". As a result, thinking about hands-free alternatives, INHS was implemented and IHNS aimed at to bring the Automated Navigation System in a user friendly manner, only by the use of the operator's voice.

B. Proposed System

IHNS system can be used by elderly and the physically different persons to move inside the home like, Kitchen, Living & Dining rooms, etc:

i. Without any difficulty.
ii. Without any external aid / care-giver.

IHNS system works with preloaded map of the home and also General directions like left, right, front, back etc. IHNS mainly consists of

i. Wheel Chair
ii. Voice Module
iii. Navigation Module

Wheel chair is used by people who find themselves unequipped to move without an external aid. Voice Module captures the voice of the persons and gives the signal to the microcontroller. Navigation Module is used to navigate the wheelchair automatically from one place to another place in the room as per predefined routes based on the voice received.

IV. FUNCTIONAL BLOCK DIAGRAM

The Block diagram is shown in Figure 1.The Block diagram of IHNS mainly consists of

- Microcontroller
- Voice Recognition
- Motor Driver Circuit & Dc Gear motors
- IR sensor
- Memory and Latch

Microphone receives the voice signal, which converts sound signal into an electrical signal. Voice recognition circuit receives the signal from microphone and compare the voice signal with memory (whether the corresponding word is stored or not). If match is present, then it gives the signal to the microcontroller through latch.

The microcontroller receives the signal and navigates the wheelchair according to the predefined location or directions. The DC motor and driver circuit is used for navigation purpose of the Wheel chair. The IR sensor and amplifier circuit is used to detect the obstacle. If it is detect the obstacle, then it sends the interrupt to the microcontroller by which the path of the wheelchair is deviated.

Therefore the IHNS system is used to navigate the wheelchair automatically from one place to another place in the room as per predefined routes based on the voice received.

A. Microcontroller

The microcontroller with 64 kB flash and 1024 B of data RAM. A key feature of the microcontroller is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (six clocks per machine cycle) to achieve twice the throughput at the same clock frequency. Another way to benefit from this feature is to keep the same performance by reducing the clock frequency by half, thus dramatically reducing the EMI.

The flash program memory supports both parallel programming and in serial ISP. Parallel programming mode offers gang-programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible.

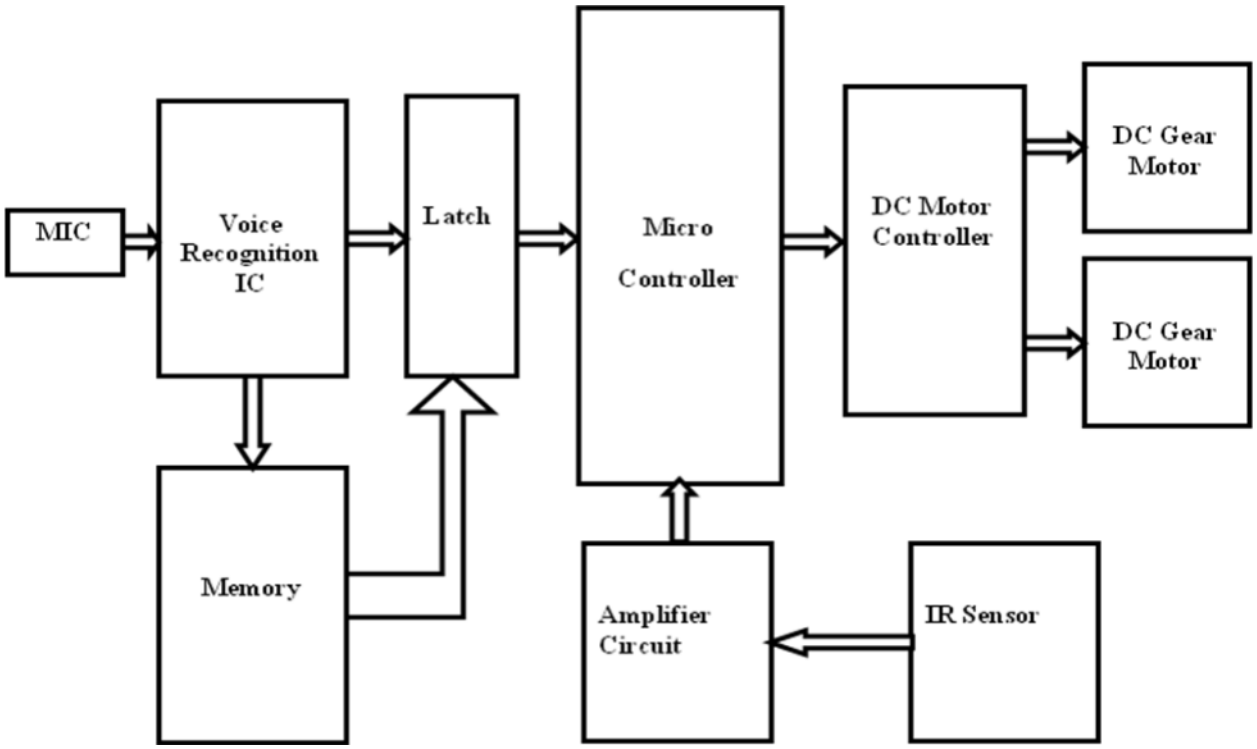

Fig.1 Block Diagram of IHNS

Features

- Compatible with 8051 family.
- 64KB of on-chip Flash Memory .
- 1KB data RAM Memory.
- Power supply voltage: 4-6V.
- Operating clock frequency: 33MHz.
- Programmable UART serial communication.
- Four 8-bit I/O ports.
- Three 16-bit timers/counters.
- 9 interrupt sources.
- DIP40 packages and TTL- and CMOS-compatible logic levels.

B. Voice Recognition

Voice or speech recognition will become the method of choice for controlling appliances, toys, tools, computers and robotics. There is a huge commercial market waiting for this technology to mature.

The heart of the circuit is the HM2007 speech recognition integrated circuit. The chip provides the options of recognizing either forty .96 second words or twenty 1.92 second words. This circuit allows the user to choose either the .96 second word length (40 word vocabulary) or the 1.92 second word length (20 word vocabulary). For memory the circuit uses an 8K X 8 static RAM.

The chip has two operational modes; manual mode and CPU mode. The CPU mode is designed to allow the chip to work under a host computer. This is an attractive approach to speech recognition for computers because the speech recognition chip operates as a co-processor to the main CPU. The job of listening and recognition doesn't occupying any of the computer's CPU time. When the HM2007 recognizes a command it can signal an interrupt to the host CPU and then relay the command code. The HM2007 chip can be cascaded to provide a larger word recognition library. Speech recognition is classified into two categories, speaker dependent and speaker independent.

Voice recognition circuit mainly consists of

- Voice Recognition IC
- Keypad
- Memory (Static RAM)
- Latch
- Seven segment Decoder

When the circuit is turned on, the Voice Recognition IC checks the static RAM. If everything checks out the board displays "00" on the digital display and lights the red LED (READY). It is in the "Ready" waiting for a command. The features are

• Single chip voice recognition CMOS LSI.
• Speaker dependent, External RAM support.

• Maximum 40 word recognition (.96 second) or Maximum word length 1.92 seconds (20 words).
• Microphone support, Manual and CPU modes available.
• Response time less than 300 milliseconds and 5V power supply.

Voice Training Steps:

The circuit can be trained to recognize up to 40 words.

- Power ON(The LED connected to READY pin will be ON)
- Clear Memory
  - Press the digit "9″ twice..i.e "99″
  - Press (*)CLR Button
- Press the Memory Location to save the word.

eg: If word "Forward" in the memory location 01, then

- Press digit '0′ followed by digit '1′
- Press (#)TRN key
- Speak the word into the microphone clearly.(The LED will momentarily blink if HM2007 accepts the word)
- Repeat the steps for saving more number of words.

Testing Recognition and Error Codes

The circuit is continually listening. Repeat a trained word into the microphone. The number of the word should be displayed on the digital display. For instance if the word "directory" was trained as word number 25. Saying the word "directory" into the microphone will cause the number 25 to be displayed. The chip provides the following error codes:

- 55- Word too long
- 66- Word too short
- 77- Word no match

C. *Motor Driver Circuit and DC Gear Motors*

The microcontrollers are not powerful enough to drive DC motors directly, so it needs some kind of drivers. A very easy and safe is to use popular L293D chips. It has Push-pull four channel drivers with diodes, which is used for wheel movement.

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors.

To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications whose operating frequencies up to 5 kHz. The L293D is assembled in a 16 lead plastic package which has 4 centre pins connected together and used for heat sinking.

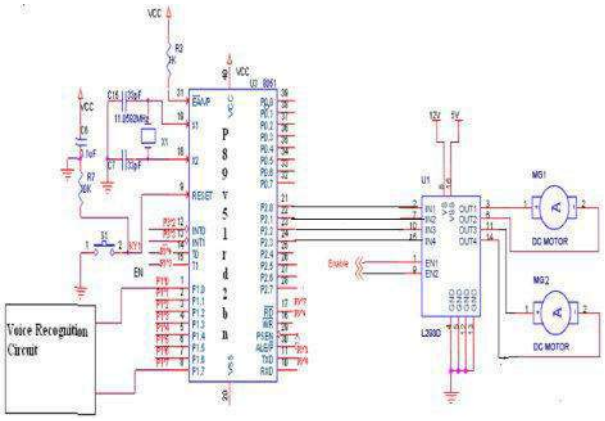

Fig.2 Interface between microcontroller and DC motors

A DC motor is electromechanical device that converts electrical energy into mechanical energy that can be used to do many useful works. The figure 2 shows the interface between microcontroller and DC motors.

DC motor is easily controlled by microcontrollers, that is start, stop, clockwise or anticlockwise direction and also speed of the motor is controlled.

D. *IR Sensors*

This sensor can be used for most indoor applications where no important ambient light is present. It doesn't contain any special components, like photodiodes, photo-transistors, or IR receiver ICs, only a couple of IR LED's, an Op amp, a transistor and a couple of resistors. In need, as the title says, a standard IR LED is used for the purpose of detection. Due to that fact, the circuit is extremely simple, and so it can easily understand and build it.

The basic idea is to send infra red light through IR-LEDs, which is then reflected by any object in front of the sensor. First of all detect the reflected IR light. For detecting the reflected IR light, we are going to use another IR-LED.

E. *Memory and Latch*

The MCM6264C is 8K x 8 Static RAM. It is fabricated using Motorola's high–performance silicon–gate CMOS technology. Static design eliminates the need for external clocks or timing strobes, while CMOS circuitry reduces power consumption and provides for greater reliability.

This device meets JEDEC standards for functionality and pin out, and is available in plastic dual–in–line and plastic small–outline J–leaded packages.

The SN54/ 74LS373 consists of eight latches with 3-state outputs for bus Organized system applications. The flip-flops appear transparent to the data when Latch Enable (LE) is HIGH. When LE is LOW, the data that meets the setup times is latched. Data appears on the bus when the

Output Enable (OE) is LOW. When OE is HIGH the bus output is in the high impedance state.

V. ALGORITHM AND WORKING

A. Algorithm

Step1: Give the supply to the microcontroller.
Step2: Record the voice in SRAM memory by using HM2007 speech recognizing IC.
Step3: The microphone sends the electrical signal to the HM2007 IC.
Step4: HM2007 process the input analog signal and convert to digital and save data in the memory.
Step5: Voice Recognition circuit receives the input voice and compare with preloaded voice in memory.
Step6: If word match with preloaded voice, then go to step7, otherwise produce error code.
Step7: Depending upon the voice, the data is processed and send to the microcontroller through Latch.
Step8: The microcontroller receives the signal and navigates the wheelchair as per preloaded route.
Step9: Check for any Obstacle in its path using IR sensor.
Step10: If IR sensor detects the Obstacle, then go to next step, otherwise go to step12.
Step11: IR sensor gives the interrupt signal to the microcontroller and microcontroller deviate the path.
Step12: If Wheelchair reaches destination, Stop the Process, otherwise go to step9.

The flowchart of Voice Based Navigation System Algorithm is shown in Figure 3.

The sample home struture is shown in Figure 4. It mainly consists of Hall room, Kitchen, Bed room and bath room.

Microphone receives the voice signal, which converts sound signal into an electrical signal. Voice recognition circuit receives the signal from microphone and compare the voice signal with memory (whether the corresponding word is stored or not). If match is present, then it gives the signal to the microcontroller through latch.

The microcontroller receives the signal and navigates the wheelchair according to the predefined location or directions. The DC motor and driver circuit is used for navigation purpose of the Wheel chair. The IR sensor and amplifier circuit is used to detect the obstacle. If it is detect the obstacle, then it sends the interrupt to the microcontroller by which the path of the wheelchair is deviated.

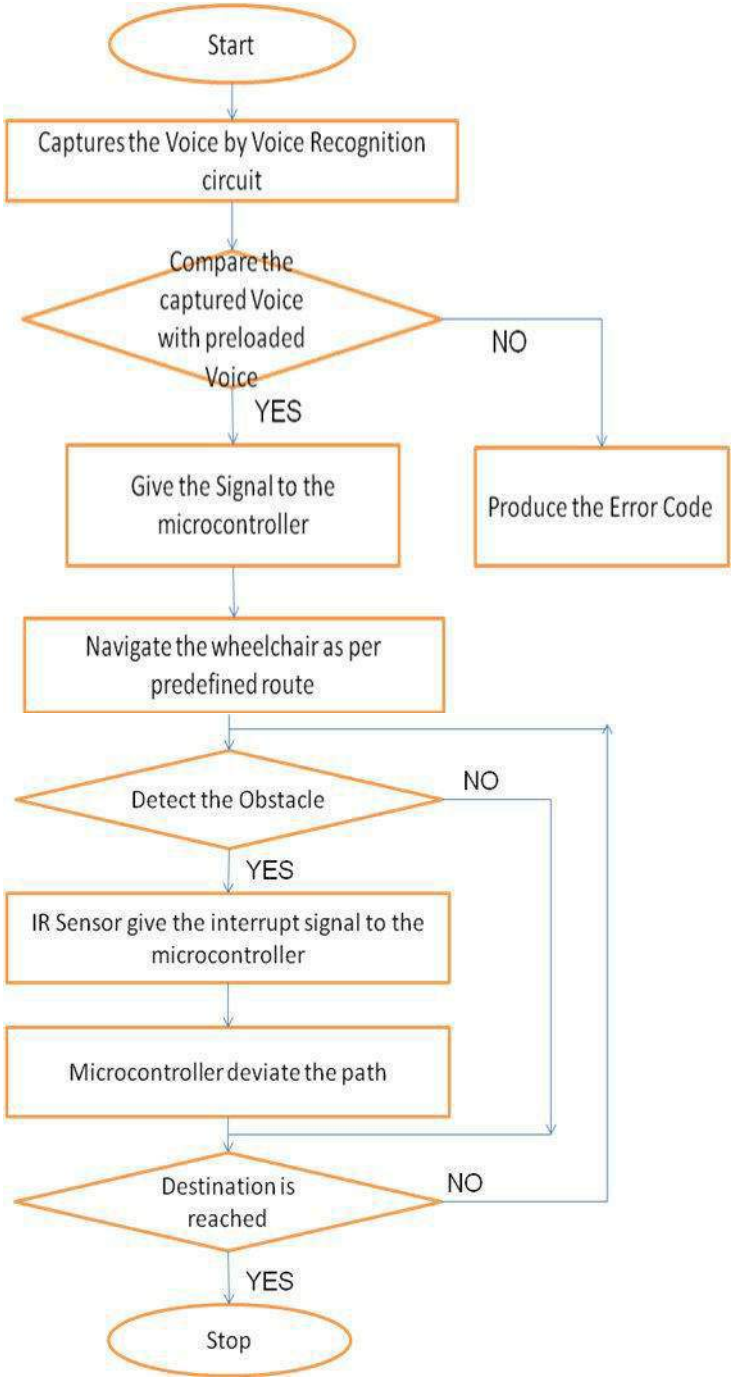

Fig.3 Flow Chart for Voice Based Navigation System Algorithm (VBNSA)

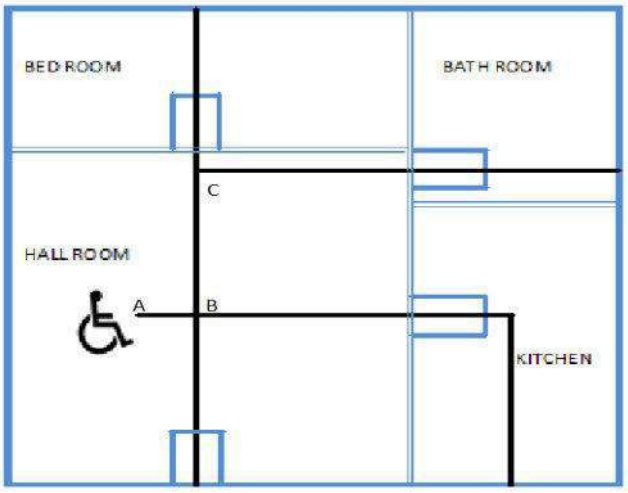

Fig.4 Sample Home Structure

Therefore the IHNS system is used to navigate the wheelchair automatically from one place to another place in the room as per predefined routes based on the voice received.

VI. EXPERIMENTAL RESULTS

The hardware setup of IHNS is shown in Figure 5. The hardware setup mainly consists of Wheelchair, IHNS equipment and microphone.

Fig. 5 Hardware setup

The IHNS equipment is connected to the base of the wheel chair and microphone is connected to the one of the armrest to the wheel chair. This is only a prototype model.

VII. FUTURE WORK

- To make the system more advanced, the navigation inside a village or a town can be included – with the help of GPS technology.
- The personal security of the person can be done through GSM Modem.
- This further helps the people who use the set up, the area of automated navigation is increased.

VIII. CONCLUSION

In this paper, a intelligent wheelchair system controlled by voice was proposed, which can be used by the persons who requires help of others for their daily life. This setup provides low cost and user friendly manner. Voice recognition and motor driver and control methods are used for IHNS. The experiments show that the system is robust.

It provides a special feature, the obstacle avoidance techniques, which can be implemented by using IR sensor with microcontroller. By making use of IHNS, elderly and the physically challenged can go to different rooms in the house like kitchen, living room, dining room, bed room etc by just speaking a word which is predefined to that particular room.

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