Intelligent Banal type INS based Wassily chair (INSW)

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Abstract

The navigation of physically impaired requires a continuous positioning with certain accuracy in their environments. This paper proposes an automated wheel chair developed for the indoor navigation using Inertial Navigation System (INS) for the physically blight persons. The Wassily chairs are the mobile chairs that facilitate the movement of the user in pre-functioned places. This is an intelligent vehicle which has all the feasibility for the usage of the physically impaired. This mobile chair replaces the traditional gear system with the keypad system to reach the destined places and to locate the things in the destined places. This makes the vehicle smart and user-friendly augmenting the viability to carry out their day to day activities. It has an additional feature, the automatic airbag system which provides hip bone protections.
Keywords*: Blind peoples, handicap, indoor navigation, wheel chair, airbag.*

I. Introduction

Nowadays, most of the upcoming wheel chairs, works based on the manual operation. Most of the wheel chairs are designed for the usage of handicaps alone. There are no wheel chairs for the usage of blinds for their motion. In this busy world no one bothers to care and help the blind in their houses. Blinds cannot do all their works by themselves in their houses [1]. They need help from others to do certain works. Here is an implementation of the wheel chair system which can be used for both the blind and handicaps. In this paper an idea is provided to help the blinds for their indoor navigations. This chair can be used by the handicaps which provide assistance for moving from one place to another in their houses without any help from others [2].

This wheel chair system is a look alike of the normal wheel chair. The project consists of a conventional wheelchair which has a touch-sensitive keypad. The intelligent wheel chair contains many intelligent sensors for budging the places like living room, dining hall, kitchen, rest room etc. There are sensors for detecting the obstacles. There are sensors for determining the chairs motion, speed, directing angle etc. Most of the automatic wheel chairs have working power source in the form of battery. But these wheel chairs are using power source from rechargeable batteries. This system is very difficult for the blind to plug-in to recharge the battery. The wheel chair overcomes this problem by providing a wireless charging method. It makes it easy for the blind to recharge the battery. The wheel chair system has an air bag system which triggers automatically during the falling time. This system provides hip bone protection for the handicaps [3].

II. Existing Methods

The existing wheel chairs operate based on manual operation, in which the user has to drive the wheel chair with the help of gears, buttons etc. These systems are used for handicaps only. The blind person uses a stick device for the assistance for their movements. None of the wheel chair contains airbag system. People having visual problems face problems in unfamiliar places and they need assistance to solve this issue. The main difficulty in the enclosed navigation is overcoming the obstacles [4].

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Most of the wheel chair is operating with battery power, but no wheel chair has the wireless charging method. If the voice is not clear, the wheel chair will not function properly. The wheel chair works like a line follower. If any misalignment is done on the line, then the wheel chair will not function and it would be difficult for the user to move from that place to another.

The Grey-Fuzzy Decision-making algorithm is used for detecting and avoiding obstacles in the path ways and for the easy movement to the destination place. The Sonar ultra-sonic sensor is used for detecting obstacles and the use of Fuzzy logic has made the operation of detection easy. By avoiding the obstacles, it becomes easy for our wheel chair to focus to the destination place. Therefore, this module provides a clear path for the wheel chair for movement within their houses. This module is helpful for easy crossing of the obstacle, when detected in the path of the wheel chair [5].

Second module is the wireless charging module. This working is based on the Electromagnetic Induction method. One end of the transmitter coil is fitted to the ground. The other end of the transmitter coil is connected to the electric supply. The power is always transmitted from transmitter coil. When the wheel chair parks, the transmitter coil automatically charges the batteries of the wheel chair. Third module is the airbag system. This system works based on the user's movement. The sensor always monitors the user's movements and registers the user's motion. If the user skip's off, the compressed air cylinder will be triggered. And the air bag will be in ON position to give protection for the user [6].

III. Proposed Ins Based Home Navigation

This section discusses various modules of banal type INS based wassily chair (INSW) workings in details. These block diagram explains the detailed function of the wheel chair. It provides all the functionality of the smart vehicle used by physically challenged persons. This project uses PIC16F877A controller for their inbuilt facilities. The power supply is provided with the help of batteries. It contains MEMS (Micro Electrical Mechanical System) sensors, SONAR sensors, DC motors and keypads. The SONAR sensors detect the obstacles in their respective path ways. IMU is the inertial measurement unit which has accelerometer, gyro meter and magnetometers on all the four sides. The motors in the right and left side of the controller are responsible for the rotation of the wheels in the chair. The microcontroller is the heart of the wheel chair which manages the operation of the wheel chair.

The block diagram of the proposed system is shown in figure 1.

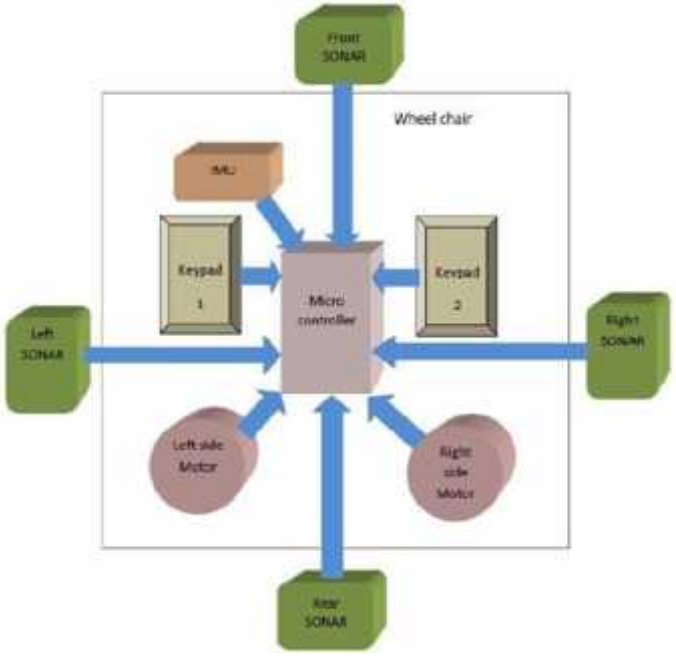

Fig.1: Block diagram of proposed system

Figure2 shows the block of airbag system which provides an additional feature to the intelligent wheel chair. The air bag system block diagram has microcontroller, accelerometer and air bag. This is used to protect the user from injuries when they fall. A reference point is predefined in the PIC 16F877A microcontroller which indicates the triggering operation of the bag. The accelerometer measures the acceleration simultaneously. The sensed value should be less than or equal to the reference value set in the microcontroller.
When the sensed value is greater than the reference value, the microcontroller instructs the air bag to be triggered. When the reading reaches the reference point, the air bag automatically triggers and protects or saves the user from injuries or bone fractures. The triggering is done by the compressed air cylinder.

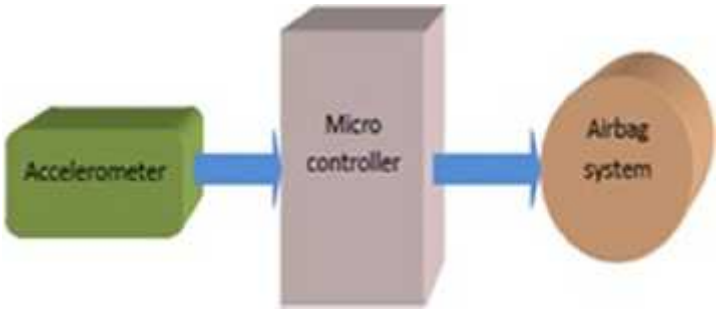

Fig.2: Schematic Diagram of Airbag System

The flow diagram of the proposed wheelchair is shown in figure 3.

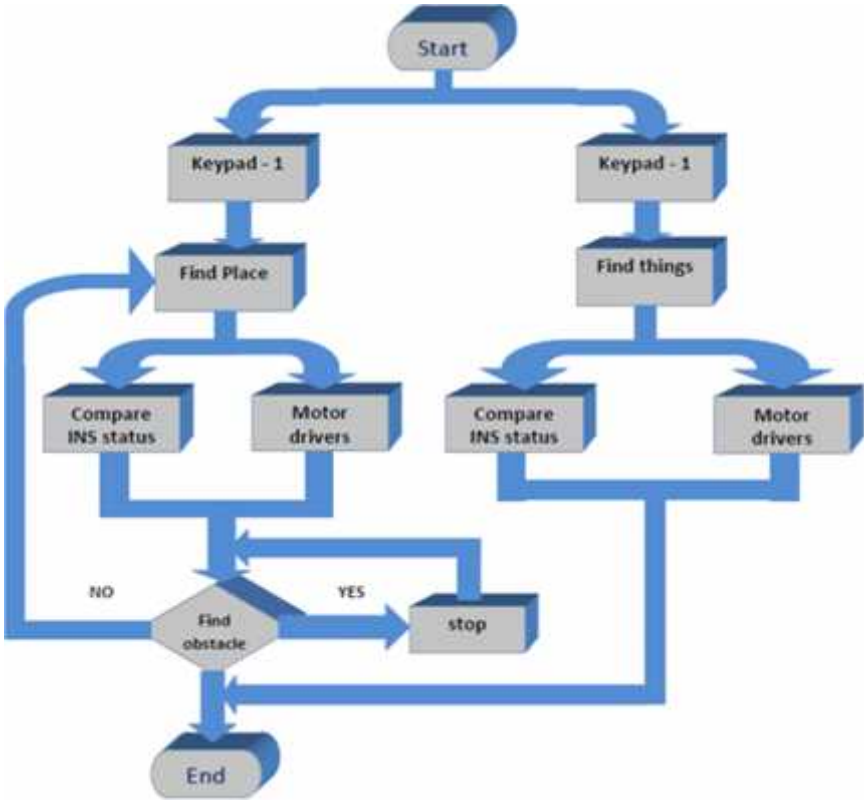

Fig 3. Flow chart of proposed system

The flow chart explains the step by step working of the wheel chair. A single module which consists of all three MEMS sensors (Accelerometer, Gyro meter, Magnetometer) which makes it more economical for the user. The inputs to the system are in numeric form and the outputs are obtained based on the type of inputs given to the system. The wheel chair has all the features in built within their chassis. The basic module of the project with

the movement of wheels in all four directions is done with the required hardware components. The wheels have the capability to travel in all directions. The chair is flexible to move to the desired direction. A product will be produced which is useful for the physically challenged peoples. The flow diagram provides a step by step process of the working of the wheel chair. The flowchart of airbag is shown in figure 4.

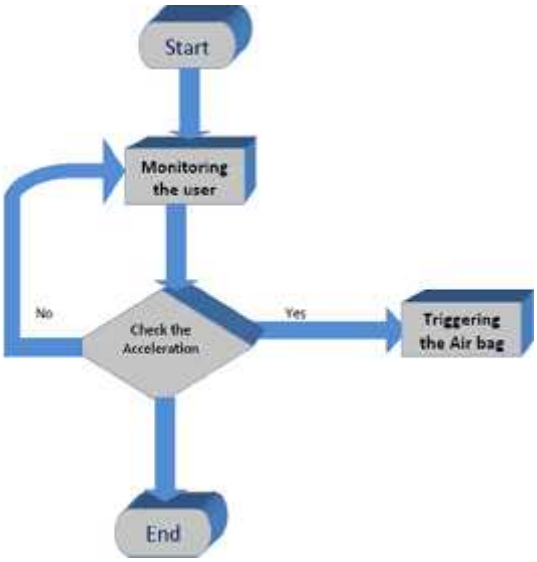

Fig 4. Flowchart of Airbag system

The flow diagram of airbag system in fig.4 provides information about the air bag system. The various modules present in the proposed system are given below:

a. Key Pads

The keypad module is used as the input device for the users. Two numbered keypads are used with each number having a pre-defined function. These keypads are placed on the right and left armrests. The keypad placed on the right armrest is used for destination place detection. It is a 3*4 matrix numbering keypad. It contains 12 keys. Each key is assigned with different places in their house. The user can press the keys depending on the destination place they want to reach. The values of the keypad are sent to the microcontroller.

The second keypad is used for locating the things in the specified direction. This keypad is a 3*4 matrix numbering keypad. It contains 12 keys. Each key is assigned with different things in their rooms. Even the blind will have some important requirements in their lives. Therefore, the keypad is programmed to locate the things in different places. The blind person can choose any key by which the wheels of the chair rotate and point out the desired directions.

b. IMU Sensor Module

The sensor module is used for navigation purpose of the wheel chair. It contains 3 sensors. They are Accelerometer, Gyro meter, and Magneto meter. These are the MEMS sensors. The accelerometer sensor gives the pitch value. Gyro meter sensor gives the Roll value and the Magneto meter sensor gives the yaw values. These values from the sensors are updated for each and every moment of the wheel chair. These values are given to the microcontroller as input.

c. Sonar Sensors

The sensor module is used for obstacle detection which occurs in the path of the wheels of the chair. It works based on the ultra-sonic sound. It produces ultra-sonic sound which hits the obstacle and echoes or returns back to the sonar receiver. The time difference between the transmitted sound and the echo gives the distance of the obstacle from the source (wheel chair). Different types of obstacles occur in the path of the wheels of the chair such as a miss placed thing from their predefined position. The obstacles are detected which is a hindrance for

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the movement of the chair. The implementation of the sonar sensor in the wheel chair is necessary. Four sonar sensors are used for the four directional movements of the wheels of the chair. By this way the obstacle can be easily detected in the path of the wheel chair.

d. **Motor Control Modules**

The motor control module is used to drive the motors of the wheel chair. There are two stepper motors in the wheel chair. These motors are controlled by the microcontroller. The microcontroller has the control of making decision for the stepper motors rotations. The motor part of the stepper motor is often permanent magnet synchronous motor, but can also be a reluctance motor, or induction motor. It can drive the motor in clock or anti-clock direction. For the turning of the wheels of the chair towards left or right, specific rotation of the motors has to take place. For turning left, both the motors rotate in clock wise direction. For turning right,vice-versa.

e. Airbag System

The air bag module is used for the protection of the user's hip. This is a wearable airbag. The airbag system is very useful for the handicap. The airbag is worn in the hip portion of the user for protection. It contains an accelerometer sensor which is a MEMS sensor. This sensor provides accurate measurements such as acceleration, pitch. The accelerometers work is to watch and register the user‟s motion in routine. The microcontroller within the airbag system has reference falling time. At the time of falling, the accelerometer senses the accelerations as usual. If the sensed value is greater than the reference value, the airbag is triggered. Then the airbag turns ON to protect the user's hip from fractures. These processes will be done within some fractions of second. This concept is described in figure 5.

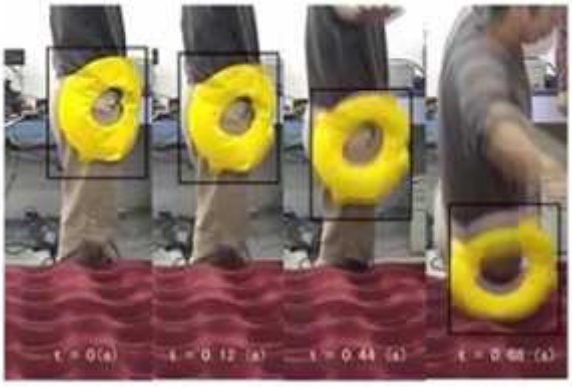

Fig. 5 Wearable Airbag system

f. Wheel Chairs

The wheel chair designs are just like a normal wheel chair. The wheel chair designed consists of components such as sensors, keypads, air bag which is responsible for producing an efficient wheel chair. Figure 6 shows the normal wheel chairs, in which the DC motor, sensors, keypads and wheels have to be connected.

Fig. 6 Wheel chair

The design of the intelligent wheel chair with embedded system is used for indoor navigation. This intelligent wheel chair is designed for the society and to the society. The wheel chair turns all around 360 degrees without any mechanical disturbances.

g. Micro Controllers

Two micro controllers are used. The micro controller is the PIC16F877A; it operates 8 bits at a time. It contains many additional features. It has inbuilt modules for analog to digital conversion and PWM (Pulse Width Modulation) Module. It is a Lead-free; RoHS-compliant .The operating speed of the controller is 20 MHz. The instruction cycle is about 200ns.The operating voltage is about 4.0-5.5V. One microcontroller is used for the movement of the wheels of the chair to the desired direction. The other controller is used in the airbag system for the triggering process for their self-protection.

h. Wireless Charge Module

The wireless charge module is to charge the batteries installed in the wheel chair without using wires. Normally user‟s resting room (bed room) is the charging place. Because the transmitter coil is fitted in the User‟s resting place (cot). The power is transmitted using electromagnetic induction method. The power transmitted to air is within 1 feet distance. The wheel chair contains the receiver which receives the electric signal and gets charged through the batteries.

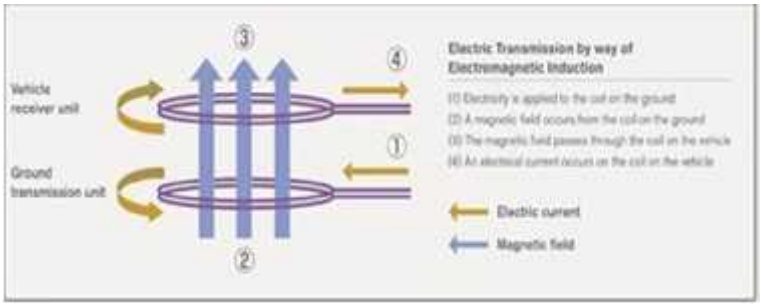

Fig.7 Wireless charging Module

The magnetic field is present in the transmitter coil. The electric current produced in the transmitter coil is transmitted to the receiver in the wheel chair. These electric signals are used to charge the batteries. This is an efficient way of charging the batteries. These batteries produce no electric charge leakages which occur due to some environmental conditions.

IV. Simulation Result

The simulation result is executed using Proteus. The simulation result consists of two keypads, a microcontroller and two motors. The program of the microcontroller is written by using the C compiler. These programs tell how the wheel chair acts. The result is shown for the possible movements such as forward, reverse, left turn and right turn with the help of the motor. The keypads are used to decide the places to be reached. When the keys are pressed, the motors on the left & right side rotate. The rotation of the motors is responsible for the turning directions of the wheels to reach the destination place as defined. The other keypad is used to pick the desired things from their places. The function of the motor is given as per the table shown below. The table describes the motion of the motors which has the control of the wheels of the chair. The basic motions of the motor are either in clockwise direction or anti-clockwise direction. The table describes how the motors rotate to direct the wheel chair.

In the table first column denotes the left side motor’s motions, second column denotes the right side motor’s motions and third column denotes the direction of the wheel chair. The simulation result is shown in fig 8. The figure shows the interface of microcontroller with keypad and motors

Table 1: Wheel Chair direction Vs. Motor Operation

LEFT MOTOR'S MOTIONS	RIGHT MOTOR'S MOTIONS	DIRECTION OF WHEEL CHAIR
Anti-clock wise	Clock wise	Forward
Clock wise	Anti-clock wise	Reverse
Clock wise	Clock wise	Left
Anti-clock wise	Anti-clock wise	Right
Stop	Stop	Stop

Based on the inputs, the motor moves the wheels of the chair to their desired destinations. The keypads are pre-defined with destined places and the things required by the user for their personal works. Keypads are used as a specialist controls which allows independent operation of the wheelchair.

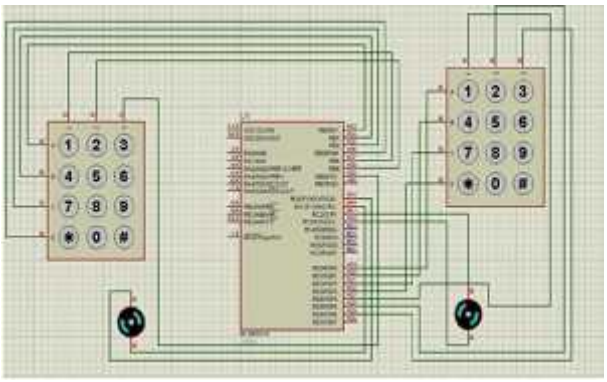

Fig.8 Simulation result of the proposed system

This provides an automated navigation which is very helpful for the users. This wheelchair can be used by handicaps in the public places by pre-defining the places as the functions to the keys of the keypad. The wheel chair does not need any external power supply units. It is an intelligent vehicle which detects the obstacle and takes different routes to reach the defined places (as predefined). It is a smart vehicle which takes you to the desired place by just a key press on the keypad. The additional feature is the human air bag system for the protection of the user from bone fractures.

V. Conclusion

In this paper, the discussion about the indoor navigation for the visually impaired and handicap persons who can move from one place to another without the help of others by just a press of the keys in the keypad. As the wheel chair is controlled by the user, it becomes a user-friendly system. This system has some additional features which is required by the user for extra protection.

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