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Multipurpose Electronic Wheelchair for Indoor Navigation (E-wheels)

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Abstract

Mobility is one of the greatest challenges faced by elderly and physically challenged people. Solution to their problem is powered wheelchairs with automatic navigation system. This paper presents a wheelchair which can be trained to self-navigate in indoor. The main objectives is to store the indoor paths covered by the chair and reuse it for future navigation. IR sensors are used to overcome obstacles when detected, a digital compass is used to detect the direction of movement of wheelchair. This system has a manual mode for the user to train and save new paths and also for navigation in outdoor. There is also a processing unit which saves the path and which is connected through a wireless communication protocol using zigbee.
Keyword- Arduino, Zigbee, IR sensor

I. INTRODUCTION

Mobility is one of the greatest challenges that physically challenged and elderly people face in their daily life. Powered wheelchairs with various methods of input such as gesture, voice, joystick etc. have proved to be effective in aiding these individuals to a certain extent. However, many of the physically challenged and elderly individuals find even these implementations difficult to use. The users are required to put continuous physical effort to navigate the wheelchair inside the house. This becomes very tedious for with high degree of disability such as quadriplegics.

Our system aims at reducing the stress of these individuals who use powered wheelchairs by developing an automatic path finding and navigation system that can be combined to the existing system. The automatic navigation system is designed for indoor only. Many of specific locations inside the house to which the user often navigates is identified and stored in the system like the kitchen, living room, bedroom etc.

Whenever the user wishes to move to these locations, he/ she can press a dedicated push button or give a predefined gesture to indicate the destination to which the wheelchair should move. On receiving the input, the system will automatically take the wheelchair to its destination through the pre-stored path.

We designed a processing unit which will always be in contact with wheelchair and recording the data of angle and distance moved by the wheelchair. It always saves the distance and direction between two points i.e. it only saves data in train mode and while we pressing the save button. We designed this algorithm using graphical programming software ProFiLab. As a part to get the initial while working in automatic mode the wheelchair have to brought to a predefined location and select the corresponding location.

An automated powered wheelchair can solve a number of problems. Firstly, because it is automated, the user does not have to continuously provide input. This substantially reduces the physical effort to guide the wheelchair and will be quite beneficial for quadriplegics. Secondly, the system does not use GPS or other devices to determine the position of the wheelchair. This way, the system's cost can be reduced without compromising in accuracy. The reduced cost can increase the popularity of this system among individuals who belong to middle class families, especially in developing countries like India.

II. SYSTEM ARCHITECTURE

Effective functioning of the system requires a significant number of hardware devices to function synchronously. The system will be divided into five modules viz. processing unit, Microcontroller module, Obstacle Detection sensors, Digital Compass module and Rotation Encoder module. The processing unit will contain the various paths saved in the house and will be responsible for executing automatic navigation. The processing unit hardware will comprise of a microprocessor and supporting hardware to communicate with the microcontroller module, here we use a zig-bee module for the communication. Figure 1 shows the block diagram of the various hardware components.

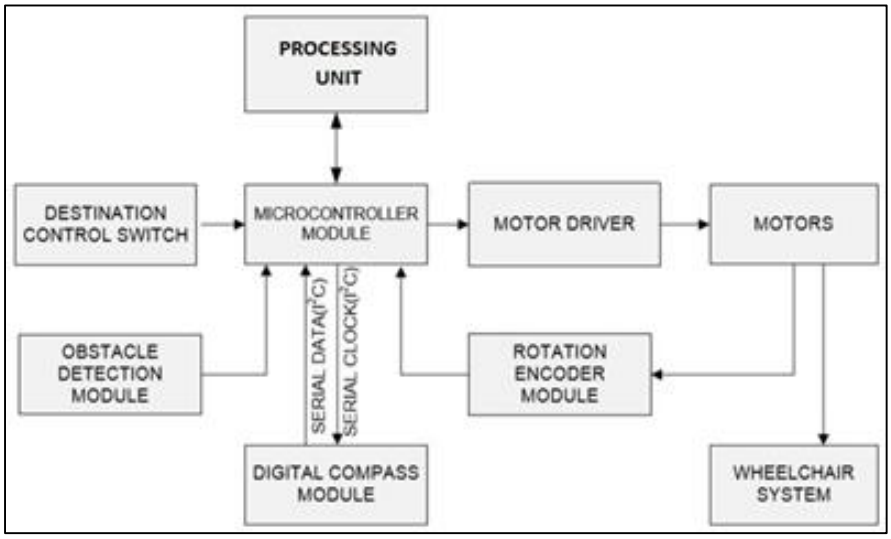

Fig. 1: System block diagram

The Microcontroller (arduino) module will function as the heart of the system. It communicates with all the other modules and makes decisions regarding the motion of the wheelchair. Once the path is calculated by the processing unit, it sends the path to the microcontroller. On receiving the path it gives signals to control the motors of the wheelchair. It continuously communicates with the Obstacle Detection sensors, Rotation Encoder module and Digital Compass module once the wheelchair is in motion.

Fig. 2: Arduino UNO board

The Obstacle Detection module constantly monitors if an obstacle is present in the path of motion of the wheelchair. It uses infrared sensors to determine the solid objects that are present before the wheelchair. If any objects are sensed, then the module gives necessary signals to the Microcontroller to halt the motion of the wheelchair.

The arduino monitors the distance travelled by the wheelchair with the help of the Rotation Encoder module. This module comprises of a hall sensor fixed beside the wheel and permanent magnets fixed on the wheel, at every full rotation of wheel 4 permanent magnets will pass the hall sensors. The hall sensor will detect magnetic field and send a pulse to controller while each magnet passes the sensor, when such each pulse detected one fourth of the perimeter of wheel is travelled by the chair. Like this the controller counts the pulse and calculates the distance travelled by the wheelchair.

The Digital Compass module as mentioned before functions when the wheelchair has to be rotated and oriented in a specific direction. It is directly linked to the microcontroller module. And it always gives angle of direction facing by wheelchair from the true north axis.

III. ALGORITHM

We have developed an algorithm as shown in figure 3 to find the path between a source and a destination from the pre-stored paths. The algorithm first identifies the present location, and then takes input of destination to be reached. From the pre-stored paths select the path to destination. Check for obstacles and move the wheelchair in the selected path, update the location of wheelchair. Compare destination and present location again check for obstacle, move forward and update the location. Until the destination is reached this process will be continued, when the destination reached the wheelchair stops.

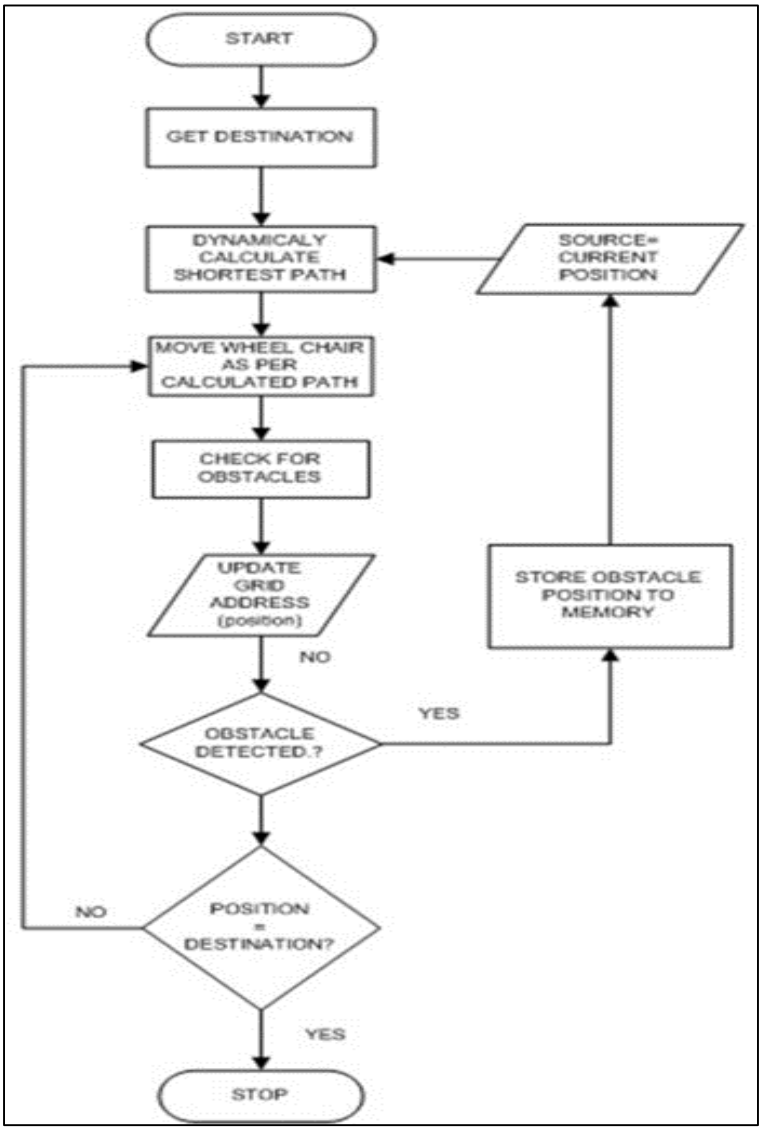

Fig. 3: Flowchart of Algorithm

IV. CONCLUSION

The Algorithm is able to provide the path possible to reach the destination for an automated powered wheelchair in a very short period of time. The cost reduction achieved can help the vast number of disabled individuals in developing nations such as India.

V. RESULT AND DISCUSSION

A prototype of automatic wheelchair system is developed. The design comprises of IR sensors, Digital compass, hall sensor, processing unit, Arduino UNO, Zig-bee, motor driver, LCD display, motors and battery. All the wiring and connections are connected to Arduino. The wheelchair is programmed using arduino, all the system work under the control of arduino. The speed direction of movement is controlled by program, the path to be moved is given to the wheelchair from processing unit through Zig-bee module. A LCD display is used to ease in user interface.

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