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WIRELESS GESTURE BASED SMART CAR CONTROL FOR HANDICAPPED PERSONS

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Abstract– Robots of the future should communicate with humans in a natural way. Hence, we are especially interested in hand motion based gesture interfaces. The purpose of this study was to present a reliable means for human-computer interfacing based on hand gestures made in three dimensions, which could be interpreted and adequately used in controlling a remote robot's movement. In this paper we discuss the development of a novel architecture of an intelligent wheelchair working on wireless hand gesture control and not by the usual method of keypad for the physically handicapped people. Unlike others before it, this project also has a distress call system (GSM) to alert the concerned people or family in times of necessity for the person, by the person himself/herself from an alert switch or when there is any sudden detection of edge or staircase during backward motion, thus saving the chair from accidents. The locomotion of the wheelchair is controlled by a MCU (microcontroller). The physically handicapped people will have the option of controlling the system through hand gesture wirelessly from ranges up to several meters and will have the independence of using the wheelchair without the help of any other people.

Keywords – wireless control, gesture control, edge avoider, distress call system, proximity sensors.

I. INTRODUCTION

People with physical disabilities and partial paralysis always find it difficult to navigate through their habitat or their home without the assistance of someone. Often after paralysis or physical disability the wheelchair is the most common means of locomotion for such people. But to navigate through one's own house without help of someone every time can be demoralizing for the person as well

With the present development on the field of robotics,embedded system and artificial intelligence a successful project has been developed in order to easily solve this matter and that too at a very low cost. The wheelchair in context can be remotely controlled from several meters wirelessly without actually sitting on it. The chair can be controlled by hand gesture method with directions as needed. Previous developments on this topic include the presence of a laptop or CPU on the wheel chair for the purpose of processing [2]. The recent development on this topic has been related to the development of gesture and voice control wheelchair [1]. The problem that these systems have is that it makes the system very heavy and the wheelchair can only be controlled while sitting on it. Therefore the technology is not providing the expected freedom for the handicapped people. Gestures control robots are extensively employed in human non-verbal communication which works with our hand gestures. This project enhances this work with the development of the wireless mechanism for control of the locomotion. This robot is mainly divided into two practical parts: 1.Transmitter – The gesture device. 2. Receiver – The Robot. They allow to express orders (e.g. "stop"), mood state (e.g."victory" gesture), or to transmit some basic cardinal information (e.g. "two"). Thus, it seems convenient that human-robot interfaces incorporate hand gesture recognition capabilities. For instance, we would like to have the possibility of transmitting simple orders to personal robots using hand gestures. The recognition of hand gestures requires both hand's detection and gesture's recognition. Both tasks are possible hand gestures (signs), and because hands are complex, deformable objects (a hand has more than 25 degrees of freedom, considering fingers, wrist and elbow joints) that are very difficult to detect in dynamic environments with cluttered back ground sand

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variable illumination. Several hand detection and hand gesture recognition systems have been proposed. Early systems usually require markers orcolored gloves tomake the recognition easier very challenging, mainly due to the variability of the Human-robot symbiotic system shave been studied extensively in recent years, considering that robots will play an important role in the future. The use of i ntelligent robots encourages the view of the machine as a partner in communication rather than as a tool. Inthe near future, robots will interact closely with a group of humans in their everyday environment in the field of entertainment, recreation, health-care,nursing, etc. In human-human interaction, multiplecommunication models such as speech, gestures andbody movements arefrequentlyused. The standardinput methods, such as text input via the keyboardand pointer/location information from a mouse, donot provide a natural, intuitive interaction betweenhumans and robots. Therefore, it is essential to createmodels for natural and intuitive communication between humans and robots. Furthermore, forintuitivegesture-based interaction between humanand robot, the robot should understand the meaningof gesture with respect to society and culture. Theability to understandhand gestures will improve thenaturalness andefficiency of human interaction withrobot, and allow the user to communicate in complex tasks without using tedious sets of detailed instructions. A system for rapidly developing industrial robotic applications with visual hand gestures and voice commands is being developed. The proposed model makes the wheelchair a lot easier to assemble and simple in the use, in addition the cost of manufacturing also gets reduced. Also, with this development the wheelchair can be controlled remotely from several meters away. So a person sitting on the sofa can control the wheelchair near or away from him just by hand gestures. It can also help people during the night without the need for a third person; for the person to get on the wheelchair and move inside the house. People will also be able to control the chair in narrow spaces without collision as the system uses proximity sensors to avoid the objects. In addition to that the person on the chair will also have the ability to send distress SOS (through SMS) to the family members or a particular person in times of emergency. This process can be activated by a single switch on the hand gesture module that can be easily pressed by a single finger. Other than that the wheelchair also has edge avoider modules on the back which helps to detect any sudden edge or stair when in the backward motion. On detection the chair will automatically move forward and on two such consecutive edge detections the wheelchair will alert the family or particular people whose numbers are pre-saved in the distress call module. Christo Ananth et al. [3] discussed about an eye blinking sensor. Nowadays heart attack patients are increasing day by day."Though it is tough to save the heart attack patients, we can increase the statistics of saving the life of patients & the life of others whom they are responsible for. The main design of this project is to track the heart attack of patients who are suffering from any attacks during driving and send them a medical need & thereby to stop the vehicle to ensure that the persons along them are safe from accident. Here, an eye blinking sensor is used to sense the blinking of the eye. spO2 sensor checks the pulse rate of the patient. Both are connected to micro controller.If eye blinking gets stopped then the signal is sent to the controller to make an alarm through the buffer. If spO2 sensor senses a variation in pulse or low oxygen content in blood, it may results in heart failure and therefore the controller stops the motor of the vehicle. Then Tarang F4 transmitter is used to send the vehicle number & the mobile number of the patient to a nearest medical station within 25 km for medical aid. The pulse rate monitored via LCD .The Tarang F4 receiver receives the signal and passes through controller and the number gets displayed in the LCD screen and an alarm is produced through a buzzer as soon the signal is received.

II. BLOCK DIAGRAM

The development of this project is done keeping in mind to enable the physically handicapped people to navigate and move around their home without the help of anyone. The present structure of the project involves the method of controlling the wheelchair using hand gestures as commands. The method can be applied wirelessly as we have done in this module using the RF receiver transmitter module. The control of the locomotion of the wheelchair is presently done by microcontroller (Arduino Open Source Prototyping Platform). The following block diagram shows how the entire system works using the hand gesture method:

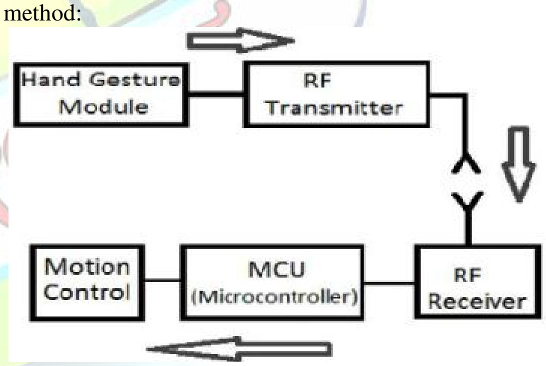

Fig. 1 – Block diagram for the hand gesture method of control

As we can see from the above block diagram the wheelchair works completely on the wireless network and is therefore much better and efficient than the previous models. The Arduino prototyping platform is as open source prototyping platform which runs on embedded C structure. The platform is extremely powerful and easy to use with several inbuilt functions and a powerful microcontroller: Atmega328 which is an 8-bit AVR RISC-based microcontroller. It combines 32 KB of ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, serial programmable USART, three timer/counters with compare modes, internal and external interrupts, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), a byteoriented 2-wire serial interface, programmable timer with internal

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oscillator, and five software selectable power saving modes.

SYSTEM – HARDWARE

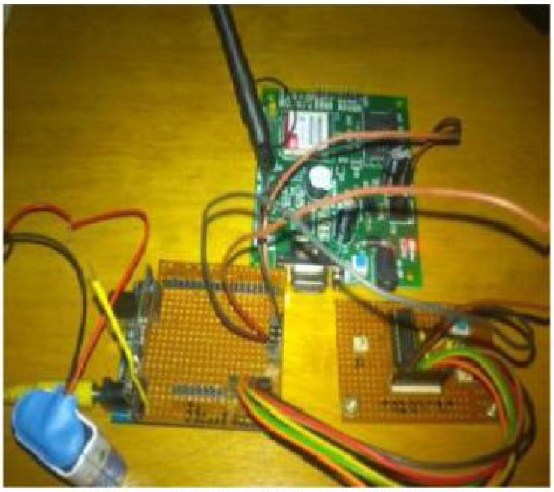


Fig. 2 – The Receiver and Locomotion Module

The system uses several small parts and modules for the complete action as listed below:

A. HAND GESTURE MODULE

The hand gesture module has been prepared by using a triple axis accelerometer sensor (ADXL 335). The relatively low cost sensor provides the data for the orientation of the hand and therefore helps in recognizing the gestures. The accelerometer sensor senses the accelerating force (acceleration due to gravity or g) and thus gives a particular voltage for the x, y and z coordinate orientation. The data can be observed in integer format through the serial port of MCU on the computer's serial monitor and accordingly the orientations of the hand can be sorted out. The basic working block diagram of the accelerometer sensor:

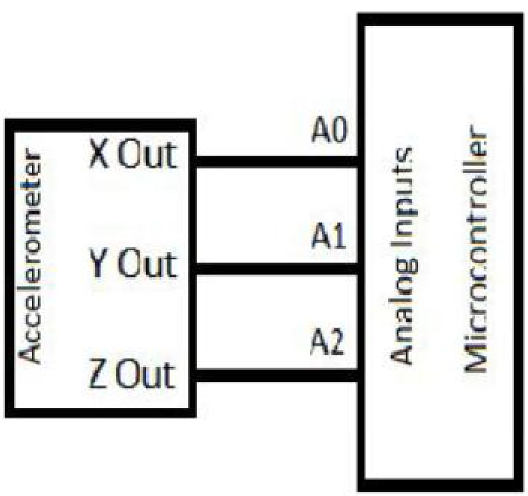


Fig. 3 – Block diagram of Accelerometer sensor to Microcontroller module

The accelerometer sensor has specific values which are read as analog inputs by the microcontroller. The data obtained from the accelerometer for the various orientations of the hand gave us the readings to decide the threshold value for each x, y and z coordinate reading:

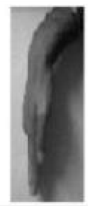
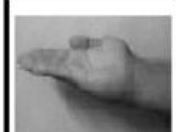
Hand Position	Direction of Motion	Thresholod values of ADXL335
	Forward	x >= 280 & y <=280 & z <=| 230 & z >=| 295
	Right	x <= 280 & y <=280 & z <=| 230 & z >=| 295
	Left	x <= 280 & y >= 280 & z <=| 230 & z>=|295
	Back	x <= 280 & y <= 280 & z <= 230
	Stop	X <= 280 & y <= 280 & z >= 295

Fig. 4 – Table of accelerometer threshold values for different hand orientation

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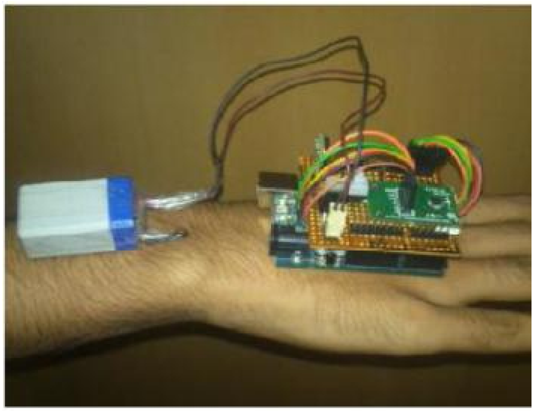

Fig. 5 – Hand Gesture Module

B. RF TRANSMITTER & RECEIVER MODULE

The RF transmitter module has been used as per the purpose of making the gesture module completely wireless. We are using a 434 MHz WS-TX-01 module for the transmitting purpose. For a specific orientation of the hand the microcontroller unit on the hand decides the condition and a particular character are sent to the receiver module. For the receiver we are using a 434 MHZ WS-RX-02 module which is a low cost receiver module. The receiver upon receiving the string sends the data to the microcontroller on the wheelchair which in turn decides the case of the locomotion for the wheelchair. The entire module is very effective for long distances as shown in the following table:

Table I – Range for Hand Gesture Module

Fig. 6 – RF Receiver Transmitter Module (434MHz)

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B. ARDUINO IDE

The Arduino IDE is an open source programming environment based on Processing and is used to program the Atmega328 on the Arduino boards. The IDE has several inbuilt functions and falls under AVR embedded C design based on Processing.

III. RESULTS AND DISCUSSIONS

All the components after integration give us the working skeleton model for the wheelchair. The wheelchair model works perfectly according to the hand gestures. The reaction time of the various modules as noticed after the several trial runs are tabulated below. The readings are calculated based on the following formula: Success Rate = (No. of successful trials*100)/ (Total no. of trials)

Along with that we also notice that the communication of the wireless module extends over several meters in the indoors. Rather than the constricted need of the person to be on the wheelchair the entire time to control it [1] [2] [6] [7], the developed idea works absolutely free of any wires or restrictions. The ability to avoid the obstacles is kept to a limit of 15 cm from the wheelchair. If detected the wheelchair turn the other direction from the obstacle still it is back on the front line. It has been seen that the proximity sensors hold good for an angle maximum of 200-250.

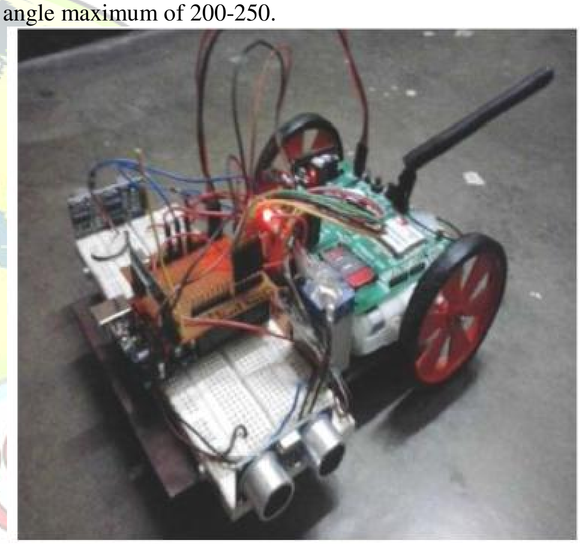

Fig. 11 – Gesture controlled skeleton test model for the wheelchair

The various gestures as outlined in Fig. 3 were tested and the outputs were studied to check if the right codes were transmitted. The mobile wheelchair is capable of sending over the air how close it was to the nearest object at its left, right and centre. With that the model is also able to transmit SOS when proper signal is received. Therefore the project is seen to be working successfully with an artificial human-machine interaction system. A snapshot of the hyper terminal window, which was used to view the transmitted data between both the gesture screen and the robot can be seen below in Fig. 12. The data has been studied and seen that the reaction of the robotic wheelchair is very fast to the gestures.

CONCLUSION

With the development of the project it can be successfully implemented on a larger scale for the handicapped people. The low cost of the assembly makes it really a bonus for the general public. The wireless system will be a boost to the confidence and

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willpower of physically challenged people as it will help them to be self reliable.

As a part of further development the project can be developed with addition voice recognition features through on board processing and power supply. There can also be the application of intelligent home navigation for handicapped people to go through the entire house and get help from technological interface for the navigation. The object avoiding and careful navigation principle can be improved with algorithm based image processing technology.

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