Automated Gesture Based Wireless Wheelchair Control by Means of Accelerometer

V Sridevi,P. Ishwarya, P. Surya Chandra, N. Suresh Kumar

Abstract ***According to a research there are about 6 million populations in the world who are paralysed and needs a wheelchair for their mobility. Earlier the wheel chairs had to be moved and be externally supported by any person. To help overcome this "joystick-controlled wheelchairs" are developed. But in regular use, these joystick-controlled wheelchairs became difficult to use. Especially in the case of paralysed people, the use of joystick became more difficult due to the hard buttons and unidirectional use of the joysticks. To overcome these problems, we've tried to develop a "gesture-controlled wheelchair" which can be moved with a slight tilt of the hand. This can be used in both hands and can be controlled to come to the user from a distance. The current work is implemented with Arduino based devices such as Arsuino NANO and UNO processors and programmed through Arduino IDE.***

Keywords: Gesture control, Arduino nano, transmitter, receiver, encoder, decoder, ultrasonic sensor

I. INTRODUCTION

In present world around 650 million people are physically challenged. Hence it is highly essential to build a system inorder to make their lives happy and more flexible. An advanced wireless wheel chair system is designed to make physically challenged person's life more convenient and flexible. In the present project a hand gesture-based wheel chair system is developed for handicapped persons, those who are partially paralyzed. In this process the physical movement of the hand is sensed with sensors. The sensed signal is converted into electrical signal and then the signal is transmitted after converting analog signal into digital signal. The designed system best suitable who are paralyzed in accidents or paralyzed due to genetic order. The designed system is enabled and working based on user hand/finger movement commands. The low cost machine design is one of the main concerns to develop this machine.

In most of the times the disable persons feel difficult when they need to move from one place to other place hence, depends on other persons to move from one location to other location. The wireless wheel chair is designed in such a way that it can sense commands and can transmit the commands in the range of 200 yards. Hence paralyzed people need not to go to the chair.

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V.Sridevi, Assistant professor, Dr. LankapallyBullayya Engineering College (for Women), Visakhapatnam, India, email:velagasridevi1985@gmail.com

P. Ishwarya, Assistant professor, Dr. LankapallyBullayya Engineering College (for Women), Visakhapatnam, India,

P.Surya Chandra, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, India

N. Suresh Kumar, Gandhi Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, India

The handicapped person can control the wheelchair from 200 yards distance and can send commands with their finger or arm or hand movement to wheelchair to call the wheel chair away from the person's location. Hence the wireless hand gesture based wheelchair helps the physically challenged persons to move from one location to other location independently without second person intervention [1].

The paralysed persons those who cannot speak, walk or cannot move any body parts the existing cannot solve their problems. Just with the tilt of his/her hand they are able to move from one place to make them self-dependent. During the development of human machine interface for wheel chair control several designs are proposed based on input signal type [2][3].

Some systems are able to sense voice signals [4], some able to recognise retina movement, and some other systems are brain reading system which is under development stage. While designing wheelchair system it is very important to develop wireless technology between receiver and transmitter interfacing to provide more hardware integrating flexibility [5]. The present system is designed for persons who able to move arm or fingers. Reading the movements of the fingers the sensory system understands the changes in the finger gesture and controls the motor [6][7].

There are some limitations existing with traditional wheelchair system such as complexity in service when repaired, use of joystick may be difficult for challenged persons, the wheel chair cannot sense any obstacles' on the path, and to move the chair they need some external help [8]. The limitations of the existing systems can be eliminated in the present system.

II. SYSTEM DESIGN

The wheel chair system design and the required components are discussed in this section.The wheelchair system contains two parts, they are transmitter and receiver. The block diagrams of transmitter and receiver are shown in figure 1 and figure 2 respectively. The components are classified into two types, one is hardware and the second one is software component.

A. Hardware Components:

Power Supply: The 9V and 12V DC power supply is connected with transmitter and receiver respectively.

Accelerometer: The accelerometer in the present work is used to measures acceleration by gravity and changes the angle of direction with respect to the earth. The accelerometer further controls the speed and device direction while moving. The accelerometer is interfaced with three analog inputs of Arduino NANO processor.

Arduino NANO: Arduino 3.0 is ATmega328 based processor and easy to operate. It supports USB interfacing. The pin configuration of Arduino NANO device is

shown in figure 3 [9]. Arduino processor supports 30 pins, out of which 8 pins can be used as analog input pins and 14-pins can be used as digital pins.

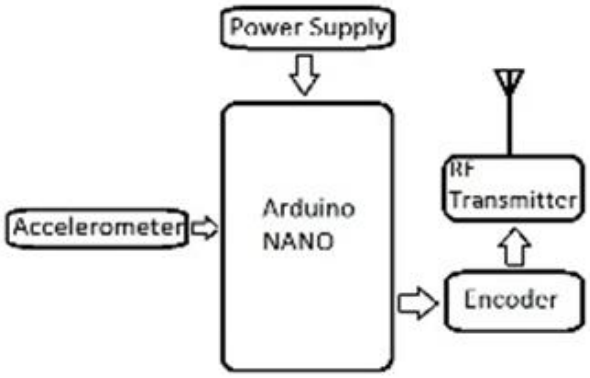


Figure 1 Block Diagram of Transmitter

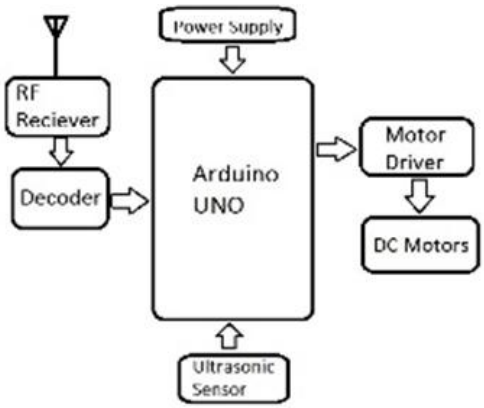


Figure 2 Block Diagram of Receiver

Encoder: In most of the applications the encoder is used to detect RF signals. In the present design the encoder is used for remote control accessing. The 12-bit digital data is converted serial data which is used to enable RF transmitter on the transmitter board. The 12-bit data is partitioned into 8-bit address and 4-bit data. The address bits can be used to sect multiple receiver devices at receiver end.

RF Module: The transmitter and receiver are interfaced with each other through RF module. The RF module receives signals serially from transmitter.

Decoder: The decoder is used to control remote operations. It converts serial input data into parallel data.

The Block diagram of receiver section and respective components involved at receiver side as shown in figure 2 is discussed in this section.

Arduino UNO: The ATmega328 based Arduino UNO processor supports 14 digital input and output pins and six analog inputs as shown in figure 4. The programs are embedded with Arduino IDE and it is very easy to interface with system using simple USB cable.

DC Motor driver: The DC motor-driver (L293D) controls the DC motor in possible rotations. In the present work the motor-driver controls two DC motors simultaneously. That means it controls the direction of two motors simultaneously which will help in moving vehicle wheels synchronously.

DC Motors: The basic principle of DC motor is it converts electrical signals into mechanical energy.

Ultrasonic Sensor: The proximity of the object is detected by ultrasonic technology. The transducer sends ultrasonic signals and senses them after reflection, when there is an object across the ultrasonic signal path.

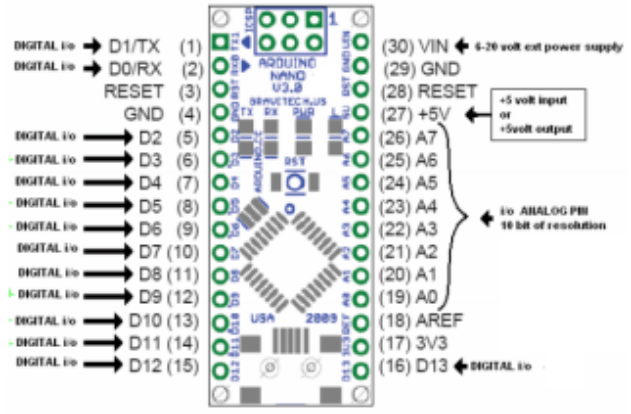


Figure 3 Pin Configuration of Arduino NANO

B. Software Component:

Arduino IDE: The IDE is software component used to upload and modify the code developed in integrated development Environment.

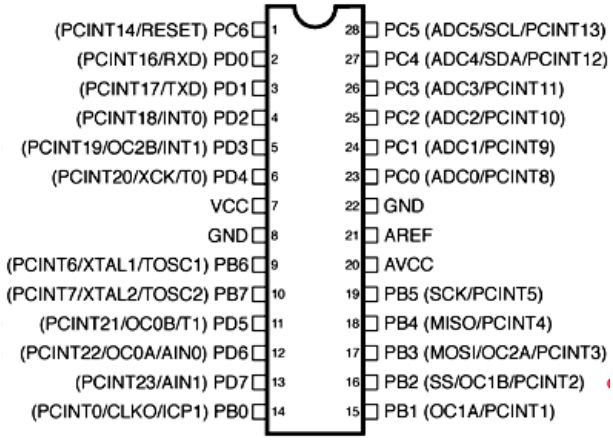


Figure 4 Pin Configuration of Arduino UNO

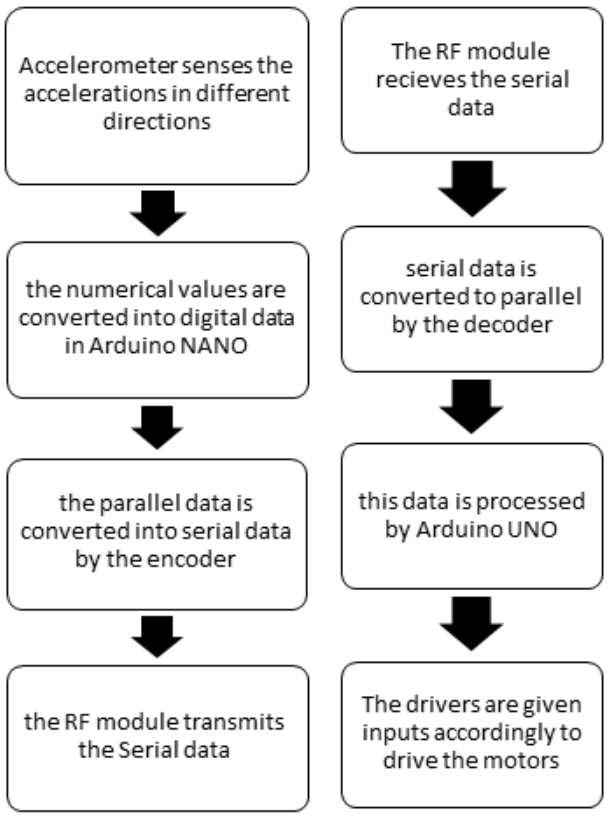
III. REAL TIME IMPLEMENTATION

In this workhand gesture based wheelchair is designed with ATmega328 microcontroller by using accelerometer. In the present system the wheel chair is tracked through the laptop for the security of paralyzed persons. The direction of the wheelchair is observed through laptop with the help of Arduino Board. The wheel chair basically takes the input signals from person hand gestures and values are displayed on laptop monitor.

In the present work, the hand gestures represent a small movement of hand or fingers made in different directions. An accelerometer sensor is used to detect different hand gestures. In the present work ADX335 is used as accelerometer sensor. The sensor can be either fixed directly with the hands of the person or can wear with hand gloves.The accelerometer supports three analog inputs and need to be convert into digital signal using ADC converter to make the analog signal output compatible with RF module.The analog to digital convertion is done with the help of ADC module embedded in ATmega328 microcontroller. Based on the ADC readings which are proportional to the accelerometer sensor, the ATmega328 will recognise

and decode different gestures of the hand.
Once the decode of hand gesture is mapped into machine understandable code, the ATmega89S52 microcontroller will send the required signal to the encoder, HT12E, for the parallel data to be converted to serial data and transmit through the RF module. At the receiver the receiver receives the data and it is converted to parallel data by HT12D and the output is given to the Arduino UNO board.
Then the Arduino UNO board sends signal to DC motor driver inorder to control the movement and direction of the wheelchair in required direction. The hand gestures are sensed and converted into displacement of the wheelchair in different direction such as left, right, forward, backward directions and stop whenever it is required. When the palm is positionedparallel to the ground the microcontroller activates stop() function.

Flow charts:



(a) **(b)**

Figure 5 Data flow diagram
a) Transmitter side b) Receiver side

The performance of the system can further be improved by introducing by parallel processing element pipeline [10][11]. The intelligent sensor network[12] need parallel processing element[11] for fast and reliable measurement.

There is an ultra-sonic sensor for the detection of the obstacle which is within 50cms of range and the wheelchair halts as shown in figure 7(a). It can be controlled to move backwards only and no other directions.The prototype of transmitter and receiver are shown in figure 6 and figure 7. The front view and top view of the vehicle model is shown in figure 7 (a) and 7 (b)

Advantages:

- The wheel chair detects the obstacle at the front and stop the movement within a range of 50 CMs.
- Without any external help the paralyzed person can operate his own chair.
- The prototype of the system is successfully developed to move the wheel chair Left, Right, Forward, and Backward directions or stay in the same position.

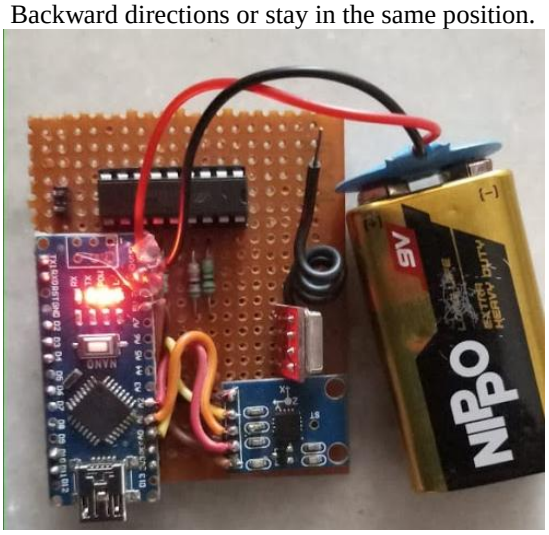
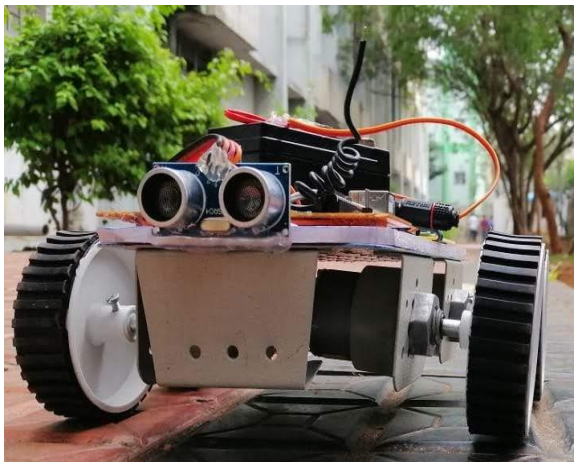
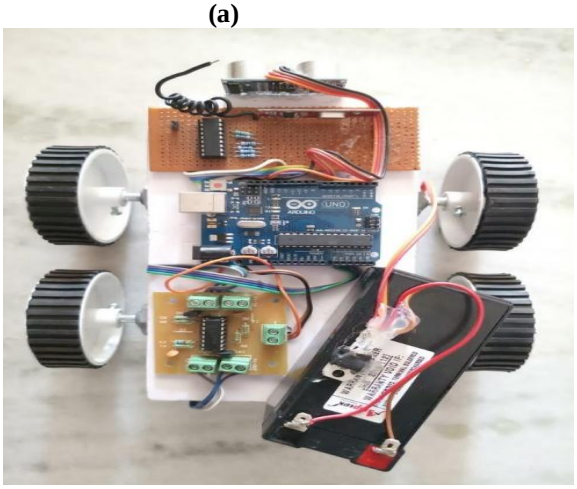


Figure 6 Prototype of the Transmitter



(a)



(b)

Figure 7 Prototype of Receiver a) front view consists sonic sensor b) top view of the model designed

Future Scope:

- Instead of using acceleration motion optical sensor can be used to detect eye retina to move wheel chair accordingly [13][14]
- On road driving need multi-dimensional parameter estimation to avoid risks [15]
- Voice command IC's can be used to interface with microcontroller
- The GSM can be embedded in to the present work to extend its feature such as sendingmessages during emergency
- Research is going on development of handicap wheel chair using nervous system of human

IV. RESULTS

The functional operations are implemented in the Arduino IDE software. The description/action of various commands used in the program is shown in table 1. Table 1 reflects the various control functions used to control and movement and direction of the vehicle in desired direction. The functions are developed in such a way that they able to provide more accurate sensitivity and response in moving and direction change. The response time of the functions with respect to the sensors is tested for several times and designed and modified the program inorder to achieve good results. The back() and front() functions are developed to control the direction of the vehicle both in forward and backward direction. Similarly, the functional commands left() and right() are developed to the control the direction of the vehicle in right and left direction. The functions reads the input signals from various sensors through analog inputs and sends output to output devices like motors to control the wheels rotation.

Table 1 Functional Table

Palm Movement	Function	Action
Upward	back()	Chair moves backward
Downward	front()	Chair moves forward
Left	left()	Chair moves left
Right	right()	Chair moves right
Horizontal	stop()	Chair stops

V. CONCLUSION

The gestured detection based wheel chair is designed with two Arduino processor and controlled left, right, forward, and backward mov. Unlike traditional design the present method is successful in carrying paralysed people without meeting any error. The functions invoked and respective directions are shown in table 1. Automated wheel chair can be used to help handicap people and the present work is aimed to help the paralysed people who can only move one side of their body or partially paralysed and help them to be able to move. In thepresent work the wireless system is successfully developed to move the wheel chair in various direction i.e., Forward, Backward,Left, and Right, or Stay in Same Position and also stop automatically when any obstacle is detected.

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AUTHOR PROFILE

VelagaSridevi has completed her M.Tech from AndhraUniversity, Visakhapatnam in 2013. The author has more than five years of teaching experience and has handled several subjects for ECE students. During her experience she has published numerous research papers in various International journals.

P Ishwarya has completed her Maters from Greenwich University of London UK in 2012. The author has more than five years of teaching experience and has handled several subjects for ECE students. During her experience she has published numerous research papers in various International journals.

P. Surya Chandra has more than 11 years of teaching experience and has handled several subjects for IT students. During his experience he has published numerous research papers in various International journals

N. Suresh Kumar has obtained PhD degree from Andhra university and hisresearch of interest is parallel processing, Internet of Things, Natural Language Processing, Reconfigurable Computing Systems, Information Communication Technology, and Computerised Process Control Measurement. He is currently working as assistant professor in GITAM Institute of Technology, Visakhapatnam, India. During his 17 years of experience he occupied different positions in academic and administration. He has published research papers in various refereed National and International Conferences and journals. The author has worked as reviewer for several of the conference papers and also working as editorial board member in various reputed journals.