Wireless head gesture controlled wheel chair for disable persons

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***Abstract*— This paper describes an indigenously developed hands-free wheel chair for physically disabled persons. The proposed device works based on the Head Gesture Recognition technique using Acceleration sensor. Conventional electric powered wheel chairs are usually controlled by joysticks or hand gesture technology which cannot fulfil the needs of an almost completely disabled person who has restricted limb movements and can hardly move or turn his head only. Acceleration sensor is used for the head gesture recognition and RF (radio frequency) module is used for the smart wireless controlling. With the change of head gesture, data is sent wirelessly to the microcontroller based motor driving circuit to control the movement of the Wheel Chair in five different modes, namely FRONT, BACK, RIGHT, LEFT and a special locking system to STAND still at some place. The proposed device is fabricated using components collected from local market and tested in lab for successful functioning, test results are included in this paper.**

Keywords: Microcontroller,Head Gesture Recognition, Intelligent Wheel Chair, Hands-free control, Acceleration sensor, RF module.

I. INTRODUCTION

Old citizens or disabled persons become dependent on other members of the family to navigate through their habitat or within residence. A smart wheel chair can be a useful assistant for them. Recent development in the field of robotics, automation, embedded system, artificial intelligence etc. can be combinedly utilised to design such a wheel chair. It can be controlled wirelessly adopting proper communication system. The chair can be controlled by head gesture as well as hand gesture method with directions as needed. The previous development of this kind of wheel chair is using a laptop or PC on the wheel chair [1]. By this development the recent wheel chairs are gesture controlled or voice controlled [2]. But the limitations of this kind of technologies is that the wheel chair is getting too bulky and it is to be controlled only by sitting on it. That's why these types of wheel chairs are not giving satisfactory feedback from the users. The proposed model makes the wheel chair a lot easier to assemble and simple in the use, in addition the cost of manufacturing also gets reduced.

II. LITERATURE REVIEW

Considerable research has already been done in the field of control using human gesture. MEMS accelerometer sensor that detects the tilt is used to change the direction of the wheelchair as commanded is a new generation invention [3]. By the increased development of voice recognition technology now a days some features are added to the wheelchair to control the device with voice command as well as body gesture command [4]. Extensive work has been there on gestures with ECAs (Embodied Conversational Agent). Bickmore and Cassell developed an ECA that exhibited many gestural capabilities to accompany spoken conversation and interpreted spoken statements from human being [5]. Sidner et al. have explored the interaction between a human and a humanoid robot [6]. Nakano et al. analyzed eye gaze and head nods in computer-human conversation and found that their subjects were aware of the lack of conversational feedback from the ECA [7]. They incorporated their results in an ECA that updated its dialog state. Matsusaka et al. uses head pose to determine who is speaking in three party conversations [8].

Several authors have proposed face tracking for pointer or scrolling control and have reported successful user studies [9-10]. In contrast to eye gaze [11], users seem to be able to maintain fine motor control of head gaze at or below the level needed to make fine pointing gestures. However, many systems required users to manually initialize or reset tracking. These systems supported a direct manipulation style of interaction, and did not recognize distinct gestures.
Lenman et al. explored the use of pie- and marking menus in hand gesture-based interaction [12].

Recognition of head gestures has been demonstrated by tracking eye position over time. Kapoor and Picard presented a technique to recognize head nods and head shakes based on two Hidden Markov Models (HMMs) trained and tested using 2D coordinate results from an eye gaze tracker [13]. Kawato and Ohya suggested a technique for head gesture recognition using between eye templates [14]. When compared with eye gaze, head gaze can be more

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accurate when dealing with low resolution images and can be estimated over a larger range than eye gaze[15]. The proposed system in this paper is based on the movement of head also. This system provides wireless control. Also it is easier to handle and cost effective as well as user friendly.

III. METHODOLOGY

This developed structure of wheelchair is so designed that a physically unable person can do their habitat and move around their house without any help of others. Our proposed wheelchair is so designed that it can be easily controlled by the head gesture command. The most attractive feature of this wheelchair is that it can be wirelessly controlled as we have done in this module using the RF receiver transmitter module. The controlling technique of this device is performed by microcontroller (Arduino Open Source Prototyping Platform).

A. SYSTEM LAYOUT

This layout reveals actual working of all components. Basically, this layout shapes the idea of overall working system. Fig.1 shows the whole system layout. The layout shows that by shaking the head in a required direction accelerometer gets a specific value which is sent to the microcontroller. Then the microcontroller processes the data and send an information through RF-TX. This information is received by the RF-RX and then send to the microcontroller. Then the microcontroller processes the data and as preprogramed it changes the directions of the wheel by changing the direction of motor.

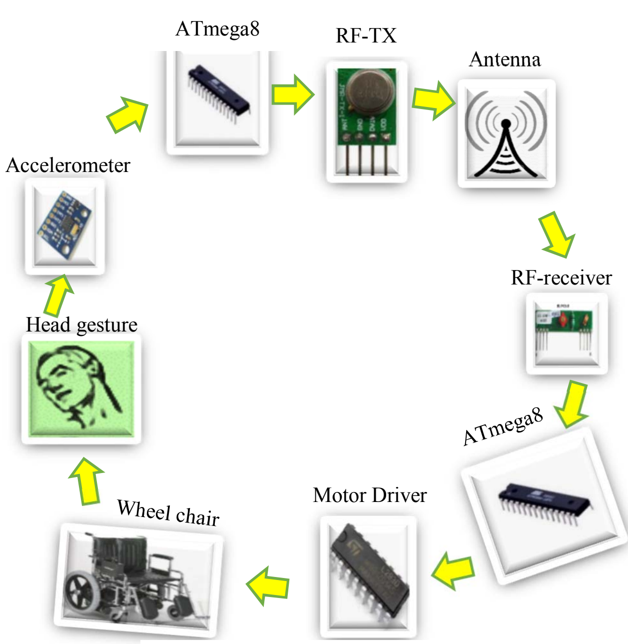


Fig. 1 : System Layout

B. BLOCK DIAGRAM

The block diagram is divided into two parts, one is transmitter system and other is receiver system.

a) Transmitter Block Diagram

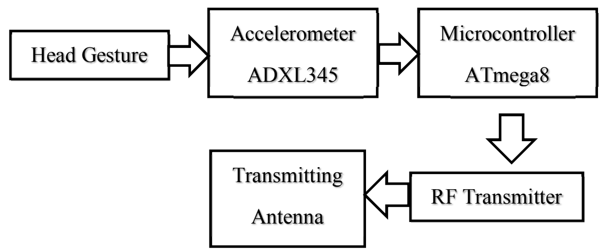


Fig. 2 : Transmitter Block Diagram

Here the transmitter block diagram represents the working procedure of the transmitter circuit. First an information is got for different head movement which is the data of the accelerometer. This data is sent to the microcontroller to take a decision as preprogrammed. Then the required instruction is sent as a data by the RF transmitter.

b) Receiver Block Diagram

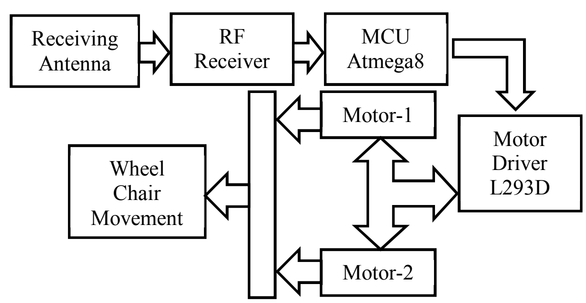


Fig. 3 : Receiver Block Diagram

The above diagram shows the controlling strategy of the wheelchair. The data which is sent by the transmitter section is received by the RF receiver and send to the microcontroller. The microcontroller then take the decision as it is preprogrammed to control the motor as well as the direction of the wheelchair. Motor 1 and Motor 2 are introduced to clarify the direction changing strategy.

C. FLOW CHART

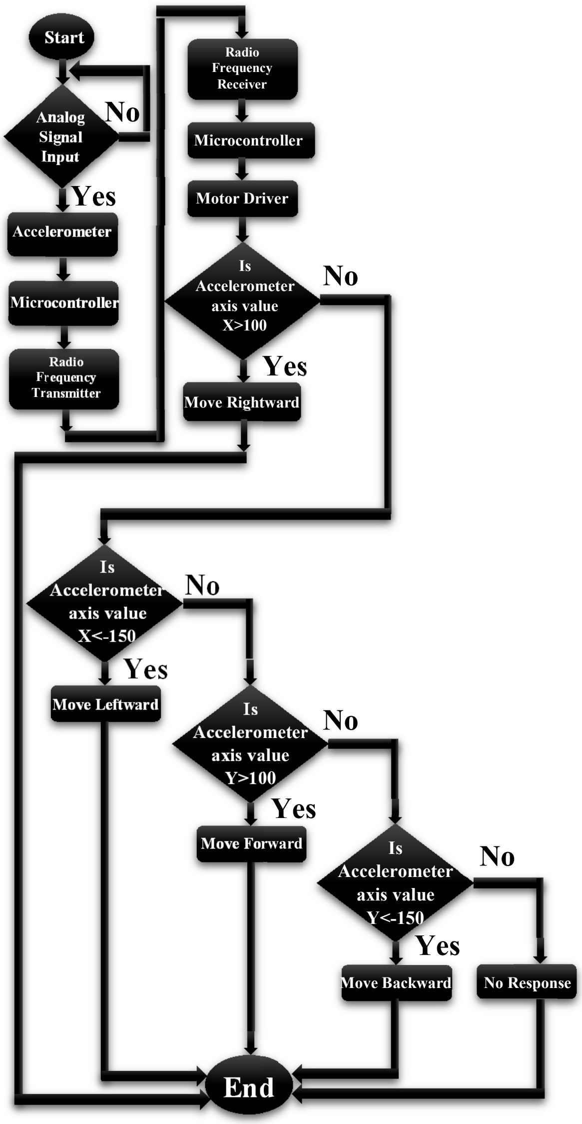


Fig. 4 : Flow Chart

Here, each component is used as a block. With arrow mark and proper block, the system sequence is shown. Here analog signal from head movements is transmitted to the receiver module. After processing the signal, a command signal is produced which controls the motor driving system and causes the ultimate rotation of wheel chair. Accelerometer receives the movement of head, logic circuit called ATmega8 performs the logic operation.

D. SCHEMATIC ARRANGEMENT

For schematic diagram here we use proteus software and printed circuit board (PCB) also designed in proteus.

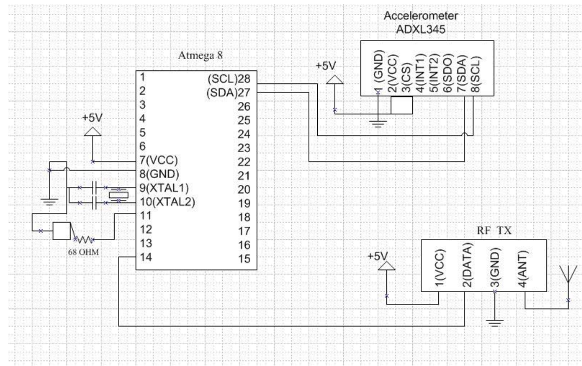


Fig. 5 : Transmitter Section Schematic

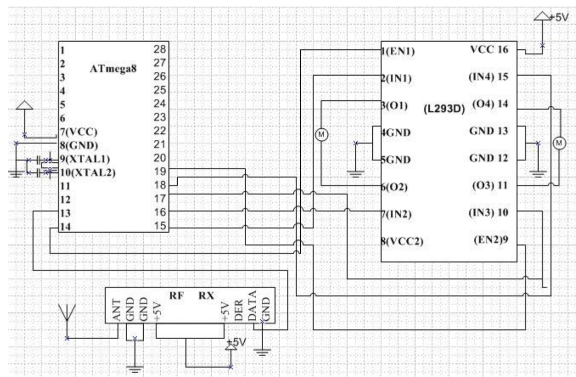


Fig. 6 : Receiver Section Schematic

E. COMPLETE STRUCTURE

The transmitter and the receiver circuit is fabricated in the lab. All the required components are available in the local market. Printed circuit boards are fabricated and all the collected components are mounted on the board. The complete system is shown in Figs. 7 and 8.

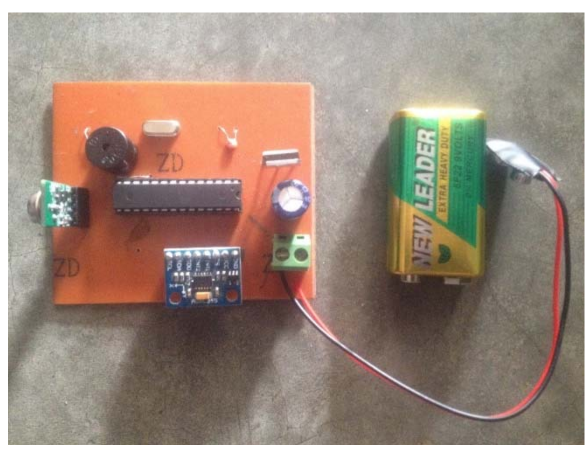


Fig. 7 : Real Transmitter Device

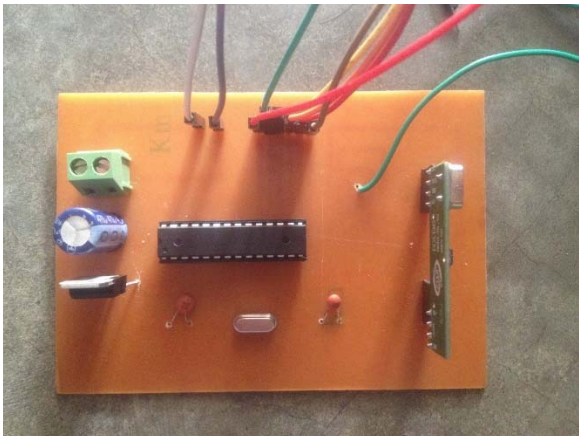


Fig. 8 : Real Receiver Device

F. COMPONENT DESCRIPTION

i. HEAD GESTURE MODULE

The ADXL345 is a small, thin, low power, 3-axis accelerometer with high resolution (13-bit) measurement at up to ±16*g*. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3- or 4-wire) or I^{2}C digital interface.

Fig. 9 : Top view of Accelerometer

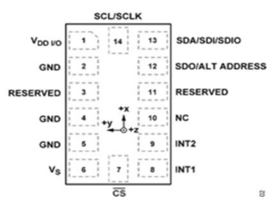


Fig. 10 : Pin Diagram of (ADXL345)

Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation. The ADXL345 is supplied in a small, thin, 3 mm × 5 mm × 1 mm, 14-lead, plastic package. ADXL345-EP Supports defense and aerospace applications (AQEC). Also Fig. 9 and Fig. 10 shows the top view and pin descriptions respectively.

ii. RADIO FREQUENCY MODULE

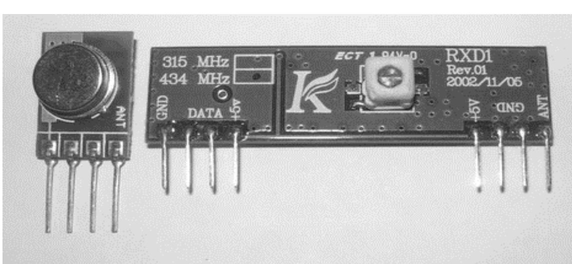


Fig. 11 : RF Transmitter & Receiver

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications.

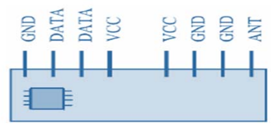


Fig. 12 : RF Receiver Module Pin diagram

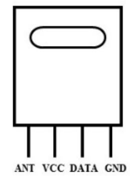


Fig. 13 : RF Transmitter Module Pin diagram

Table 1 : RF Receiver Pin Descriptions

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

Table 2 : RF Transmitter Pin Descriptions

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data input pin	Data
3	Supply voltage; 5V	Vcc
4	Antenna output pin	ANT

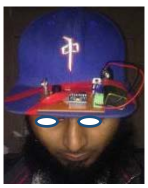
iii. MICROCONTROLLER(ATMEGA8)

The high-performance, low-power Atmel 8-bit AVR RISC-based microcontroller combines 8KB ISP flash memory with read-while-write capabilities, 512B EEPROM, 1KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timers/counters with compare modes, internal and external interrupts, serial programmable USART, a byte oriented two-wire serial interface, 6-channel 10-bit A/D converter (8-channel in TQFP and QFN/MLF packages. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

IV. RESULT & DISCUSSION

Each component, as described above, has been tested separately in the lab for proper functioning. Then all the components are connected together and a prototype of the proposed wheel chair is fabricated. The transmitter is fitted in a cap which is placed on the head of the operator.

Table 3 : Accelerometer Response and Wheel Chair movement

Head Movement Directions	Corresponding Analog Value	Wheelchair Directions
	Accelerometer axis Value Y>100	**Forward Direction**
	Accelerometer axis Value Y<-150	**Backward Direction**
	Accelerometer axis Value X>100	**Right Direction**
	Accelerometer axis Value X<-150	**Left Direction**
	Accelerometer axis Value Y>150	**Lock**

When the operator moves his head downward as shown in the 1st figure of table 3 the wheelchair moves in forward direction. By moving the head upward (shown as 2nd figure of table 3), the wheelchair moves in backward direction. Moving the head downward and keeping stand still for three seconds, the wheel chair comes to stop. When the head of the operator is inclined rightway (shown as 3rd figure of table 3), the wheelchair turns on right side. Similarly, for inclining the head leftway (shown as 4th figure of table 3), the wheelchair turns on left. The locking system has been accomplished by holding the head in downward (shown as 5th figure of table 3) for a specific time period (in trail it is set up for 3 seconds). The following table encapsulates the whole procedure.

A. SOFTWERE OUTPUT

Proper functioning of the response of the acceleration sensor for different modes of positioning of the operator's head is cross checked by computer software. The following figure shows the corresponding snap shot of the display. The snap shot confirms the successful operation of the hardware.

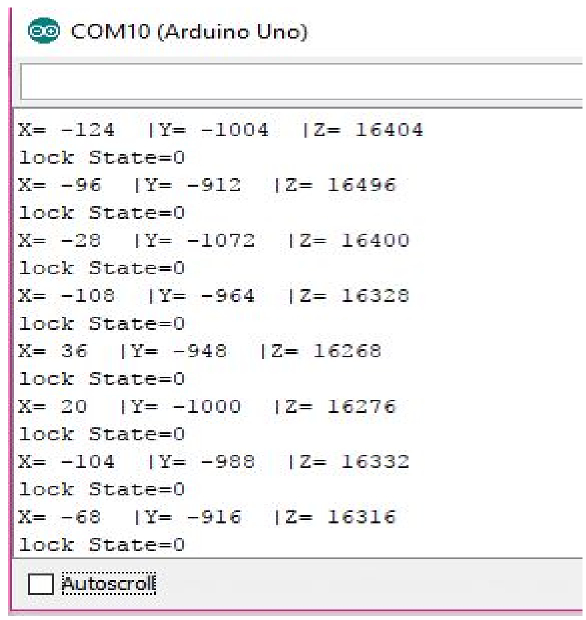


Fig. 14 : Software calibration data of the accelerometer for different directions

B. SUBJECTIVE EVALUATION

The prototype device is tested in three (3) different surfaces by several users. The three surfaces are a. Indoor smooth surface, Outdoor Carpeted rood and Outdoor green Field. The response of the device inside the room upon smooth surface is more satisfactory then the other two surfaces. For testing purpose the device was running for approximate 15 meters. The device works smoothly in any distance coverage.

V. CONCLUSION

The proposed head gesture based smart wheel chair is tested in the laboratory and shows satisfactory results. All the parts and required electronic components including sensors, trans-receiver, microcontroller etc. are collected from the local market at considerable low price, which makes the device cost effective, compared to the cost of similar imported wheel chair. Wireless connection between the transmitter, fitted on the head (cap) and the receiver makes its use very simple and comfortable. Commercial production of the presented wheel chair could be a good replacement of imported one and could be a great help to the disabled patients in our country.

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