‘Smart Wheelchair for Disabled Persons’

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Abstract

The project aims at the motorization of a manual wheelchair converting it to a power wheelchair controlled by hand gestures with automatic obstacle sensing system. It targets on providing old people and youngsters needing temporary rehabilitation with an easy-to-use and economic solution to independent movement. Being dependent on others for simple navigation such as getting to the washroom causes an inherent sense of helplessness and leads to depression. It also binds the aide/relative responsible to the wheelchair. This smart wheelchair hopes to provide 24/7 easy navigation to invalids and elders for better independence and a proud smile.

Introduction

It is a common sight in our daily lives to see a disabled person being driven around on a wheelchair by an aide/relative. These wheelchairs are mostly manually operated either by the disabled person himself or by an aide. Although such wheelchairs provide mobility they do not provide independence to a person. Wheelchairs are commonly used by people suffering from extreme old age, a severe fracture of limbs or semi-paralytic patients. It is not possible for an aide/relative to be present all the time with the patient and this creates awkward dependent situations which are highly de-motivating to any individual. Thus, the concept of a **Smart Wheelchair** is born which provides independent navigation to disabled people along with a few other perks through the automation of a simple wheelchair

1. Scope of the Project

Currently in India the population still majorly consists of rural and working class people. The following are a few statics as per the census carried out in the country which highlight the need of a smart wheelchair in the current state.

As per the census carried out in 2011 over 27 million people are living with disabilities out of which about 5.4 million suffer from movement disabilities.

Disabled Population by Type of Disability
India : 2011

Type of Disability	Persons	Males	Females
Total	**26,810,557**	**14,986,202**	**11,824,355**
In Seeing	5,032,463	2,638,516	2,393,947
In Hearing	5,071,007	2,677,544	2,393,463
In Speech	1,998,535	1,122,896	875,639
In Movement	5,436,604	3,370,374	2,066,230
Mental Retardation	1,505,624	870,708	634,916
Mental Illness	722,826	415,732	307,094
Any Other	4,927,011	2,727,828	2,199,183

Figure 1: Disabled Population in India 2011

Out of these only a meagre 1.5% - 3% have access to wheelchairs. The rest of the populace is either rural and is unaware or is financially incapable of affording high-end wheelchairs.

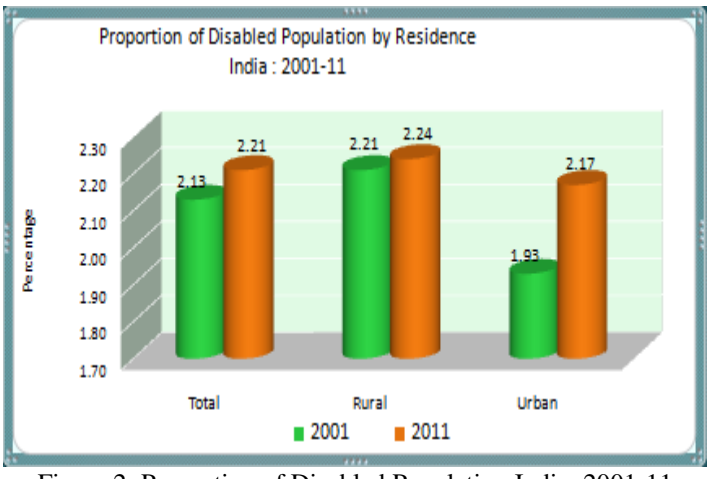

Figure 2: Proportion of Disabled Population India :2001-11

A definite increase has been observed in the number of people with disabilities from 2001 to 2011. Also it can be seen that rural areas have recorded more cases of disabilities than urban areas.

2. Proposed System

Our proposed system is a motorized wheelchair that works on gesture control. Basically an accelerometer will be fitted to the hand of the user wherein the gesture (wrist flick) will be taken as a command to move forward, backward, right, left or to stop. This command will be encoded and transmitted via an RF transmitter to the receiver circuit mounted onto the wheelchair. The RF receiver will receive the command and relay it to the decoder. The decoder will then send the signal to the ARDUINO UNO board which processes it and activates the motion of DC motor.

Secondly IR sensor mounted onto the chair will sense obstacles in the path of the chair. As soon as an obstacle is detected signal will be relayed to the ARDUINO UNO board and motion of the DC motor will be stopped.

3. Hardware and Software Requirements

4.1. ARDUINO UNO board

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

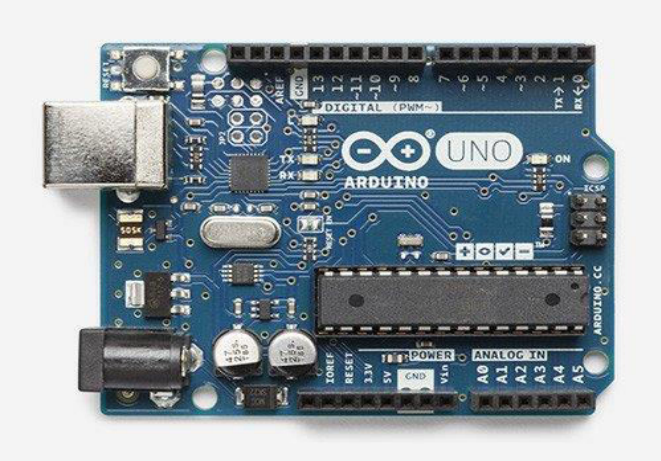

Figure 3: ARDUINO UNO board

4.2. Accelerometer

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

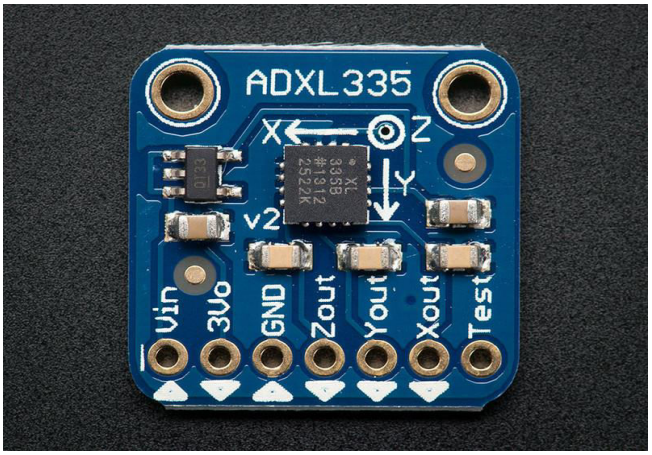

Figure 4: Accelerometer (ADXL 335)

The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

4.3. DC Motor

Permanent Magnet DC Motor is suitable for small and medium CNC machines and for replacement of stepper motors to DC servos which provides high speed and accuracy. This motor with drive can replace a stepper motor upto NEMA 34 size where high speeds are required. Motor runs on 12V to 24V DC and gives up to 6000 RPM on 24V. This motor may be directly coupled with ball screw linear system with a coupler. Reduction is possible with external timing belt and pulley system.

The Motor is a Industrial grade motor with replaceable carbon brushes, hardened shaft and skewed armature for reduction of cogging effect.

4.4. Transmitter and Receiver Module

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. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

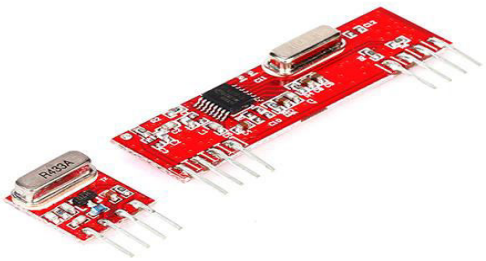

Figure 5: RF Pair

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx /Rx) pair operates at a frequency of 434 MHz . An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

4.5. HT12E/HT12D

HT12E is an encoder integrated circuit of 212 series of encoders. They are paired with 212 series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops.

Figure 6: HT12E/HT12D

HT12D is a decoder integrated circuit that belongs to 212 series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 212 series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.

HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits. The data on 4 bit latch type output pins remain unchanged until new is received.

4.6. Infrared Sensor

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion .These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

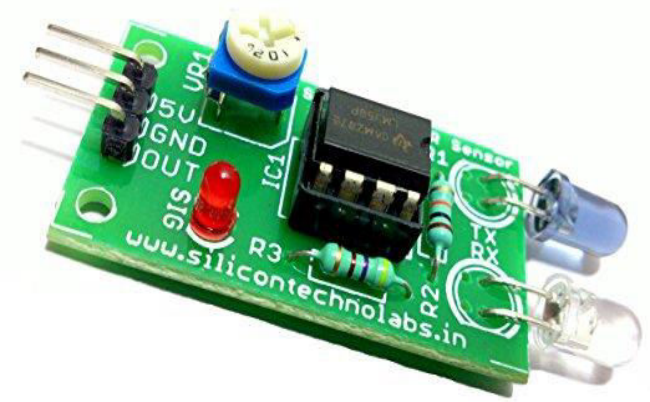

Figure 7: IR Sensor

4.7. Software Development

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio, which can be used for programming Arduino.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It was created for people with no profound knowledge of electronics. It includes a code editor with features such as syntax highlighting, brace matching, cutting-pasting and searching-replacing text, and automatic indenting, and provides simple one-click mechanism to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a series of menus.

A program written with the IDE for Arduino is called a "sketch". Sketches are saved on the development computer as files with the file extension .info. Arduino Software (IDE) pre-1.0 saved sketches with the extension .c.

The Arduino IDE supports the languages C and C++ using special rules to organize code. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two functions, for starting the sketch and the main programs loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

4. Flowchart

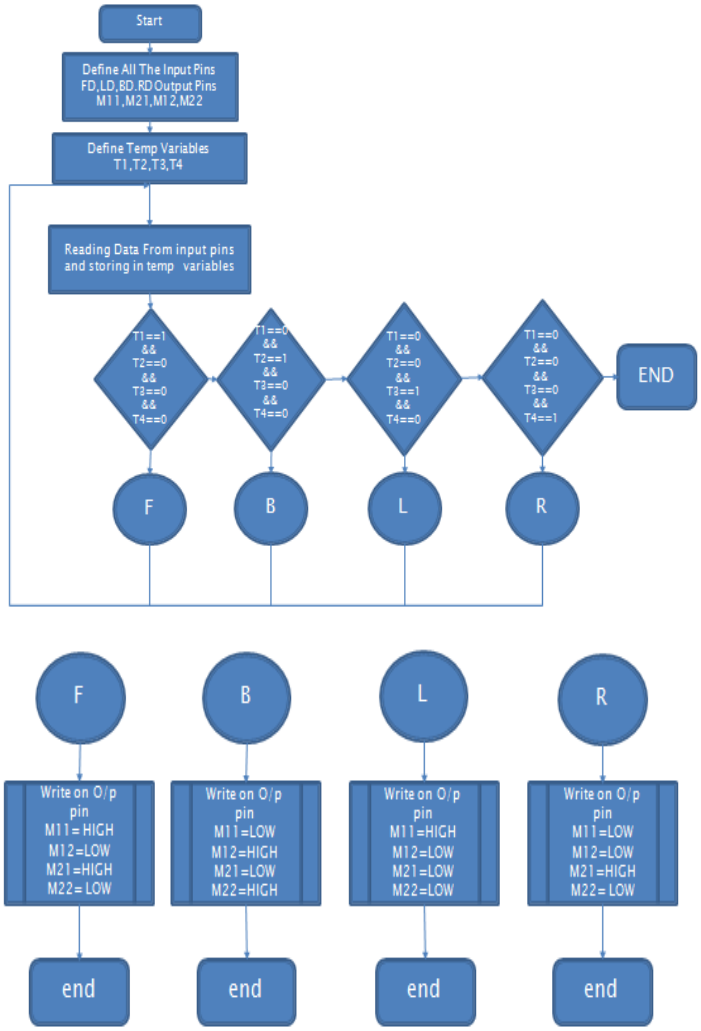

Figure 8: Flowchart

5. Application

Provide independent navigation to old people who require aide for walking/movement. Provide a simple rehabilitation method to individuals suffering from fractures or spinal cord injuries. Replace manual chairs with an easily controlled power chair. Secure individuals with disabilities more efficiently by introducing obstacle sensing systems. Via this project an easy, economic and simple solution can be provided to people who require navigator help with independence.

6. Conclusion

We are currently building a smart wheelchair to cater to the general needs of elders and individuals with temporary

rehabilitation requirements. The project is simple, cost-effective and can be marketed to individual patients or to hospitals in batches. It can also be further extended to include additional features depending on an individual's personal requirements and monetary status.

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