OBJECT CONTROL VIA EYE MOVEMENT

A PROJECT REPORT

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BONAFIDE CERTIFICATE

Certified that this project report titled **OBJECT CONTROL VIA EYE MOVEMENT** is the bonafide work of Ananya Banerjee [RA1511004010350], Induvalli Sriram [RA1511004010450], Aishwarya Balaje [RA1511004010463] and Sonali Sharma [RA1511004010474] who carried out the project work under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The purpose of this project is to design a prototype of a wheelchair which can help differently abled individuals move independently. The motion of the wheelchair is controlled via the subject's eye movement using IR sensors. The eye tracking-based technology employs the use of Infrared (IR) sensor modules, that are mounted on an eye frame to trace the movement of the iris. Since, IR sensors detect only white objects a unique sequence of digital bits is generated corresponding to each eye movement. These signals are then processed via a micro controller to control the motors of the wheelchair. The potential and efficiency of previously developed rehabilitation systems that use head motion, chin control, sip-n-puff control, voice recognition, and EEG signals variedly have also been explored in detail. They were found to be inconvenient as they served either limited usability or non-affordability. After multiple regression analyses, the proposed design was developed as a cost-effective, flexible and stream-lined alternative for people who have trouble adopting conventional assistive technologies.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my guide, Mr. S. Praveen Kumar for his valuable guidance, consistent encouragement, personal caring, timely help and providing us with an excellent atmosphere for doing the project. All through the work, in spite of his busy schedule, he has extended cheerful and cordial support to us for completing this project work.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Rehabilitation technology: A growing need

The ability to exercise one's freedom of mobility affects an individual's sense of dignity and confidence. If Census 2001 is to be believed, of the 2.1 percent of India's disabled, 0.6 percent (equivalent to almost 61 lakhs) is suffering from movement disability. This statistic has supposedly increased prolifically in the last decade. When it comes to adopting the right assistive technology (whether prostheses or orthoses), people are either unable to afford or are faced with a myriad of logistic inefficiencies. As an upshot, most of the victims are unable to contribute financially or socially and are depended on their families'/caregivers' charity, making concessions with their own dignity. Since the degree of disability is a variable, and specialized needs of each person is different, it is highly unlikely a universal model can ever be developed that is also cost-effective.

As such the market for technology-aided human support systems is quite small, governed by archaic rules and limited resource knowledge. Though the recent introduction of 'Rights of Persons with Disabilities Bill, 2014' (in addition to the already existing Disability Act, 1995) increases the ambit of the disabled people, the absence of a more comprehensive Assistive Technology Act causes a chronic non-use, abandonment and discontinuance of rehabilitation technology.

Since most disabled people view their assistive devices as an extension of themselves, it has become a subject of utmost necessity to develop devices that users can successfully integrate into their lifestyle. A large variety of electric powered wheelchairs that use different human machine interfaces (HMI) such as head motion, chin control, sip-n-puff control, voice recognition and EEG signals, EOG signals, are available. Such rehabilitation technology, though highly effective, is extremely expensive, requires continuous calibrations through the years and is hardly used to facilitate the majority. We have devised a new design based on eye tracking technology that has rapid computational speed, high accuracy and is cost-effective.

The Proposed System

This project's objective is to design an 'Eye Ball Motion Controlled car prototype using IR Sensors' for the elderly and differently abled people. In this eye tracking-based technology, Proximity Infrared (IR) sensor modules are used. These signals are then processed via a micro controller IC to control the motors of the wheelchair.

The proposed design has been developed as a cost-effective, flexible and stream-lined alternative for people who have trouble adopting conventional assistive technologies.

CHAPTER 2

LITERATURE SURVEY

In order to design our project, we had to familiarize ourselves with the various existing technologies in the domain of rehabilitation assistance. The following are the papers (arranged in order of relevance) that have been explored during the formulation of our prototype.

S no.	Name of the paper	Journal	Authors	Year Published
1	Eyeball Motion Controlled Wheelchair Using IR Sensors	World Academy of Science, Engineering and Technology International Journal of Computer and Information Engineering Vol:9, No:4	Monika Jain, Shikhar Puri, Shivali Unishree	2015
2	IR Sensor-Based Gesture Control Wheelchair for Stroke and SCI Patients	IEEE Sensors Journal, vol. 16, no. 17	Rajesh Kannan Megalingam, Senior Member, IEEE, Venkat Rangan, Sujin Krishnan, and Athul Balan Edichery Alinkeezhil	2016
3	Eye Movement Based Electronic Wheel Chair for Physically Challenged Persons	International Journal of Scientific & Technology Research, volume 3, issue 2	Gunda Gautam, Gunda Sumanth, Karthikeyan K C, Shyam Sundar and D. Venkataraman	2014
4	Electroencephalography (EEG)-Based Brain–Computer Interface (BCI): A 2-D	IEEE transactions on neural systems and rehabilitation	Dandan Huang, Member, IEEE, Kai	2012

	Virtual Wheelchair Control Based on Event-Related Desynchronization/Synchronization and State Control	engineering, vol. 20, no. 3	Qian, Ding-Yu Fei, Member, IEEE, Wenchuan Jia, Xuedong Chen, and Ou Bai	
5	A Novel Eye-Gaze-Controlled Wheelchair System for Navigating Unknown Environments: Case Study With a Person With ALS	IEEE Access	Mohamad a. Eid , Nikolas Giakoumidis , and Abdulmotaleb el Saddik , (fellow, IEEE)	2016

Problem Statement

The above-mentioned rehabilitation technologies, though highly effective, are extremely expensive and require continuous calibrations, hence making it inconvenient and inaccessible in terms of usability for the majority.

Objective

The proposed design has been developed as a cost-effective, flexible and stream-lined alternative for people who have trouble adopting conventional assistive technologies.

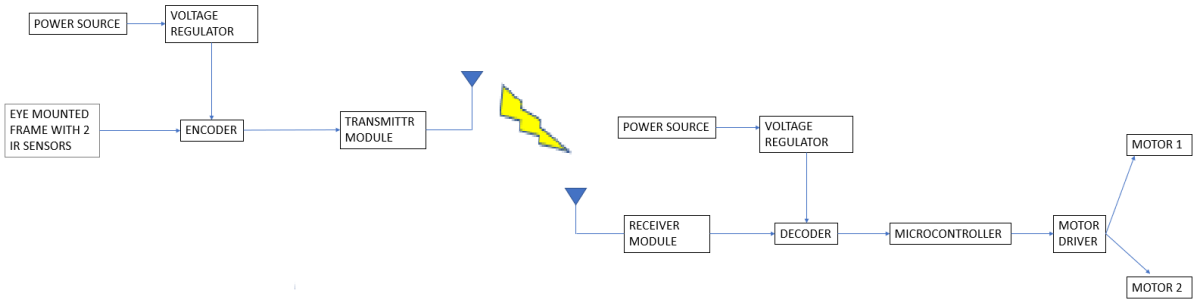
CHAPTER 3

SYSTEM DESIGN AND DESCRIPTION

System Design

The prototype consists of many components which can be broadly divided into the following modules:

- The eye-based tracking system
- The transmitter
- The receiver
- The microcontroller unit
- The motor driver



Block diagram of proposed system

Description

The Transmitter side

Eye-tracking involves the tracking of eye movements. It is a method where the scan path of a person's gaze, while looking over a picture or in a particular direction, is traced and recorded. Not all eye tracking devices can correctly measure and identify the different types of eye movements and not all eye movements can be correctly measured. Therefore, they must be properly controlled in experiments. The use of infrared technology plays a critical role in eye tracking as it allows one to draw connections from a psychological perspective between eye-movement data and neurological processes in the brain.

In this proposed design, an eye mounted frame has been developed that is worn like spectacles, IR sensors have been drilled into it.

With the help of a single eye (with or without vision), a wheelchair can be commanded. IR sensor modules emit a continuous beam of IR rays. Whenever a white object (obstacle) comes in front of the receiver, these rays are reflected back and captured.

When faced with a black object (no obstacle) the IR rays are absorbed by the surface and cannot be captured. The sclera is white and thus acts as an obstacle while the iris acts as the reflecting object. The IR sensor works by illuminating the eye and eyelid area with infrared light, then monitoring the changes in the reflected light using a phototransistor and differentiator circuit. The car prototype is controlled via the blinking motion of the eye.

The raw signals are picked by IR sensor module connected to the eyepiece are amplified and then sent to the ADC channels of microcontroller where they get converted to digital form.

The digital signal is then transmitted.

The receiver side

At the receiver the microcontroller receives the signal from the transmitter side. This signal controls the movement of the motors, which in turn controls the movement of the wheels. Since motors require more current than the micro-controller pin can generate, we use motor drivers as current amplifiers.

By using a timer delay of 3 seconds it has been ensured that the normal blinking of a user (12-13 times in a minute) doesn't interfere with the working of the program as the average blink time is 0.3 to 0.4 seconds. The Arduino code has been written with respect to this principle.

The microcontrollers program relates the blinking of the eye to the movement of the car.

ORIENTATION OF THE EYE-LID	MOVEMENT OF THE CAR
OPEN	STATIONARY
CLOSE	FORWARD
LEFT EYE-LID CLOSED	LEFT
RIGHT EYE-LID CLOSED	RIGHT

CHAPTER 4

METHODOLOGY ADOPTED

Eye movement tracking is used in this project to determine the motion of eye. Based on this, commands are given to an electrically driven wheelchair. It consists of transmitter, receiver and a wireless medium. IR sensor is used to detect the movement of the eye. It reflects the light when the eye is open and the sensor senses it. However, sunlight should not be sensed by the IR which causes its LEDs to blink continuous. Based on the blinking pattern of eye and the corresponding movement of the car code is designed and debugged using Arduino software. The detailed explanation of each module is explained above.

CHAPTER 5

HARDWARE-SOFTWARE REQUIREMENTS AND COST MODELLING

Hardware requirement

The following components are utilized in the process of constructing this project:

- IR sensors
- Power sources
- Voltage regulators
- Encoder
- Decoder
- Transmitter
- Receiver
- Microcontroller
- Motor driver
- Motors

IR Sensor

The eye-blink sensor works by illuminating the eye and eyelid area with infrared light, then monitoring the changes in the reflected light using a phototransistor and differentiator circuit.

SPECIFICATION

Operating Voltage: +5V DC regulated

Operating Current: 100mA

Output Data Level: TTL Level

Eye Blink Indicated by LED and Output High Pulse

USING SENSOR

Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. When Eye closed, LED is off & the output is at 0V. The distance between the sensor and eye is about 15 mm. The output is active high for Eye close and can be given directly to microcontroller for interfacing applications.

EYE BLINK OUTPUT

5V (High) → LED ON When Eye is close.

0V (Low) → LED OFF when Eye is open.

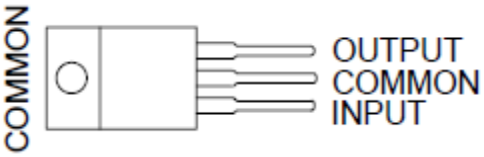
IR Module

Power Sources

Three 9V batteries are used.

Voltage regulators

The voltage regulator L7805 is used since it converts the input voltage of 9V to 5V, which is fed to the encoder and the decoder as input. As the IR sensor operated at 5V.

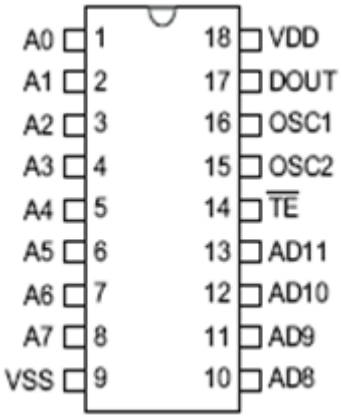


IC L7805

Encoder

The HT 12 E has 8 address pins and 4-address/data pins. It has no negative polarity and no carrier output. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal.

The signal to be transmitted is encoded before transmission.



Encoder pin diagram

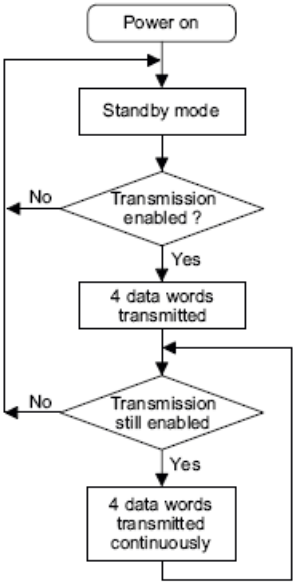
SPECIFICATIONS

- Operating voltage - 2.4V~12V for the HT12E
- Low power and high noise immunity CMOS technology
- Low standby current: 0.1_A (typ.) at VDD=5V
- Minimum transmission word
- Four words for the HT12E
- Built-in oscillator needs only 5% resistor
- Data code has positive polarity
- Minimal external components

OPERATION

This encoder begins a 4-word transmission cycle upon receipt of a transmission enable, TE as active low. This cycle will repeat itself as long as the transmission enable TE is held low. Once the transmission enables high, the encoder output completes its final cycle and then stops.

Encoder Operation



Transmitter

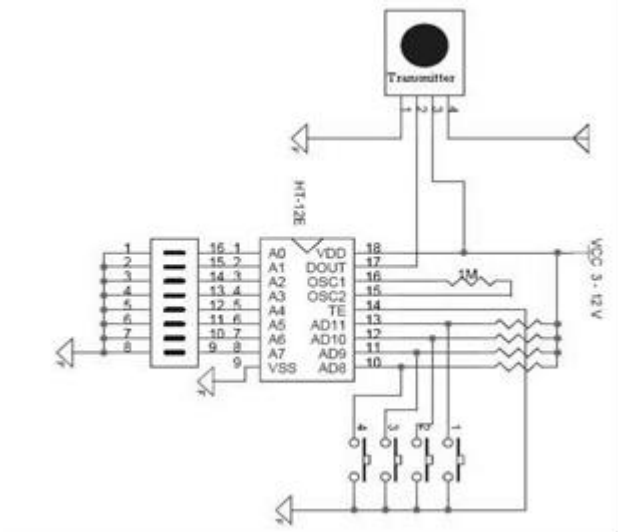
1. Ground
2. Data
3. Vcc
4. Antenna

The transmitter is responsible for transmitting the RF signal that it obtains from the encoder to the receiver.

SPECIFICATIONS

- Frequency Range: 433.92 MHz
- Modulate Mode: ASK
- Circuit Shape: SAW
- Date Rate: 8kbps
- Supply Voltage: 3~ 12 V
- Power Supply and All Input / Output Pins: -0.3 to +12.0 V

- o Non-Operating Case Temperature: -20 to +85 *C
- o Soldering Temperature (10 Seconds): 230 *c



Transmitter Module

Receiver

Pin 1. Gnd

Pin 2. Digital output

Pin 3. Linear output

Pin 4. Vcc

Pin 5. Vcc

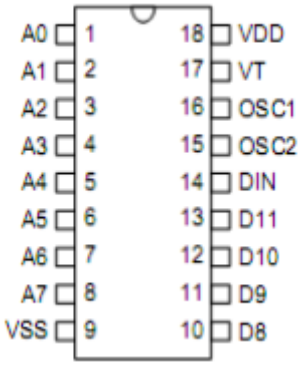
Pin 6. Gnd

Pin 7.Gnd

Pin 8. Ant

When the signal is received the data is decoded with the help of the HT 12D decoder IC**.**

*Decoder:*HT12D is arranged to provide 8 address bits and 4 data bits. The decoder receives serial addresses and data from a programmed HT 12 E encoder that are transmitted by a carrier using an RF transmitter.



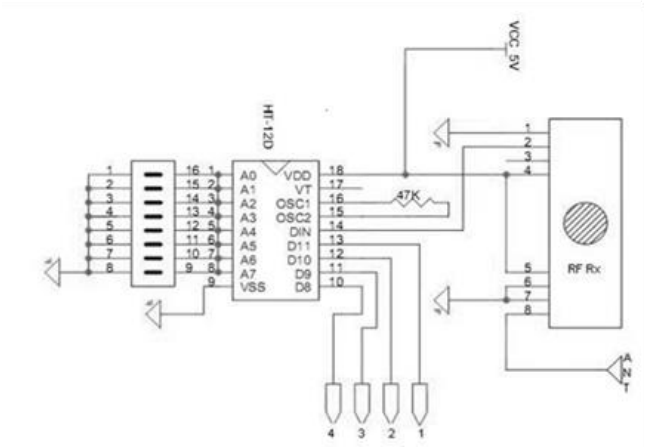
Decoder pin diagram

SPECIFICATIONS

- Operating voltage: 2.4V~12V
- Low power and high noise immunity CMOS technology
- Low standby current
- Received codes are checked 3 times
- Built-in oscillator needs only one external resistor
- Valid transmission indicator
- Easy interface with an RF or an infrared transmission medium
- Minimal external component

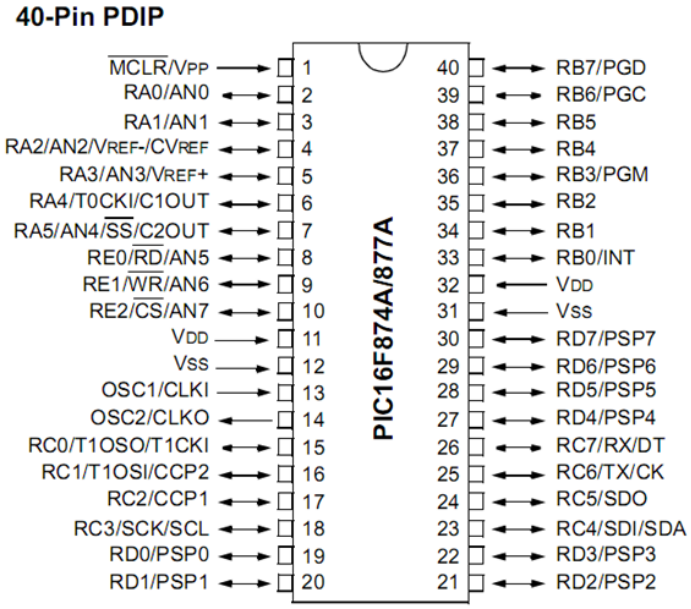
OPERATION

The decoders receive data that are transmitted by an encoder and the signal on the DIN pin activates the oscillator, which in turn decodes the incoming address and data.



Receiver Module

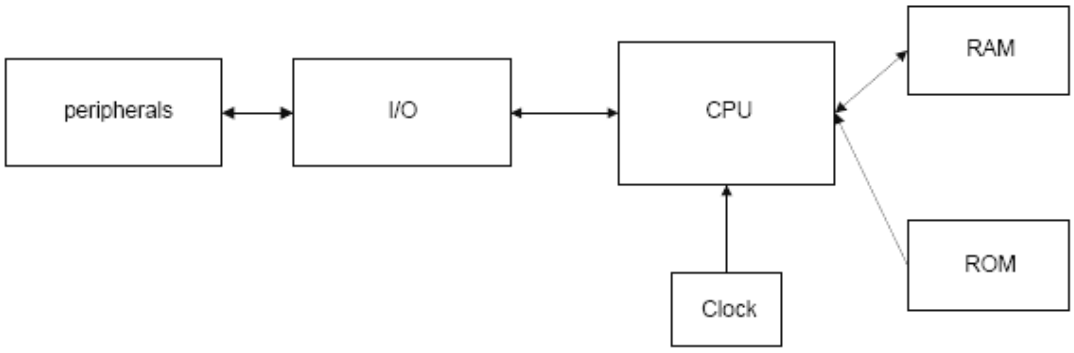
PIC Microcontroller



PIC in short form means Peripheral Interface Controller. All microcomputer systems, irrespective of their complexity, are based on similar building blocks

These are shown in Figure 4.1 and consist of the following:

- CPU - the part that does all logic and arithmetic functions
- RAM - storage for programs and/or program variables
- ROM - read-only parts of programs
- I/O - connection to internal and external devices



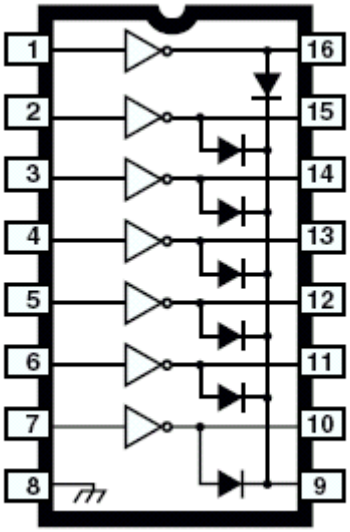
Microcontroller Block diagram

SPECIFICATIONS

Key Features	PIC16F877A
Operating Frequency	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	8K
Data Memory (bytes)	368
EEPROM Data Memory (bytes)	256
Interrupts	15
I/O Ports	Ports A, B, C, D, E
Timers	3
Capture/Compare/PWM modules	2
Serial Communications	MSSP, USART
Parallel Communications	PSP
10-bit Analog-to-Digital Module	8 input channels
Analog Comparators	2
Instruction Set	35 Instructions
Packages	40-pin PDIP 44-pin PLCC 44-pin TQFP

Motor Driver

Ideally suited for interfacing between low-level logic circuitry and multiple peripheral power loads, the Series ULN20xxA/L high-voltage, high-current Darlington arrays feature continuous load current ratings to 500 mA for each of the seven drivers. At an appropriate duty cycle depending on ambient temperature and number of drivers turned ON simultaneously, typical power loads totaling over 230 W (350 mA x 7, 95 V) can be controlled. Typical loads include relays, solenoids, stepping motors, magnetic print hammers, multiplexed LED and incandescent displays, and heaters.



Motor Driver IC ULN20xxA/L

Software Requirements

Arduino IDE:

CODE:

```
void main()
 {
TRISC.F0=1;
TRISC.F1=1;
TRISD.F0=0;
TRISD.F1=0;
PORTD.F0=0;
PORTD.F1=0;

   while(1)
   {
if(PORTC.F0==0 && PORTC.F1==0)
{
PORTD.F0=0;
PORTD.F1=0;
}
if(PORTC.F0==1 && PORTC.F1==1)
{
PORTD.F0=1;
PORTD.F1=1;
}
if(PORTC.F0==1 && PORTC.F1==0)
```

```
PORTD.F0=1;
PORTD.F1=0;
}
if(PORTC.F0==0 && PORTC.F1==1)
{
PORTD.F0=0;
PORTD.F1=1;
}
}
}
```

An Arduino software is used in which the program is designed and the code is developed. This code is debugged into the Arduino board through the USB port.

STEPS:

To begin, you'll need to install the Arduino Programmer, aka the integrated development environment (IDE).

Connect your Arduino to the USB port of your computer. This may require a specific USB cable. Every Arduino has a different virtual serial-port address, so you 'll need to reconfigure the port if you're using different Arduinos.

Set the board type and the serial port in the Arduino Programmer.

Upload the code to your Arduino, disconnect it from your computer and integrate it into your project as directed.

Cost of Modelling

The cost of the components utilized in the process of constructing this project are as follows:

- IR sensors (2): INR 100
- Power sources (2): INR 20
- Voltage regulators (2): INR 20
- Encoder: INR 65
- Decoder: INR 65
- Transmitter: INR 298
- Receiver: INR 298
- Microcontroller: INR 159
- Motor driver: INR 12
- Motors (2): INR 214
- Metal mount: INR 150

CHAPTER 6

REALISTIC CONSTRAINTS AND DELIVERABLES

Wheelchair controllers aren't easy to interface to - they have a number of safety features which make controlling them externally a real chore (and you won't be able to get any information from the manufacturer either). The best way to deal with it is to avoid it - purchase and use a high-current h-bridge motor controller for the wheelchair; just note that such controllers can be very expensive, depending on your stall current needs of the motors.

Also - you will be left having to design everything else for the wheelchair - speed/acceleration/braking profiles, safety systems, etc - to make it safe for a user. Even then, it won't be certified as a medical use device, and so not really safe for an actual user (there are ways around needing this medical certification - mainly dealing with how you market and describe the device to avoid "trigger words" that would get the AMA or similar authorities involved).

CHAPTER 7

CONCLUSION

The IR sensor based eye-motion tracking system can be used as basic infrastructure in future technologies such as home automation. The system can be used for wireless automation by using radio frequency modification in the circuitry. This interface can be used to include an explicit input from the user by detecting intentional blinks and eye motions to create unique signatures. These signatures can then be used to generate control functions for individual home appliances. With various modifications, the proposed method can also be successfully implemented in vehicle automation. The steering can be controlled by the motion a person's eyeball. Thus, we have made a platform for demonstrating and testing eye based interfaces at a very low cost and high efficiency which can be used on a large scale in various fields.

The system functions with an accuracy of 70-90%. The aim of this project is to contribute to the society in our small way by setting out an idea for a system which could actually better the lives of millions of people across the globe. Direction in which the pupil looks is decided by fixing range to the particular direction as user looks. Direction of the pupil is done even on illumination unless the illumination is covering whole eye, this is because when the light hits the pupil and illumination spreads on the pupil which ignores those pixels so as we treat the illumination spots it will leave behind a maximum change edges that cannot be determined and the operator will consider another position to be a iris location. This process works even if the image taken in little dark environment.

The aim of this project is to contribute to the society in our small way by setting out an idea for a system which could actually better the lives of millions of people across the globe. We believe we have done great justice to the idea, and ended up getting more than satisfying results.

Future Modifications:

Though our prototype performs satisfactorily, but a lot of work needs to be done before making the product commercially viable. Some sort of sequence of events should trigger start of detection, because we do not want the wheel chair to move when the person is just casually glaring in different directions. Similarly, we can incorporate certain sequence for turning ON and OFF electrical devices, or door locks. Also since the criticality of the application is so high, lot of safety precautions need to be incorporated. It needs to be made sure that the system is not fatal to the health of the person. A lot of testing needs to be done before making such a product a reality.

CHAPTER 8

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