Design and Construction of an Digital Techometer

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STATEMENT OF CANDIDATE

All praises are for the Almighty Allah! I have successfully completed my project "Design and construction of an digital Techometer. I assure that this long cherished project is done by me and this project report is also written by me. I would like to give special thanks to my honourable teacher, Mr Arefin Ahmed Shuvo, without whom I could not complete my project.

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Acknowledgments

I would like to express our deepest gratitude to my supervisor Mr. Arefin Ahmed Shuvo for his guidance on this project showing us the path of conducting successful research and above all for always being there as my mentor. He shared his wisdom with me in analyzing subject matters and at the same time valued our thinking approach to synthesize those topics. His suggestions drove me towards better ways of thinking, his reviews enriched me in solving problems, and his support gave me strength at the time of my disappointment. I shall forever cherish the memories of working with him. I deeply thank our friends and families for always believing in me even at the moment when I was losing confidence.

ABSTRACT

Electrical and mechanical machineries are used in industrial and domestic applications. Measurement of speed of revolving machineries is necessary for their proper functioning and controlling. Tachometer is an instrument which is used to measure the speed of revolving shaft gear and pulley. This report describes the basic construction of a tachometer and analyzes its performance. The basic tachometer circuit consists of two stages. In the first stage mono stable wired around IC NE555 is used and in the second stage a digital decade-counter based 4-digit counter IC 4026 is used for the construction of the tachometer. A 5V regulated power supply circuit and 12V on rotating shaft circuit are also used. The instrument will measure speed in term of RPM.

Keywords: Mono stable, Rotating shaft circuit, RPM.

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CHAPTER 1

INTRODUCTION

1.1 Background and Objectives

1.1.1 Background

The tachometer is an instrument that measures the rotation speed of a shaft or disk. It is also known by several other terms including a rev-counter and rpm gauge[1]. The gauge usually displays the revolutions per minute (rpm) on a calibrated analogue dial. On a vehicle, such as a car or bike the Tachometer measures the rate of rotation of the engine's crankshaft. With a Tachometer, drivers are able to assess the 'engine speed' and change the gearing ratio accordingly. Each Tachometer indicates the maximum RPM for that particular engine.
The Tachometer was first used to measure speed on a vehicle (a locomotive) in 1840. Even though the first petrol or gasoline powered automobile was developed in 1886 by Karl Benz[2], it is unclear when the first car featured a Tachometer.

1.1.2 Objectives

The objective of this project are:

- To design and implement digital tachometer
- To study the basic circuit and behavior of IC's and logic gates.

1.2 Significance

The main significance of this project includes:

- A tachometer has the capability to measure revolution per minute (rpm) of the revolving shaft.

1.3 Applications

The main applications of this project is listed below:

- Measures the speed of rotating shaft.

1.4 Limitations

- The IR module is sensitive towards direct sunlight, fluctuation on reading may occur.
- Distance must be maintained between tachometer and the rotating shaft for accurate reading.
- For highter speed the value given by techometer differs from the commercial ones

1.5 System Overflow

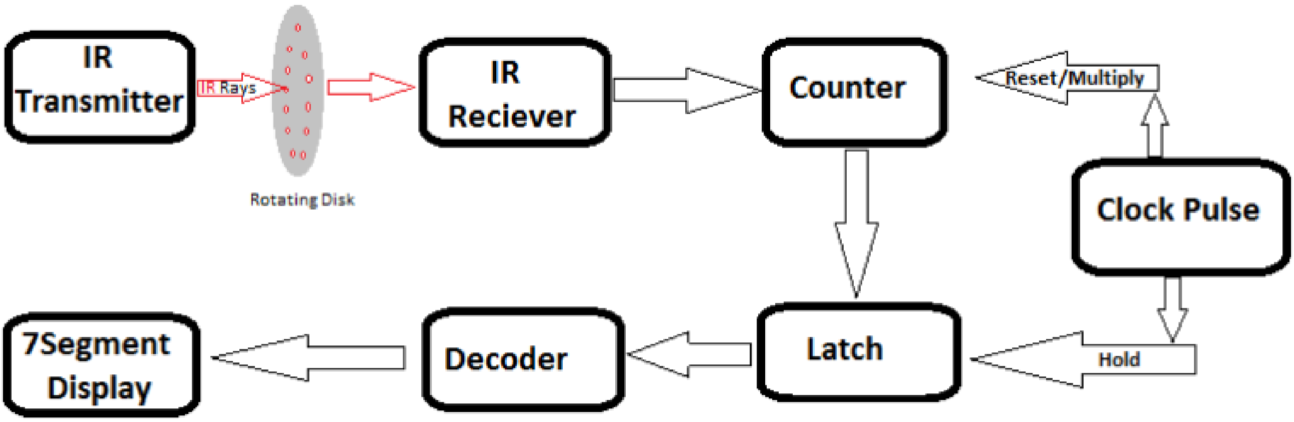

Figure 1.1: block diagram

IR Transmitter is used for propose of transmitting IR light trough the disc and a receiver. The IR LED transmits the signal which will be further received by the receiver. When the signals sent by Transmitter is received by receiver the output will be active low. Output of receiver will be high when no signals is received by it and the output will be low when infrared rays fall on it. The signal or output from the receiver is then forwarded to the decade counter, which counts the generated pulse in the BCD bits. The BCD bits counted by the counter are hold by the Latch which will need to be multiplied by 60 times or by reading the pulse generated for 10 sec and making 6 no. of holes on the rotating disc for RPM and then the multiplied bits will be decoded by the decoder. This whole function of counter, latch and decoder is done by an IC of CMOS series of 4026. And they are ready to display through Common Cathode seven segment displays. The display section is the most important section of the system. The output data from the decoder are decoded into 7 segment display.

1.6 METHODOLOGY

For the successful design and operation of Digital tachometer we have done the following tasks:

- Collecting information from different sources to implement the circuit.
- Design of different circuits, observing and analyzing them.
- Applying the circuit in bread board.
- Implementing the bread board circuit in Matrix board.
- Finally fabricating the circuit in PCB. This circuit contains IC NE555, IC 4026, IR transmitter and receiver and finally seven segment display unit.

At first timer IC 555 configured as monostable and it produce timing pulse for certain time when switch is pressed, the LED indicates the sensing duration. The IR transmitter and receiver is used to produce changing logic levels depends on the blocking or interrupting IR light beams. AND logic gate N1 enables decade counter (IC 4026) and also we use 4026 for BCD to 7 segment decoder this counter drives seven segment display. There are three decade counter and three seven segment display to show RPS from 000 to 999. This illustration shows how to make a rotating interrupter, measure the slot width and depth of the shaft or rotating machine. One interruption to the IR beam by the rotating disc, which will take as one count and total count of rotation is RPS, by the way we can multiply 60 to RPS to know revolution per minute (rpm).

CHAPTER 2

LITERATURE REVIEW

The first mechanical tachometer was similar in operation to a centrifugal governor. The inventor of the first mechanical tachometer is assumed to be a German engineer Dietrich Uhlhorn[3] ; he used it for measuring the speed of machines in 1817[3]. Since after then, it has been used to measure the speed of locomotives in automobiles, trucks, tractors and aircrafts. Early tachometer designs were based on the principle of monostable multivibrator, which has one stable state and one quasistable state. The circuit remained in a stable state, producing no output. However, when it receives triggering current pulse from the ignition system, the circuit transitions to the quasistable state for a given time before returning again to the stable state. This way, each ignition pulse produced a pulse of fixed duration that was fed to the gauge mechanism. The more of such fixed duration pulses the gauge received per second, the higher it read.

2.1 Classification of Digital Techometer

Digital tachometers are classified into four types based on the data acquisition and measurement techniques. Based on the data acquisition technique, the tachometers are of the following types: Contact type and Non-Contact type digital tachometer. Based on the measurement technique, the tachometers are of the following types: Time measurement and Frequency measurement digital tachometer.

2.1.1 Contact Type Digital Techometer

A tachometer which is in contact with the rotating shaft is known as contact-type tachometer. This kind of tachometer is generally fixed to the machine or electric motor. An optical encoder or magnetic sensor can also be attached to this so that it measures its RPM.

2.1.2 Non-Contact Type Digital Tachometer

A tachometer that does not need any physical contact with the rotating shaft is called as noncontact digital tachometer [6]. In this type, a laser or an optical disk is attached to the rotating shaft, and it can be read by an IR beam or laser, which is directed by the tachometer

2.1.3 Time Measurement Digital Tachometer

A tachometer that calculates the speed by measuring the time interval between incoming pulses is known as a time-based digital tachometer. The resolution of this tachometer is independent of the speed of the measurement, and it is more accurate for measuring low speed.

2.1.4 Frequency Measurement Digital Tachometer

A tachometer that calculates the speed by measuring the frequency of the pulses is called a frequencybased digital tachometer. This type of tachometer is designed by using a red LED, and the revolution of this tachometer depends on the rotating shaft, and it is more accurate for measuring high speed.

2.2 Components Description

2.2.1 NE555

The NE555 is a highly stable controller capable of producing accurate timing pulse. The operation, the time delay and the frequency is controlled by external resistors and capacitors. A timer can be used as linear ramp, pulse position modulation, pulse width modulation, frequency divider and in astable, monostable and bistable mode.
Monostable Mode: The 555 can operate as an oscillator. Monostable multivibrator is also know as one short multivibrator. As its name indicated it has one stable state and it switches to unstable state for predetermined time period when it is triggered. The time period T when it is triggered. The time period T is determined by the RC time constant in the circuit. Monostable mode of 555 timer is commonly used for generating Pulse Width Modulated (PWM) waves.

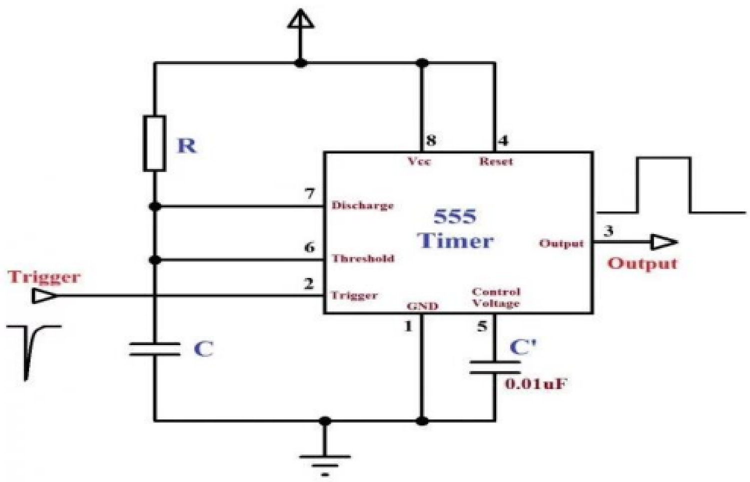

Figure 2.1: Monostable mode

2.2.2 LCD Display

A liquid-crystal exhibit (LCD) are a flat-panel exhibit or other electronically modulated optical contrivance that utilizes the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead utilizing a backlight or reflector too engender images in color or monochrome. LCDs are available too exhibit arbitrary images (as in a general-purport computer exhibit) or fine-tuned images with low information content, which can be exhibited or obnubilated, such as preset words, digits, and seven-segment exhibits, as in a digital clock. They utilize the same rudimental technology, except that arbitrary images are composed of an astronomically immense number of minuscule pixels, while other exhibits have more astronomically immense elements. LCDs are utilized in a wide range of applications including LCD televisions, computer monitors, instrument panels, aircraft cockpit exhibits, and indoor and alfresco signage.

Figure 2.2: LCD Display

2.2.3 IR LED

An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. Such LEDs are usually made of Gallium Arsenide or Aluminum Gallium arsenide. They, along with IR receivers, are commonly used as sensors. The appearance is same as a common LED. Since the human eye cannot see the infrared radiations, it is not possible for a person to identify whether the IR LED is working or not, unlike a common LED. To overcome this problem, the camera on a cell phone can be used. The camera can show us the IR rays being emanated from the IR LED in a circuit.

2.2.4 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

2.2.5 Capacitor

A capacitor is a passive two-terminal electronic component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. While some capacitance exists

Figure 2.3: LED

Figure 2.4: Resistor

between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit.

2.2.6 Switch

In electrical engineering, a switch are an electrical component that can "make" or "break" an electrical circuit, interrupting the current or diverting it from one conductor too another. The mechanism of a switch abstracts or recuperates the conducting path in a circuit when it are operated. It may be operated manually, for example, a light switch or a keyboard button, may be operated by a moving object such as a door, or may be operated by some sensing element for pressure, temperature or flow. A switch will have one or more sets of contacts, which may operate simultaneously, sequentially, or alternately. Switches in high-powered circuits must operate rapidly to avert destructive arcing, and may include special features too avail in rapidly interrupting a cumbersomely hefty current.

Figure 2.5: Capacitor

Figure 2.6: Switch

2.2.7 Vero Board

In electrical circuit design Varo board is one of the most familiar component. In early 1960s this Varo board is introduced and updated later. IT is a circuit board material which is made of copper strips. The copper is embedded on a board which is insulating bonded. The Dept. of Electronics of VPE takes the challenge to update it. At the early days the maiden Vero board manufacture of different wiring board which is actually a prototype. The gentile position of 'strip board' and 'Vero board' are now assumed to be as a synonymous. A machine tool dept. known as VPE take the decision to make newly propose this type of Varo board. This boards are generally in the size of 122 mm x 456 mm. For a 2nd action an individual tool which is consists with 63 hardened punch along with number of bits is 1.35 mm in diameter. It is mounted on the base block which was built to repeat-punch a matrix of holes.

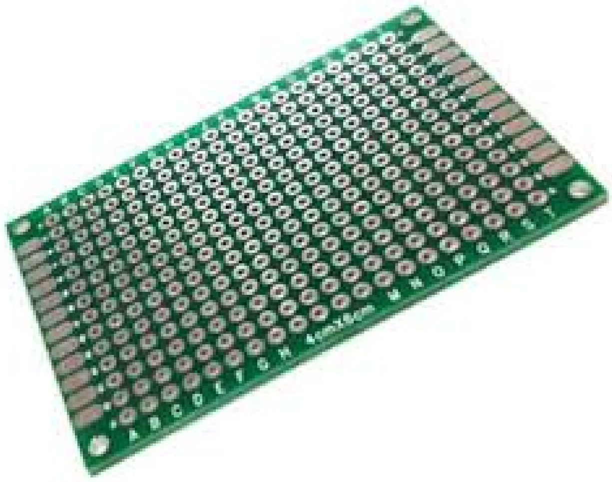

Figure 2.7: Vero Board

2.2.8 Battery

The 3.7volt battery, which is a usual size shape of battery which was inaugurated of the primary transistor made radios. This has polarized snap connector at the head and a rectangular prism shape with perfect edges. This is commonly utilized in clocks, walkie-talkies and a smart device named smoke detectors which detects smoke. This 3.7 volt battery has a format which is generally obtainable in fundamental alkaline and carbon-zinc chemistry. Also in fundamental lithium iron disulfide. This format which is Mercury-oxide batteries in many years have not been made because of the content named mercury. Title for this type the formation comprise MN1604 6LR61 or for zinc-carbon NEDA 1604. Most of the 3.7 volt batteries of alkaline is being manufactured of 6 different 1.5volt LR62 cells covered in a suitable wrapper. This cells are marginally minute than LR9D325 BBBB cells also can be utilized in their places for several contrivances, although these are 3.5 mm smaller. With six flat cells in a stack Carbonzinc types are constructed, covered in a moisture-resistant wrapper to avert drying.

Figure 2.8: Battery

CHAPTER 3

SOFTWARE ANALYSIS

3.1 Introduction

Several important topics are discussed in this chapter. Firstly a brief description about the software which is utilized. Here we mention about the program language in which the code is defined. The tools related to the code dumping are also elaborately discussed.

3.2 Description of the Software:

To write code and upload it to the I/O board, the ATMEGA8a environment create it much easier. This code can run on Mac OS X, Windows and Linux. The screen shot of ATMEGA8a 1.6.8 is shown below. The compiling and uploading of programs to the board can be possible by it with a

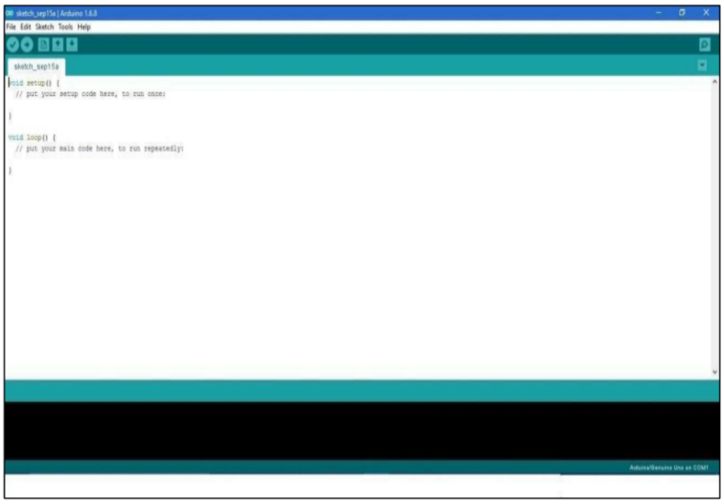

Figure 3.1: Software Platform

single click. With several third party tools such as Ion the building on command line is possible if required. On a command-line interface here it is generally not necessary to edit make files or run.

Figure 3.2: Software Coding

3.3 The Compiled Window of my code is shown below

A smart Fire base Data restore system is used by us in this application .Our all design is very simple and it is easy to use for all Customer. It has food menu list and Menu bar. It also has a calculator system. Every food list is very easy to use and all data is store in our data base system. It has also an admin Login Panel. Every order list and table no will be show from there.

3.4 Flow Chart of Diagram:

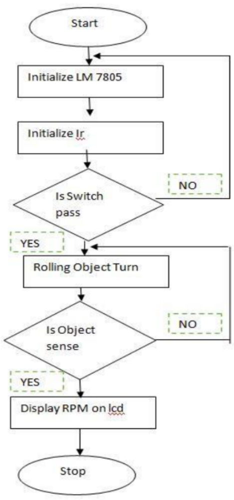

Figure 3.3: Software Platform

CHAPTER 4

SYSTEM ANALYSIS AND EXPERIMENT

This chapter deals with the balancing of Linear Inverted Pendulum systems. The system prototypes are inverted pendulum on a cart and a self balancing two wheel vehicle. Firstly, the systems are briefly described, then the equations of motion are derived and mathematical modeling is done, then the design of the controller, simulation of the controlled model and finally prototype response is approached.

4.1 Work Accomplished

- Simulation of 3 digit tachometer circuit in rpm
- Circuit of digital tachometer circuit on breadboard upto 999 rpm
- Mechanical work (making of shaft and rotating disc, frame for the circuit).
- Development of circuit in matrix board
- Solving of limitations.
- Development of PCB.

Monostable Mode:
In this circuit of Monostable mode pin no. 8 and 1 pin of 555 timer are given VCC and Ground respectively. 4 pin is the reset pin of 555 timer, which is active low so it is connected to VCC to avoid accidental resets. 5 pin is the control voltage pin used to provide external reference voltage to internal comparators. Since it is not used to provide external reference voltage to internal comparators. Since it is not used here, it is grounded via a capacitor to avoid high frequency noises. When a negative trigger is applied on the trigger input of 555, output goes high and capacitor starts charging through resistor R. when the capacitor voltage becomes greater than 2/3 VCC, output goes low an capacitor starts discharging through the discharging pin of 555 timer

4.2 IR Transmitter and Receiver

IR transmitter receiver works by letting one component flash an infrared light in a particular pattern, which another component can pick up and translate into an instruction. This transmitter

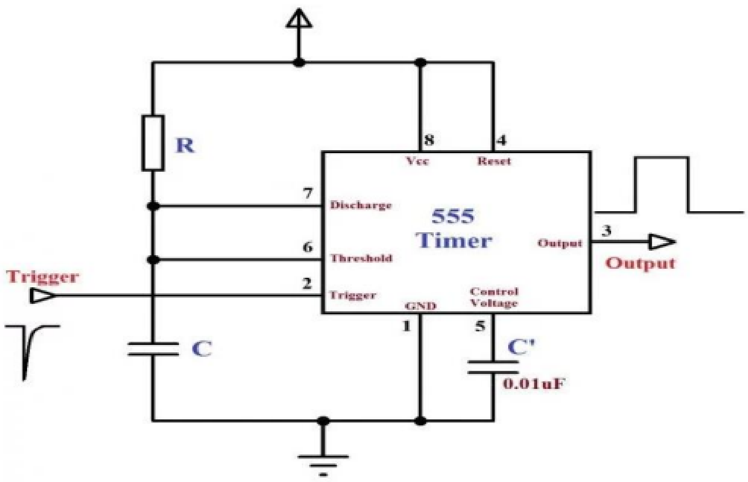

Figure 4.1: Monostabe mode of timer

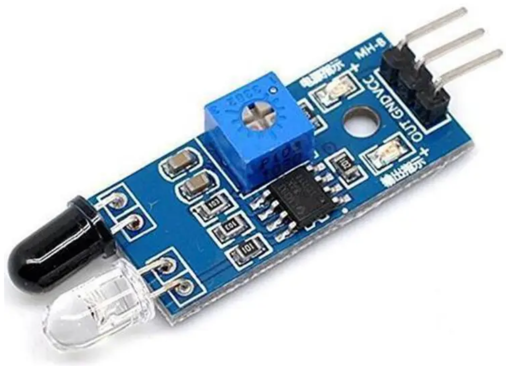

Figure 4.2: IR Transmitter and Receiver

receiver are used in our remote and televisions. Basically, the concept of transmitter and receiver is for the purpose of generating pulses which is further detected by CD4026 decade counter. The transmitter sends the IR through a rotating disc and reflects towards the receiver that counts the pulse. The IR module is sensitive towards the direct sunlight which may fluctuate the generated pulse.

4.3 Circuit Diagram

From the above circuit diagram two NE555 timer is used in monostable multivibrating state suppose T1 and T2. As usually the IR module will receive the pulse generated from the rotating disc, the received pulse and the output of T1 timer (monostable for time period 10sec)[2] is send to AND gate. This will take the reading of pulse generated within 10sec, as per our calculation in (1.5) this enables the calculated value in RPM. Further on the output of AND gate is send to CD4026 IC counter for counting purpose. While T2 timer (monostable for time period 10.5 sec) is for the purpose of triggering the IC to send the stored value of CD4026 to 7-segment display.

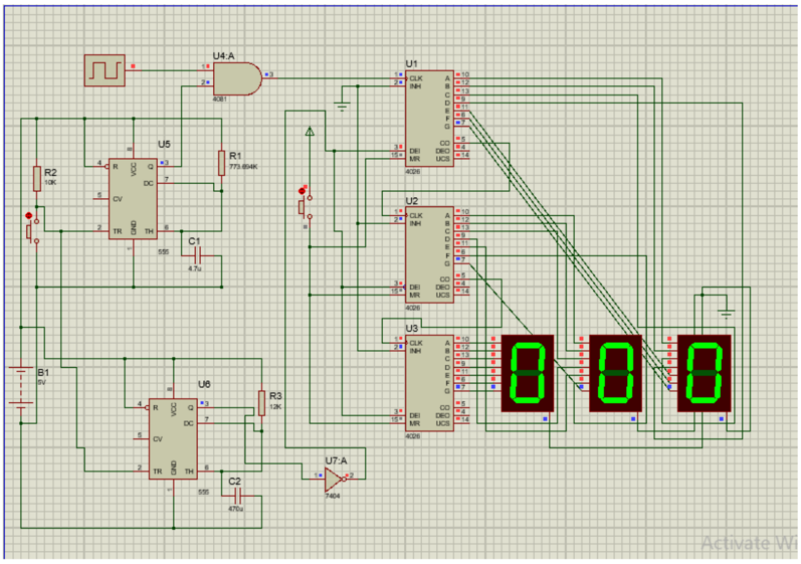

Figure 4.3: Circuit Simulation on Proteus

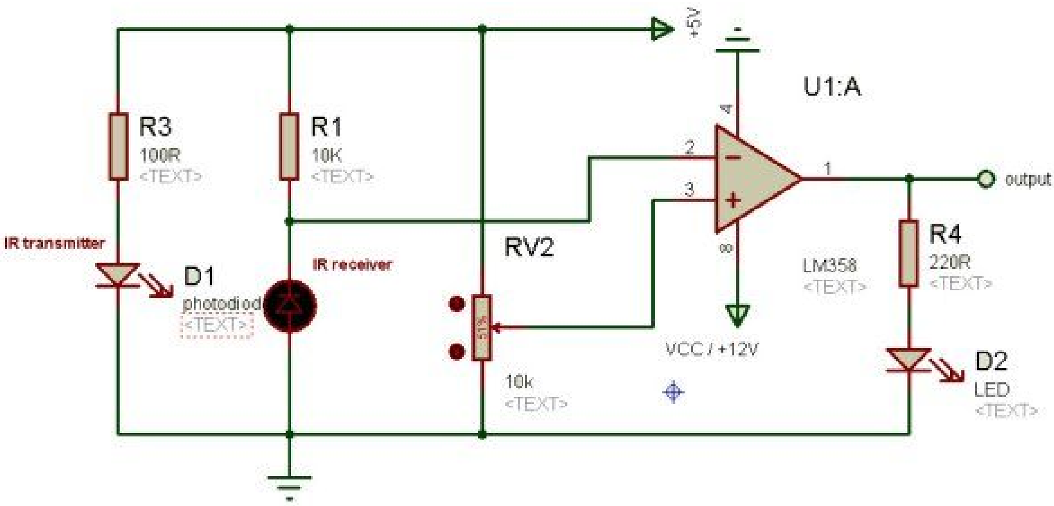

Figure 4.4: IR sensor circuit

As CD4026[1] is a decade counter, also it works as latch that stores the counted value of 10.5sec. This way the RPM of the any rotating disc can be determined.

CHAPTER 5

RESULT AND DISCUSSIONS

The overview of this project is explained which includes the information of the list below:
5.1. Calculate output
5.3. Designed instruments output
5.4. Comparison of two output
5.5. Result
5.6. Future Scope

5.1 Calculate Output:

Techometer Formula:

For counting the RPM of a fan, we're utilizing an IR break-beam that counts every interruption which is required to realize that first. The great thing is we realize the first objective, except one thing. The CPU fan has 7 blades which required to realize also. These designates that there are seven interrupts in 1 RPM. If we keep track of the interrupt count, we can ken that 1 full rotation has just occurred after every 7th interruption designates. We can then facilely calculated the full RPM if we keep track of the time which takes for every full cycle. To calculate the RPM we'll utilize the formula visually perceived above in the code. The performance that is how well our ATMEGA8a can keep track of the time between full rotation counts and interrupts will precise our tachometer.

$$Time\ For\ 1\ Rotation = P\frac{\mu S}{rotation} \quad , \quad P\ is\ unkown$$

$$RPM = \frac{Rotations}{Minute}$$

$$= 60{,}000{,}000\frac{\mu S}{minute} \times \left(\frac{1}{P}\right)$$

$$= \frac{60{,}000{,}000}{P}\frac{rotations}{minute}$$

Figure 5.1: Techometer

5.2 Techometer Data Output

5.3 Result:

For testing issue a motor which is rated 4000 rpm was utilized. A microcontroller based tachometer and a subsisting tachometer both were utilized for 4 readings at different pulse width modulation. These are shown in the chart below.

PWM	RPM measured with existing Techometer	RPM measured with microcontroller based techometer
14	200	190
33	500	460
90	1000	910
100	1500	1220

Table 5.1: Data Table

CHAPTER 6

CONCLUSION

6.1 Conclusion of the project:

A digital tachometer predicated on an infrared light reflection technique has been demonstrated prosperously. Its major advantage are that it doesn‚Äôt require any physical contact with the rotating shaft too quantify its celerity. This project can be elongated further by integrating data logging feature too it. The IR LED transmits an infrared light towards the rotating disc and the photo detecting diode receives the reflected light beam. If the entire disc surface are effulgent and reflective, utilize a piece of ebony paper instead so that the IR light will be absorbed by this portion once per rotation. In either case, a pulse will be engendered at the output of the signal conditioning circuit for each consummate rotation of the disc.

6.2 Advantage:

A device which is utilize for measuring the rotational speed of the shaft or disc is known as tachometer or revolution counter or the rpm gauge. The digital displays are providing much satisfactory result while the engine or other device usually displays the number of rpm on the calibrated analog dial, but.In fact the word tachometer and speedometer are of equal importance: A device that measures the speed.
It is an arbitrary combination that one is used for the engine in the automotive industries and the other to the vehicle speed.

6.3 Disadvantage:

The interruption of the emitter/detector circuit which sent elevating edge signals of +5v to the microcontroller is done by a fan. The LCD output of the congruous value from the rpm counter corresponding to the fan‚Äôs current speed and it was precise. The disadvantage of this device is it can‚Äôt work on day light because of the so used sensors instead of laser.

6.4 Future Scope:

- We can measured any type of rolling device RPM.
- In Future we can provide batter output for this system.

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APPENDIX A

CODING PART

```
Transmit code
intval;
intir=A1;
Long last=0;
int stat;
int stat2=LOW;
int counter=0;
int rpm;
intsens=200;
intmilisec=1000;
void setup()
{Serial.begin(38400);
pinMode(ir,INPUT);}
void loop(){ val=analogRead(ir); if(val<sens)
{ stat=HIGH; } else {
stat=LOW; }
if(stat2!=stat) { counter++; stat2=stat; } if(millis()-last>=milisec)
{ rpm=(counter/2.0);
Serial.write(rpm);
counter=0;
last=millis();
}
}
#Receiver code
#include <LiquidCrystal.h>
LiquidCrystallcd(10,12,14,16,18,19);
int data=0;
int rpm=0;
intmilisec=2000;
if(Serial.available() > 0){
data = Serial.read();
```

```
rpm=data*60000.0/(milisec);
lcd.clear();
lcd.setCursor(0,1);
lcd.print(rpm); }
}
```