Project Report on

Propeller LED Message Display

Submitted in partial fulfillment of the requirements

of the degree of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND TELECOMMUNICATION

by

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CERTIFICATE

This is to certify that the project entitled **"Propeller LED Message Display"** is a bonafide work of **"Lenin Fonseca (Roll No. 30), Vinit Gaikar (Roll No. 31), Arunlal Gupta (Roll No. 38) and Rollins Miranda (Roll No. 61)"** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **Bachelor of Engineering** in **Electronics and Telecommunication Engineering**.

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Project Report Approval for B.E.

This project entitled ***'Propeller LED Message Display'*** by ***Lenin Fonseca, Vinit Gaikar, Arunlal Gupta and Rollins Miranda*** is approved for the degree of ***Bachelor of Engineering in Electronics and Telecommunication*** from University of Mumbai.

Examiners

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ABSTRACT

The Propeller LED Message Display works on the principle of an optical phenomenon called the persistence of vision which works in the background to reproduce a sequence of visual images in a motion picture. Most of the existing display grids consists of large number of LEDs and hence consume a lot of energy. In the present work, virtual grids are used in order to reduce the number of LEDs. Virtual grids are formed by placing eight LEDs serially on a propeller. The propeller is subject to rotation at high speed to create virtual grids for displaying short messages which can be used in advertising and in marketing campaign as a display device. As compared to the conventional dot-matrix displays the POV display consumes less power.

Keywords: Propeller, Persistence of Vision.

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List of Abbreviations

ADC	Analog to Digital converter
AVR	Alfred and Vegard's RISC
CAD	Computer Aided Design
CAM	Computer-aided manufacturing
EDA	Electronic Design Automation
EEPROM	Electrically erasable programmable read-only memory
FTDI	Future Technology Devices International
IC	Integrated Circuit
ICSP	In-circuit serial programming
IDE	Integrated development environment
ISP	In system programming
LED	Light Emitting Diode
MIPS	Million Instructions per second
MQTT	Message Queue Telemetry Transport
PCB	Printed Circuit Board
POV	Persistence of vision
QFNP	Quad Flat No-Lead package
RCLK	Register clock pin
RISC	Reduced instruction set computer
SER	Serial data pin
SHCP	Shift register clock pulse
SPI	Service provider interface
SRAM	Static random-access memory
SRCLK	Serial clock
STCP	Storage clock pulse
TQFP	Thin quad flat package
USART	Universal Synchronous/Asynchronous Receiver/Transmitter
USB	Universal Serial Bus

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included; we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in this submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Chapter 1

Introduction

The Propeller LED Message Display works on the principle of an optical phenomena called the persistence of vision which works in the background to reproduce a sequence of visual images in a motion picture. The display will allow the users to program an image or a pattern on the LED grid via PC interface. A persistence of vision (POV) refers to the phenomenon of the human eye in which an after image exists for a brief time. Spinning a one-dimensional row of LED's through a two-dimensional space at such a high frequency creates a continuous series of images.

1.1 Motivation

The purpose of this project is to design and create a persistence of vision (POV) display. The display will allow the users to program an image or a pattern on the LED grid via PC interface. A persistence of vision (POV) refers to the phenomenon of the human eye in which an after image exists for a brief time. A POV display exploits this phenomenon by spinning in one dimensional row of LED's through a two-dimensional space at such a high frequency that a two-dimensional display is visible.

1.2 Problem Statement

Conventional dot matrix displays need large number of LEDs which increases the power consumption.

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1.3 Methodology

We use a propeller type display so that the led count can be kept to a bare minimum and make it more efficient than traditional displays.

1.4 Organization of Project Report

This project report is organized as follows:

Chapter 2 presents the literature survey on the existing techniques.

Chapter 3 provides a brief explanation of design methodology.

Chapter 4 presents the details about software and hardware support in our project.

Chapter 5 is dedicated to results and discussions.

Chapter 6 presents the conclusions and future scope for this project.

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Chapter 2

Literature Survey

This project was started with a simple principle which is frequently encountered in our everyday life, which is Persistence of Vision. This phenomenon makes one feel fast moving/changing objects to appear continuous.

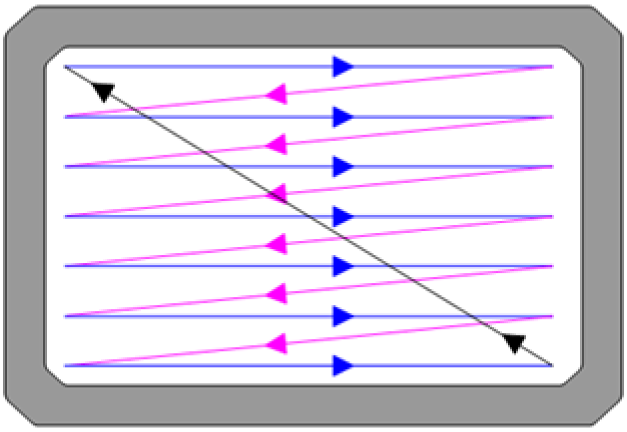

Fig 2: Path of electron beam when using a raster scanning technique [2].

A television is a common example; in which image is re-scanned every 25 times, thereby appear continuous. Further, a glowing objects if rotated in a circle at fast speed, it shows a continuous circle. By modifying this basic idea, 8 LEDs can be rotated in a circle, showing 7 concentric circles. But if these LEDs are switched at precise intervals, a steady display pattern can be shown as per Fig 2.

2.1 Existing System

Existing systems use individual LED to display each pixel. This results in a huge number of LEDs even for small sized displays.

Most LED displays are limited to displaying the 16 hexadecimal characters. Some can display only the numbers 0 through 9. Existing LED displays are limited to possible binary combinations of the four input leads, for a total of 16. Due to this there is a limited number of combinations for the seven segments on the LED display.

2.2 Propeller LED 2D display

The Propeller LED 2D display is the evolved part of 7 segment display.

- Here a linear (1-dimensional) array of LED lights rotates around a single point, like a bike wheel.
- By measuring their rotation rate and controlling their flashes with millisecond precision, we can create the illusion of a 2-dimensional image lingering in thin air.
- It requires less number of led compared to 7 segment displays but still it is more than number of led required in POV globe (our project) which can display more character and images which is not possible in 7 segment or propeller LED display.

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2.3 Advantages of POV globe over Propeller LED 2D display

- A three-dimensional display has the added benefit of being viewable from any direction around the system which is not possible in 1-dimensional array of LED system which can be only viewed from one or two side at a time.

- The resolution of a POV display is partially dictated by the number of LEDs physically present in the system. However, due to the persistence of vision phenomenon caused by physical movement of the LEDs, the perceived resolution in the directions of motion is much greater than the actual number of LEDs present. This type of better resolution is not possible by any means of modification in Propeller LED display.

- POV displays uses single-color LEDs in order to produce their text, images or other media.
- The novelty of the device would be a key factor here, as well as the potentially reduced cost of the lower number of LEDs required compared to LEDs required in Propeller display.
- The main advantage is that the POV display consumes comparatively less power than the conventional LED displays.

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Chapter 3

Design Methodology

3.1 Block diagram

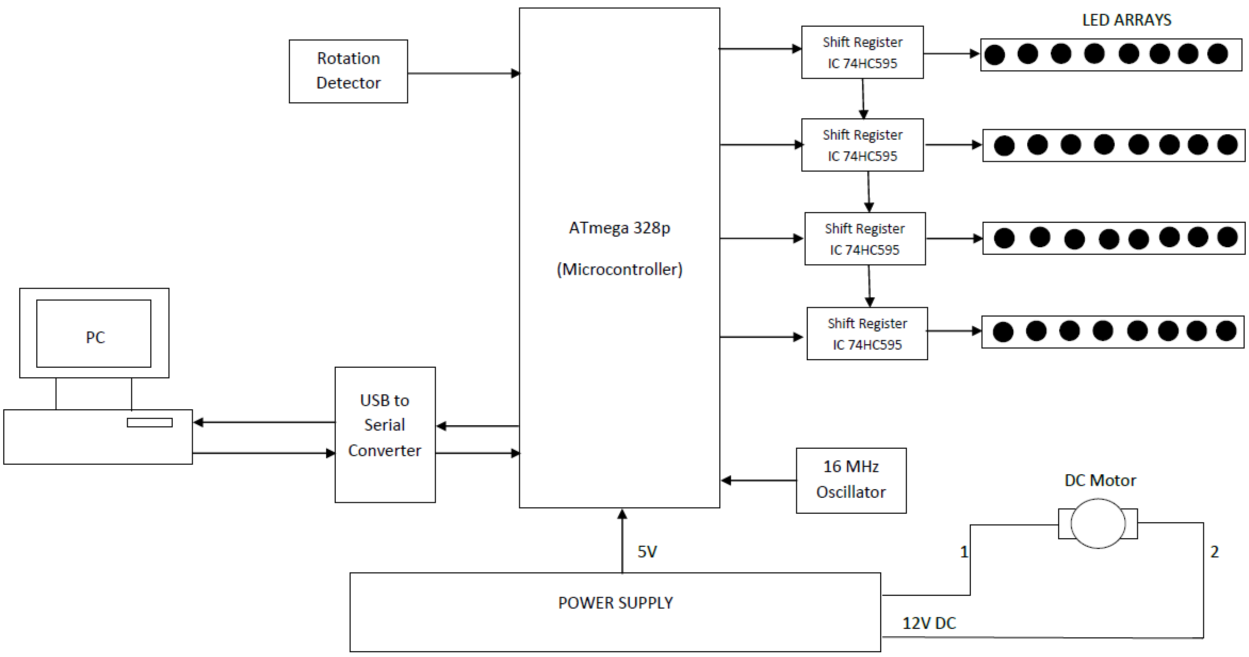

Fig 3.1: Block diagram.

As shown in Fig 3.1, we divide this system into 4 main parts:

- The electronics, which control at least 24–40 LEDs using an Arduino Uno microcontroller and 74HC595 shift registers.
- The POV Calculator software that breaks down an image into a bit-pattern.

- The Arduino sketch that breaks this pattern into segments and sends it to the shift registers

The mechanics that rotate the LEDs. The microcontroller's job is to issue a predetermined pattern of binary pixels to the large number of LEDs. This data must be sent synchronously with the ring's rotation, triggered by Hall effect sensor which is a is a transducer that varies its output voltage in response to a magnetic field. Hall effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications. But the Arduino has relatively few output pins, so we resort to a trick. We use simple shift register chips, which collect the serially transmitted data (8 bits per chip) and on command make the data parallel (available all at once) at their output pins.

This strategy takes advantage of the Arduino's high-speed serial (SPI) pins, requires much less programming effort, and greatly simplifies the wiring.

3.2 Ignition Timing

When the globe is spinning, the bit-pattern that's output to the LEDs must always begin at precisely the right instant. The purpose of the Hall sensor mounted on the ring is to fly past a stationary magnet with each revolution. This triggers a hardware interrupt on Arduino pin D2, providing the "ignition timing" for starting each output. The output frequency is also calculated from the rotational speed so that the pattern can be sent at a matching speed.

3.3 Bitwise input to LED

A shift register is a clocked logic circuit that stores and supplies a push of binary data. It consists of a series of flip-flops. As shown in fig 3.3, with each clock pulse on the clock pin (SRCLK), one bit (state HIGH or LOW) is sent to the serial data pin (SER) and stored in the register at the first flip-flop location. On the next clock pulse, that bit is passed to the next space in the register and the first space is reassigned a new bit like a bucket brigade. Thus, the data is always shifted by one digit at each clock pulse as per shown in fig 3.4. In a latching register like the 74HC595, the data is first loaded into an internal buffer, then copied all at once to the output register when the latch signal is received a HIGH pulse on the register clock pin (RCLK).

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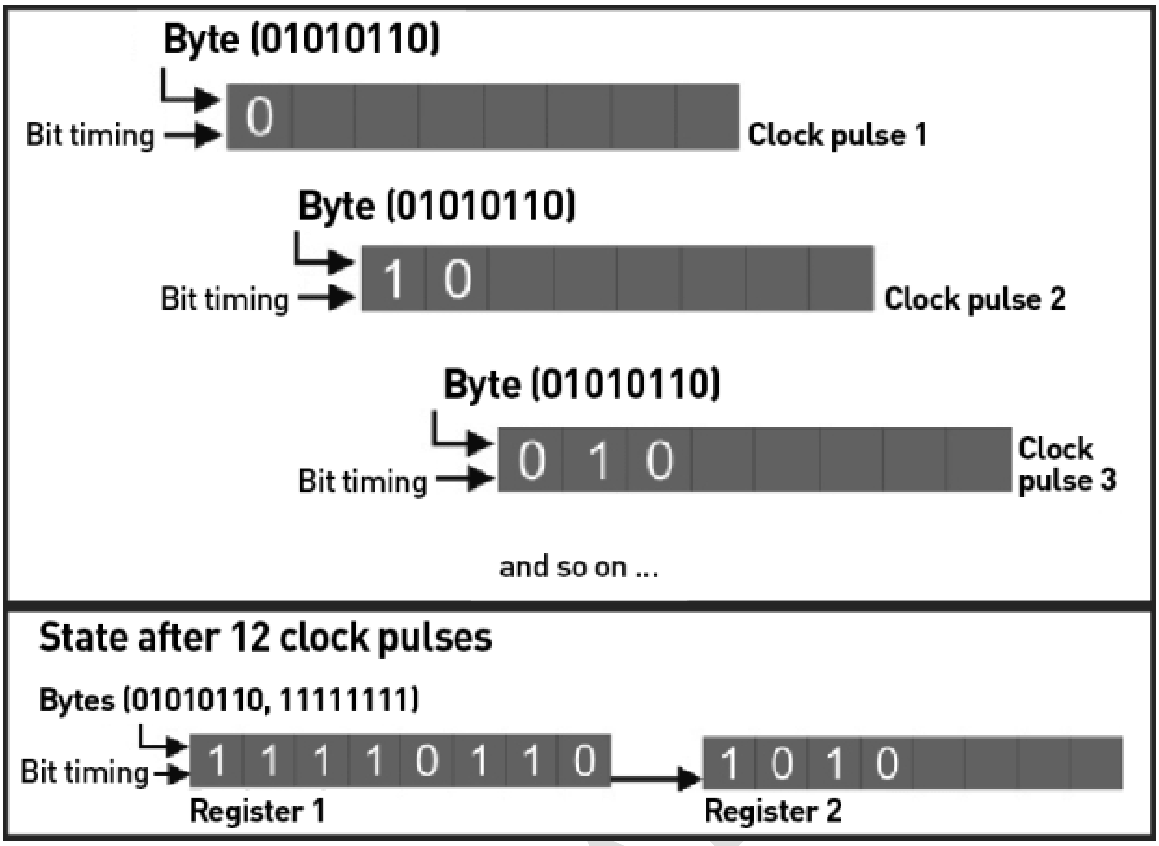

Fig 3.3: Bitwise input to LED [3]

This way, we can transmit the next batch of data without disturbing the existing state of the outputs (and our LEDs). When the shift register fills up spaces Q_0–Q_7 (parallel data output pins) it overflows to the Q_7' output (pin 9), which continues to pass new values along to the next shift register in the daisy chain, even while the latch isn't being triggered.

3.4 Design Flowchart

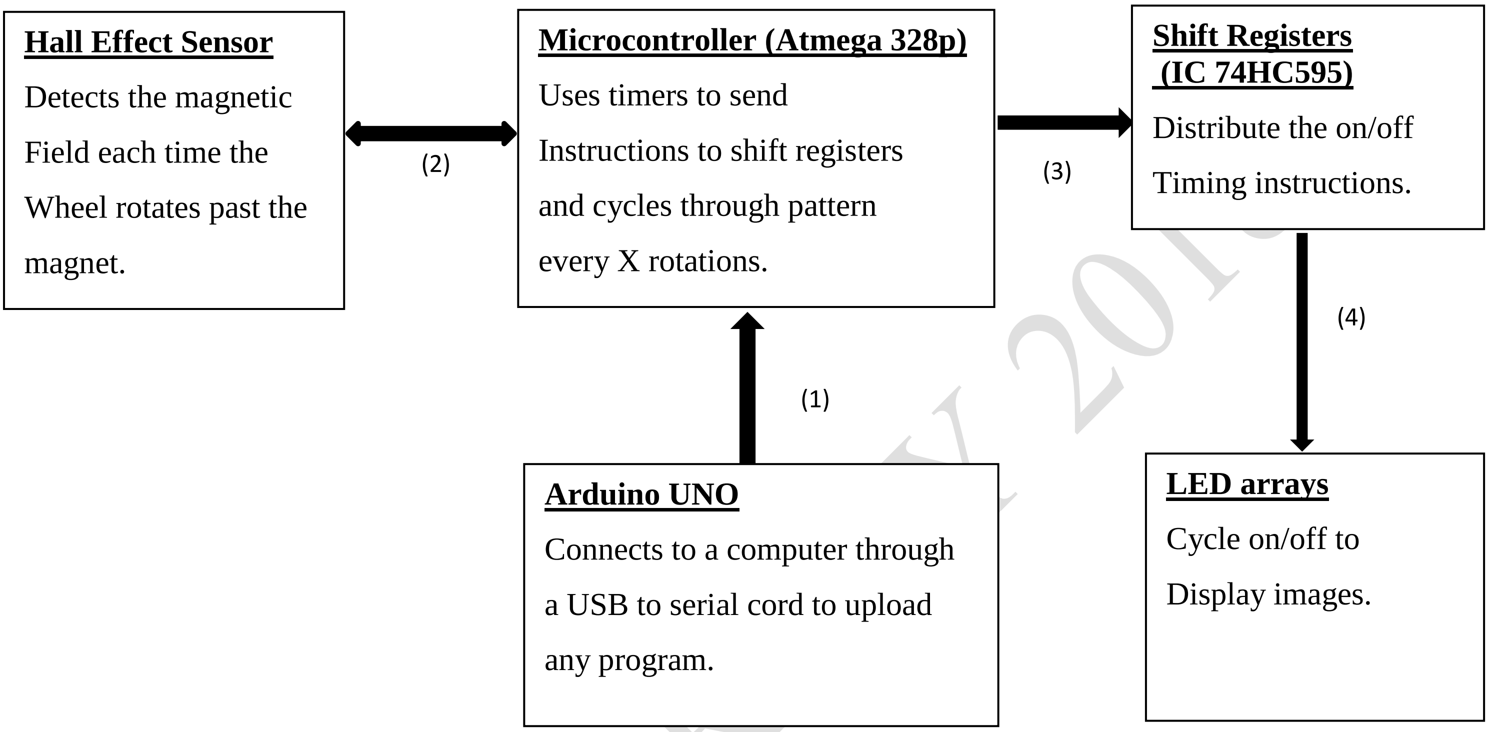

Fig 3.4: Design flowchart

According to the Block Diagram, the above fig 3.4 demonstrates the series of actions which will be performed during the operation of the system.

Chapter 4

Software and Hardware Support

This chapter constitutes of a detailed view of the software and hardware support used in the project

4.1 Eagle CAD

Eagle is a scriptable electronic design automation (EDA) application with schematic capture, printed circuit board (PCB) layout, auto-router and computer-aided manufacturing (CAM) features. It contains a schematic editor, for designing circuit diagrams. Schematics are stored in files with .SCH extension, parts are defined in device libraries with .LBR extension. Parts can be placed on many sheets and connected together through ports.

4.2 Arduino (IDE)

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

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4.3 Arduino Board

Arduino board as shown in fig 4.3 is able to read inputs light on a sensor, a finger on a button, or a Twitter message and turn it into an output activating a motor, turning on an LED, publishing something online. We can tell our board what to do by sending a set of instructions to the microcontroller on the board. To do so we use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

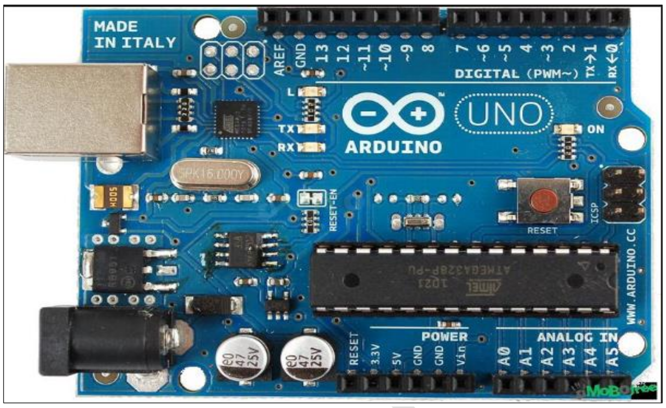

Fig 4.3: Arduino Board [4]

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

4.4 Atmega328p Microcontroller

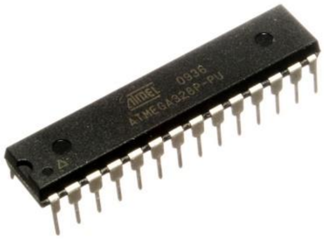

Fig 4.4: Atmega 328p IC [5]

As shown in fig 4.3, the high-performance Microchip 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter, programmable timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

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4.4.1 Specifications

PARAMETERS	VALUES
Pin Count	28/32
Flash (Bytes)	32K
SRAM (Bytes)	2K
EEPROM (Bytes)	1K
General Purpose I/O Lines	23
SPI	2
TWI (I2C)	1
USART	1
ADC	10-bit 15kSPS
ADC Channels	8
8-bit Timer/Counters	2
16-bit Timer/Counters	1

Table 4.4.1: Atmega 328p IC specifications [5]

4.4.2 Pin Configuration/Description

- <u>VCC:</u>

  Digital supply voltage.

- <u>GND:</u>

  Ground

- <u>Port B (PB [7:0]) XTAL1/XTAL2/TOSC1/TOSC2:</u>

  Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability.

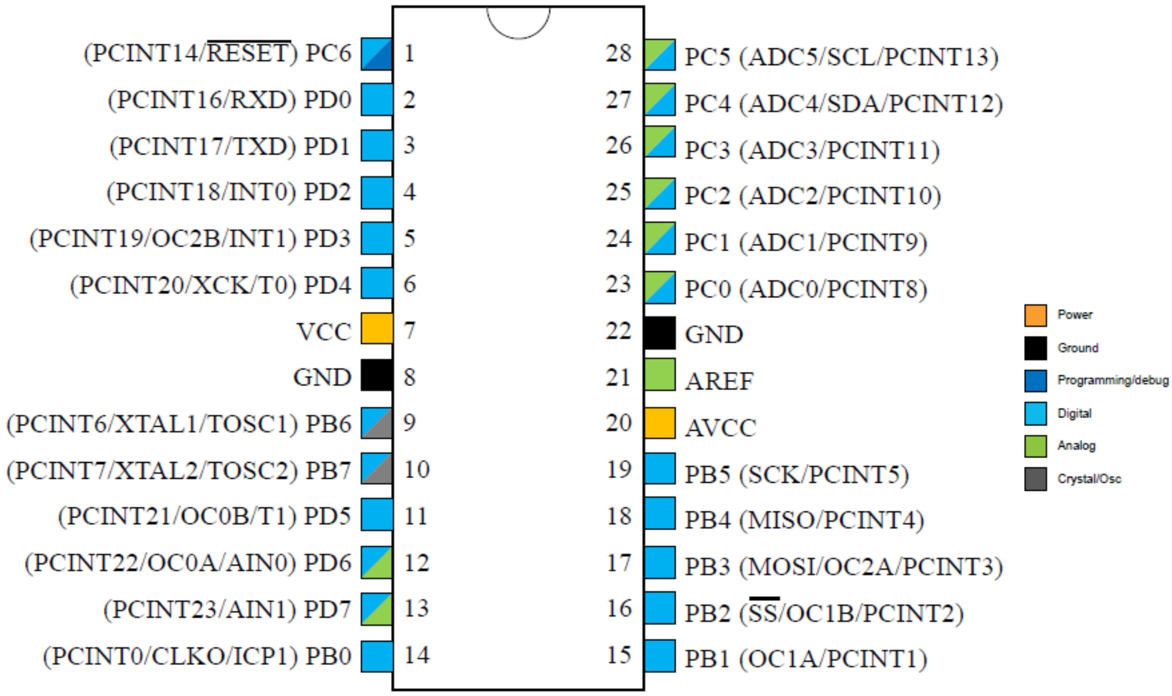

Fig 4.4.2: Pin Configuration [5]

As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB[7:6] is used as TOSC[2:1] input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

- Port C (PC[5:0]):

  Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC[5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- PC6/RESET:

  If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset. The various special features of Port C are elaborated in the Alternate Functions of Port C section.

- Port D (PD[7:0]):

  Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

- AVCC:

  AVCC is the supply voltage pin for the A/D Converter, PC[3:0], and PE[3:2]. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC[6:4] use digital supply voltage, VCC.

- AREF:

  AREF is the analog reference pin for the A/D Converter.

- ADC[7:6] (TQFP and VFQFN Package Only):

  In the TQFP and VFQFN package, ADC[7:6] serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

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4.5 IC 74HC595 (Serial to parallel converter)

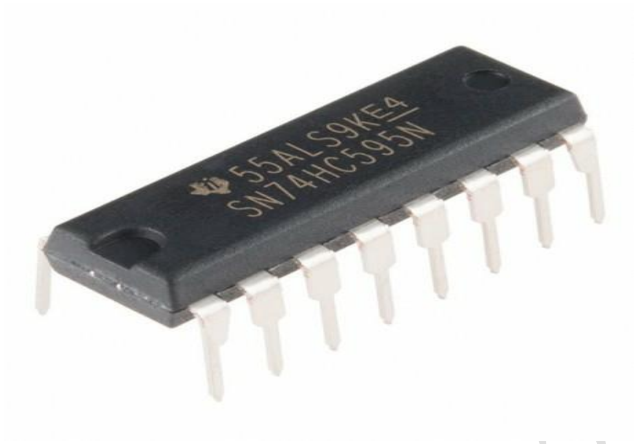

Fig 4.5: IC 74HC595 [6]

The 74HC/HCT595 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL. The IC (fig 4.5) is an 8-stage serial shift register with a storage register and 3-state outputs. The shift register and storage register have separate clocks. Data is shifted on the positive-going transitions of the SHCP input. The data in each register is transferred to the storage register on a positive-going transition of the STCP input. If both clocks are connected together, the shift register will always be one clock pulse ahead of the storage register.

4.5.1 Specifications

SYMBOL	PARAMETER	TYP.		UNIT
		HC	HCT	
t_{PHL}/t_{PLH}	Propagation delay			
	SHCP to Q7'	16	21	ns
	STCP to Qn'	17	20	ns
	$\overline{MR}$ to Q7'	14	19	ns
f_{MAX}	Maximum clock frequency SHCP, STCP	100	57	MHz
C_I	Input Capacitance	3.5	3.5	pF
C_{PD}	Power dissipation capacitance per package	115	130	pF

Table 4.5.1: IC74HC595 specifications [7]

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4.5.2 Pin Configuration/Description

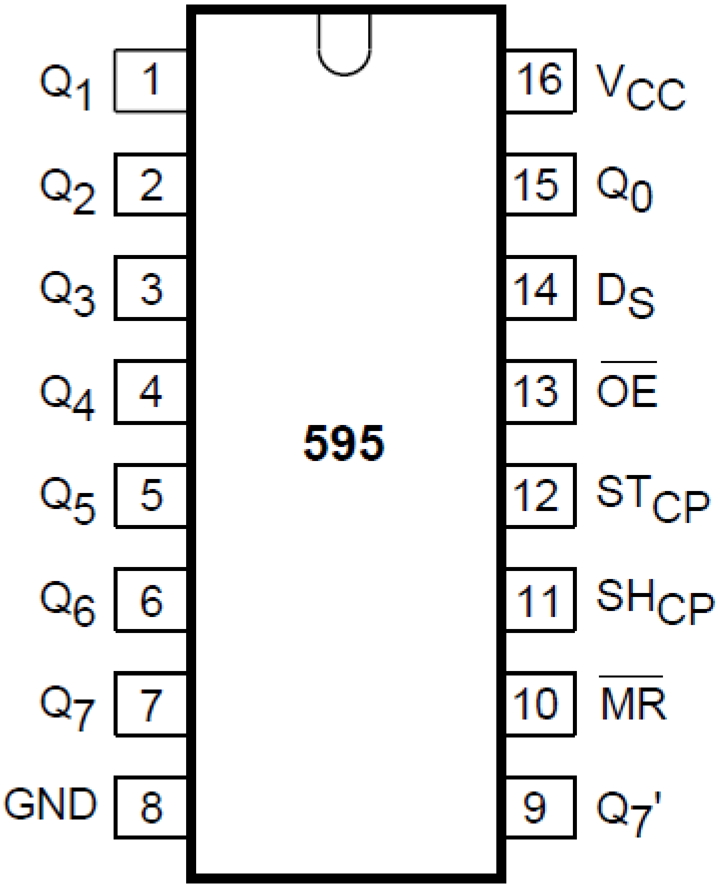

Fig 4.5.2: IC74HC595 Pin configuration [7]

SYMBOL	PIN	DESCRIPTION
Q_0 to Q_7	15,1 to 7	Parallel data output
GND	8	Ground (0 V)
Q_7'	9	Serial data output
$\overline{MR}$	10	Master reset (active LOW)
SHCP	11	Shift register clock input
STCP	12	Storage register clock input
$\overline{OE}$	13	Output enable (active LOW)
Ds	14	Serial data input
Vcc	16	Positive supply voltage

Table 4.5.2: IC74HC595 Pin description [7]

4.5.3 Functional Block diagram

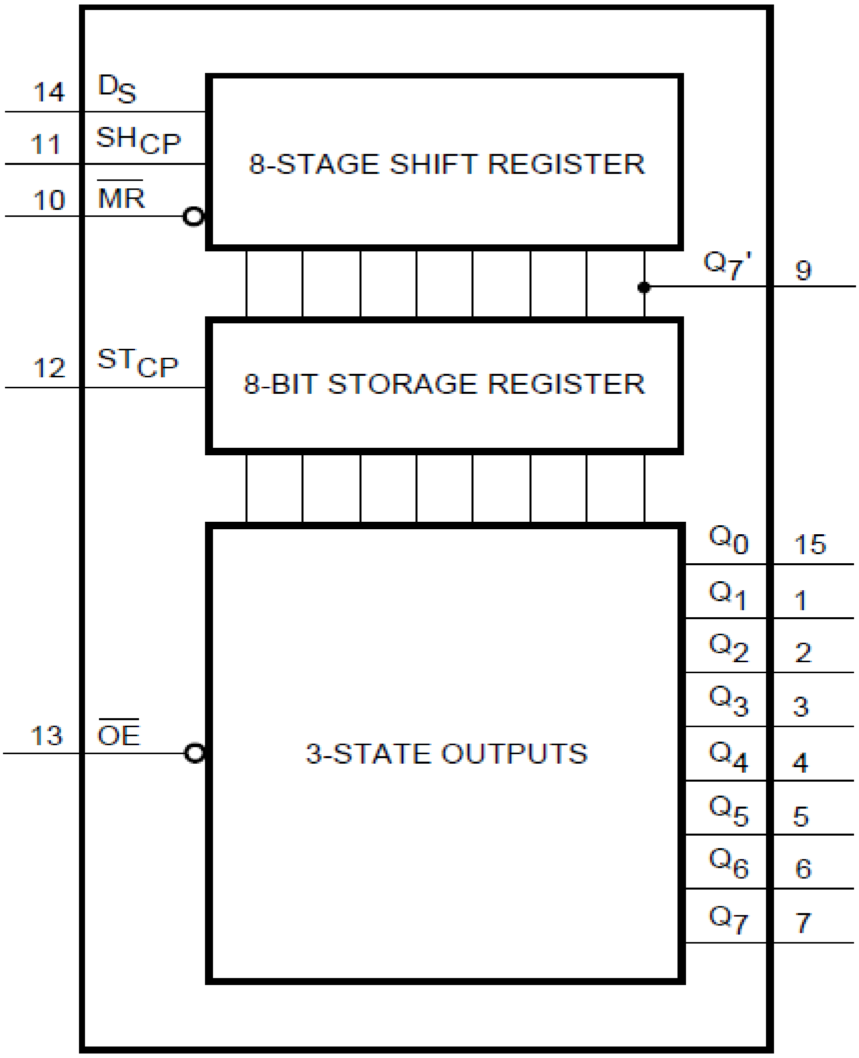

Fig 4.5.3: IC 74HC595 functional block diagram [7]

From fig 4.5.3, the serial interface on the 74HC595 is a 4-wire serial interface using four inputs (DIN, CLK, LE, Output Enable) and a data output (DOUT). This interface is used to write display data to the 74HC595. The serial -interface data Byte length is 8 bits, D0–D7. The functions of the five interface pins are as follows DIN is the serial-data input and must be stable when it is sampled on the rising edge of CLK. Data is shifted in, MSB first. This means that data bit D15 is clocked in first, followed by 8 more data bits finishing with the

LSB, D0. CLK is the serial-clock input, which shifts data at DIN into the 74HC595 8-bit shift register on its rising edge. LE is the latch load input of the 74HC595 that transfers data from the 74HC595 8-bit shift register to its 8-bit latch when LE is high (transparent latch) and latches the data on the falling edge of LE. The fourth input provides output-enable control of the output drivers. OE is high to force outputs OUT0–OUT8 high impedance, without altering the contents of the output latches, and low to enable outputs OUT0–OUT8 to follow the state of the output latches. OE is independent of the operation of the serial interface. Data can be shifted into the serial-interface shift register and latched, regardless of the state of OE. DOUT is the serial-data output, which shifts data out from the 8-bit shift register on the rising edge of CLK. Data at DIN is propagated through the shift register and appears at DOUT 8 clock cycles later. In our circuit, we make use of 2 LED drivers as we want to drive 40 LEDs. The LED drivers are cascaded one after the other. Thus, we can send serially send 4 bytes of data to control the 40 LEDs. When 4 bytes of Data has been transferred, the serial to parallel shift register inside the driver is full. When the remaining data is received at Din of driver, the data in the above-mentioned register is clocked out into the cascaded LED driver. Now, both serial to parallel shift registers are full and ready for operation. Thus, we can increase the number of LEDs by increasing the number of cascaded drivers.

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4.5.4 Timing Diagram

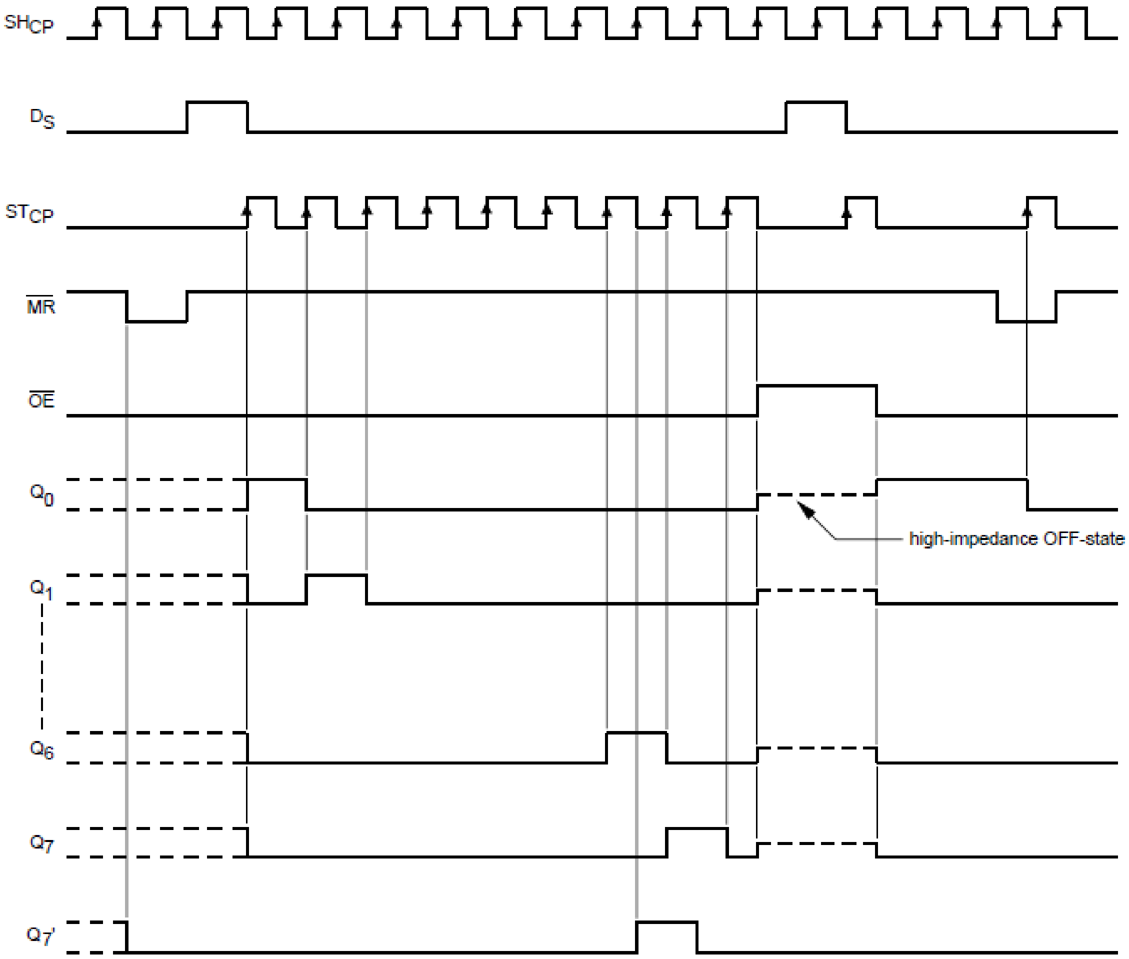

Fig 4.5.4: IC 74AHC595 timing diagram [7]

As shown in above fig 4.5.4, Data is shifted on the positive-going transitions of the SHCP input. The data in each register is transferred to the storage register on a positive-going transition of the STCP input. If both clocks are connected together, the shift register will always be one clock pulse ahead of the storage register. The shift register has a serial input (DS) and a serial standard output (Q7') for cascading. It is also provided with asynchronous reset (active LOW) for all 8-shift register stages. The storage register has 8 parallel 3-state bus driver outputs. Data in the storage register appears at the output whenever the output enable input (OE) is LOW.

4.6 Hall Effect sensor

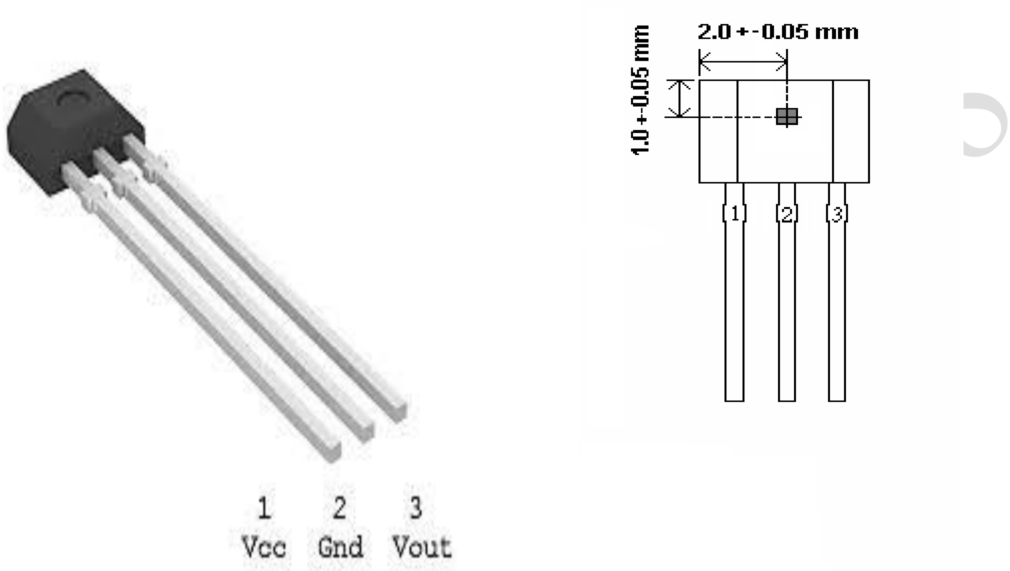

Fig 4.6: WSH130 Hall Effect sensor [8]

WSH130 is designed to integrate Hall sensor with output driver together on the same chip, it is suitable for speed measurement, revolution counting, positioning, and DC brushless motors ref fig 4.5 It includes a temperature compensated voltage regulator, a differential amplifier, a Hysteresis controller and an open-collector output driver capable of sinking up to 20mA current load. An on-chip protection resistor is implemented to prevent reverse power fault. The temperature-dependent bias increases the supply voltage of the hall plates and adjusts the switching points to the decreasing induction of magnets at higher temperatures.

The output can keep switching on/off on more precise switch point regardless to the ambient temperature. WSH130 are rated for operation over temperature range from –40˚ C to 125 ˚C and voltage ranges from 2.4V to 26V.

4.6.1 Specifications

PARAMETERS	VALUES
Output breakdown Voltage (Vout)	30 V
Magnetic flux density (B)	Unlimited
Reverse Protection Voltage (Vr)	26 V
Output ON Current (continuous) (Ic)	25 mA
Operating Temperature Range (Ta)	-40˚C to +125˚C
Storage Temperature Range (Ts)	-65˚C to +150˚C
Package Power Dissipation (Pd)	500mw

Table 4.6.1: WSH130 Specifications [9]

4.6.2 Pin Description

NAME	PIN	DESCRIPTION
Vdd	1	Positive power supply
GND	2	Ground
Vout	3	Output pin

Table 4.6.2: WSH130 Pin description [9]

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4.6.3 Functional Block

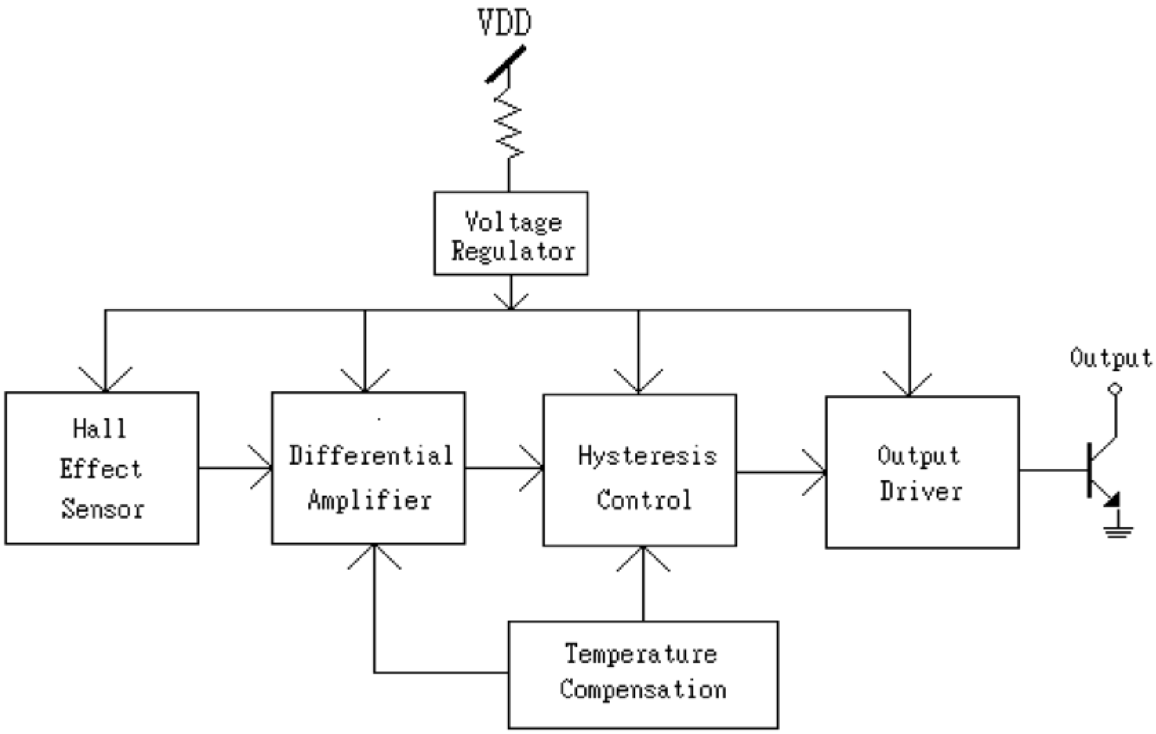

Fig 4.6.3: WSH130 Function Block [9]

Refer fig 4.6.3, In a Hall effect sensor, a thin strip of metal has a current applied along it, in the presence of a magnetic field the electrons are deflected towards one edge of the metal strip, producing a voltage gradient across the short-side of the strip (perpendicular to the feed current). Inductive sensors are just a coil of wire, in the presence of a changing magnetic field a current will be induced in the coil, producing a voltage at its output. Hall effect sensors have the advantage that they can detect static (non-changing) magnetic fields.

In its simplest form, the sensor operates as an analog transducer, directly returning a voltage. With a known magnetic field, its distance from the Hall plate can be determined. Using groups of sensors, the relative position of the magnet can be deduced. Frequently, a Hall sensor is combined with threshold detection so that it acts as and is called a switch. Hall sensors are commonly used to time the speed of wheels and shafts, such as for internal combustion engine ignition timing, tachometers and anti-lock braking systems. They are used in brushless DC electric motors to detect the position of the permanent magnet. In the pictured wheel with two equally spaced magnets, the voltage from the sensor will peak twice for each revolution. This arrangement is commonly used to regulate the speed of disk drives.

4.7 Crystal Oscillator (16 MHz)

Oscillators are always used in electrical designs but commonly used for generating radio waves, tone generators, generating counters to keep tracking time, and generating clock signals to maintain the speed of the digital processors including computers what we are regular using. When we start working on digital processors like micro-controllers we encounter a thing called clock oscillator. A clock oscillator is a circuit that generates square wave that controls how faster a processor runs. More faster the oscillator clock best the processing performance at the cost of increased power consumption.

4.8 DC Motor

Every motor has magnetic poles, just like a permanent magnet. These poles are created by bundles of magnet wire wound together in the slots of the stationary part of the motor (the stator core). Look inside an electric motor, and we can count the number of poles or windings. The number and alignment of these bundles of wires creates magnetic poles, and the number of poles in the motor determine the motor's speed, stated in revolutions per minute. No-load RPM is a factor of motor poles and power frequency, not voltage, horsepower, or motor diameter.

4.9 LED

Our display uses super bright 5mm LEDs which are extremely bright with a wide beam angle so they're good for use in projects, illuminations or anywhere where we need low power, high intensity reliable lighting or indication.

Parameters	Values
Reverse Voltage	5 Volt
Reverse Current (Vr =5V)	100mA
Operating Temperature Range	-40°C to 85°C
Storage Temperature Range	-40°C to 100°C
Lead Soldering Temperature (1.6mm (1/16) From Body)	260°C for 5 Seconds

Table 4.9: LED specifications [10]

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4.10 IC LM7805

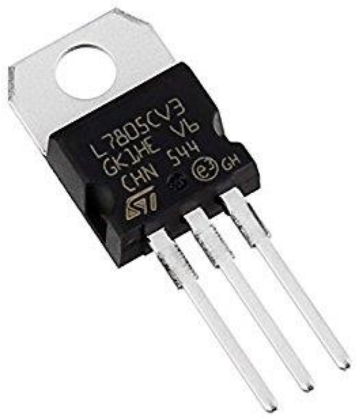

Fig 4.10: IC LM7805 [11]

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. From above fig 4.10, 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink.

4.10.1 Pin Description

NAME	PIN	DESCRIPTION
Input	1	Input Voltage (5-18V)
Ground	2	Ground (0 V)
Output	3	Regulated Output (4.8-5.2V)

Table 4.10.1: IC LM7805 Pin description [11]

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4.11 IN4007

A diode is a device which allows current flow through only one direction. That is the current should always flow from the Anode to cathode. From fig 4.11, the cathode terminal can be identified by using a grey bar as shown in the picture above. For 1N4007 Diode, the maximum current carrying capacity is 1A and it withstands peaks up to 30A. Hence, we can use this in circuits that are designed for less than 1A. The reverse current is 5uA which is negligible. The power dissipation of this diode is 3W.

4.12 Mechanical Support

To make the mechanical support the steps given below were followed

Step 1: The Rotor ring

To make the rotor ring, we used aluminum flat bar (20 mm wide and 3 mm thick) as it should be flexible enough and problem-free to work with. Before bending, holes are drilled for the LEDs, the Hall sensor, the central axis, and the balancing weights. If we use a 4.9mm drill bit, we can press-fit 5mm LEDs tightly into the ring without glue and then bend the bar into a circle carefully.

Step 2: The LEDs

For easier assembly and repair, we didn't solder the LEDs to the circuit board, but connected them with female jumper wires. These come with a connector on each end; since we need just one connector per lead, we cut them to make 2 leads from each jumper. The cable ends are stripped a few millimeters and a piece of heat-shrink tubing is slipped over each one. On each LED, the positive lead (anode, the longer leg) is bent outward at a 90° angle. The negative lead (cathode, shorter leg) is cut to 5mm–7mm in length and bent into a small eyelet. Then the positive lead is trimmed to 10mm–15mm long and the stripped cable end is wound around it, soldered in place, and insulated with the heat-shrink.

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<u>Step 3:</u> The Center Mast

Attach the board to the threaded rod that serves as an axis. Threaded rods under tension tend to become distorted, so no to tighten the nuts too tightly. Alternatively, we could substitute ordinary 8mm steel rod, threaded only at the ends.

<u>Step 4:</u> The Wooden Base

Fix the threaded metal rod along with the aluminum ring on a four-legged wooden support. Then bolt the DC motor to the moving rotor from the other side of the wooden base exactly at the center.

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Chapter 5

Results and Discussion

This section consists of the results that we obtained after PCB fabrication and implementation of the project model.

5.1 PCB Layouts

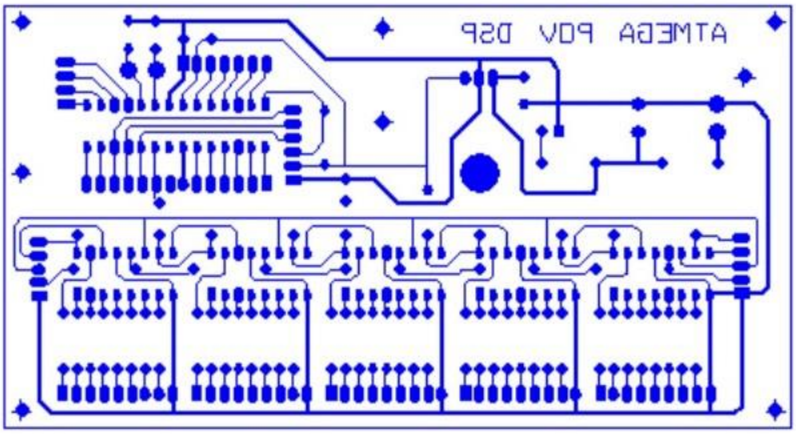

Fig 5.1.1: PCB layout (main)

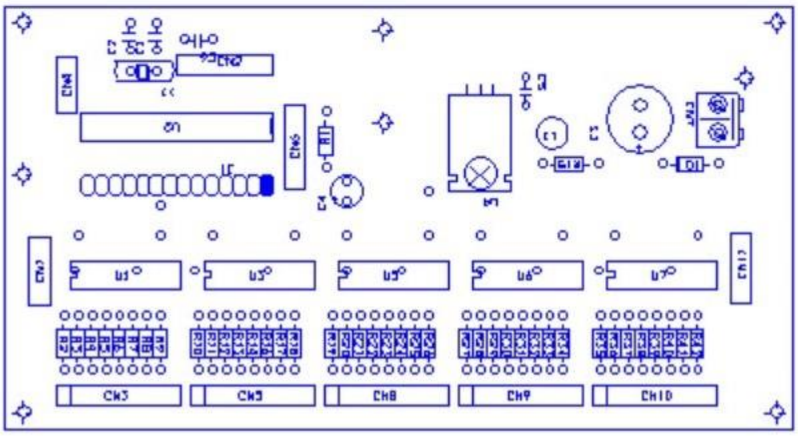

Fig 5.1.2: PCB layout (reference)

5.2 Project Model

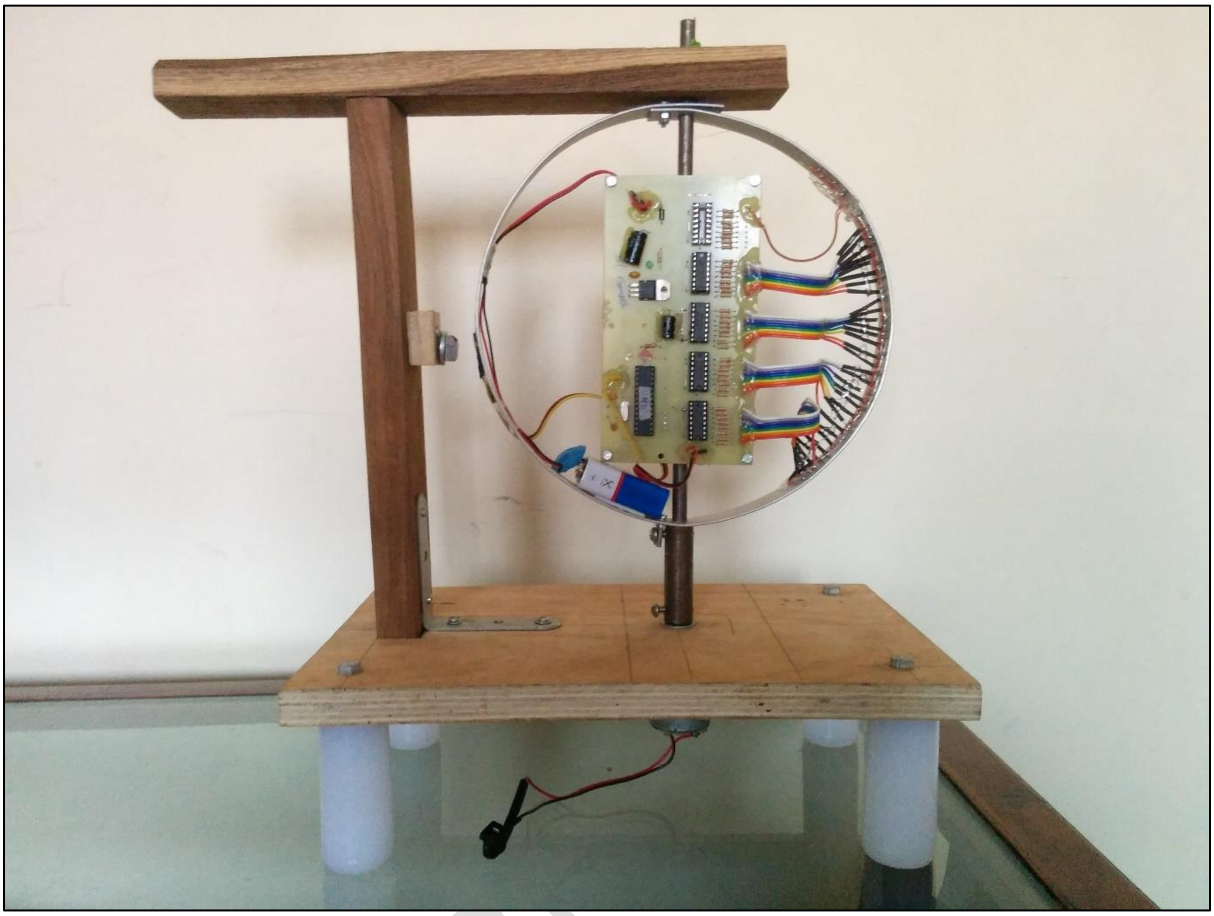

Fig 5.2.1: Project Model

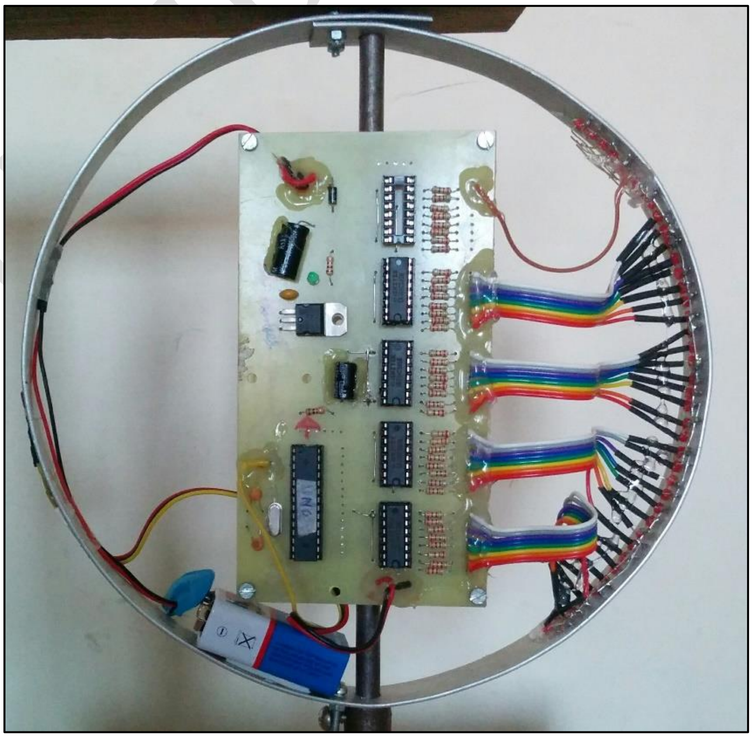

Fig 5.2.2: Main circuit

5.3 Display Output

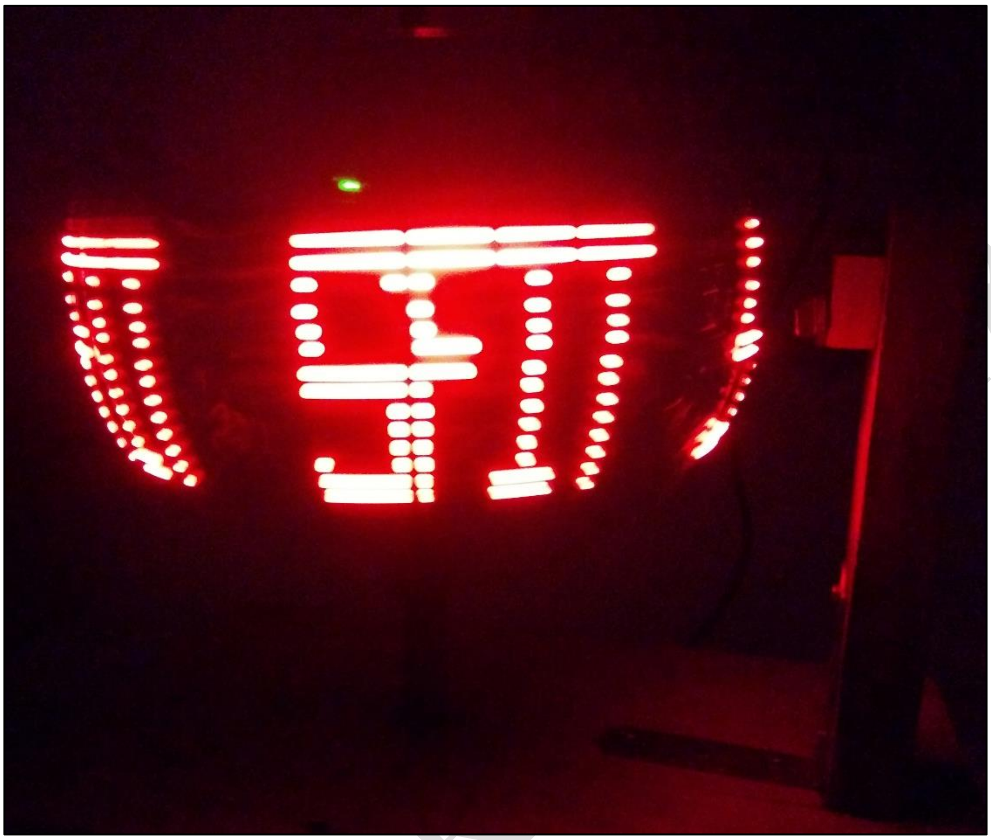

Fig 5.3.1: Character Display

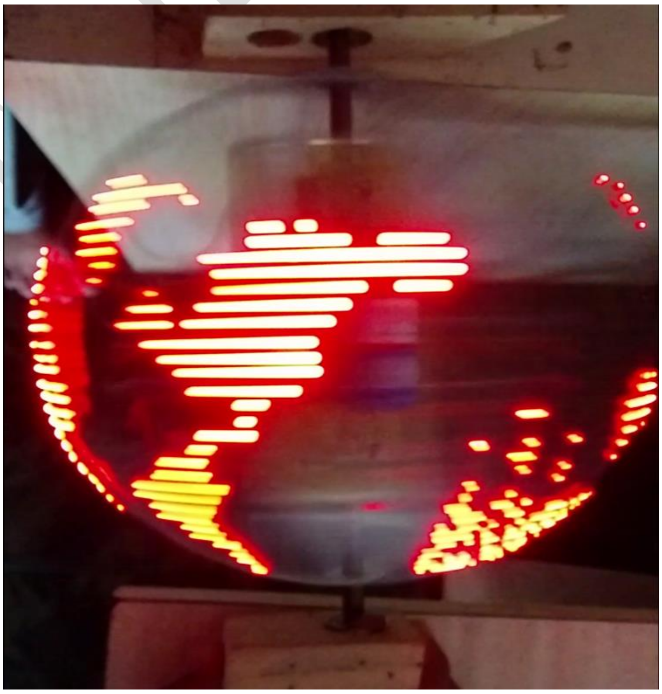

Fig 5.3.2: Pattern Display (Globe)

5.4 Circuit Explanation

The functional circuitry comprises just a microcontroller which drives the 40 LEDs via Shift Resistor IC 74HC595 and is linked to the Hall sensor. As the microcontroller cannot source enough current and IO Pin to Interface 40 LED's for pulsing the hefty LEDs, a follower stage comprising Shift Resistor IC's is provided. The eight rotating LEDs 'write' an image built up from eight lines of light (not from left to right of course but in continuous 360-degree rotation) and for this reason the microcontroller needs to be synchronized with what in TV or computer displays we would call a frame pulse, a signal indicating the start of a new image. This task is handled by the Hall switch, which alters its output level when it detects a magnetic field (in the vicinity of magnet in other words). Its normal State produces a 'high' output that goes 'low' on approaching a magnet. This change of level sets in motion the process of building up the image.

The program produces small image elements representing text fragments relating to character strings stored in the controller. These text fragments are then re-written as columns and fed out to the LEDs in a defined time frame. The rotation of the motor creates the impression of text written around the periphery of the ring. These characters are stored in the array, which contains three elements (three segments of text) that are read out and displayed sequentially. Readout of these characters is synchronized by the Hall switch already mentioned, which also provides the information whether the motor is in operation (when the motor is static the LEDs all remain unlit). The length of the rolling text in the 'display' depends on the radius of the circle created by the rotating LEDs, hence on the length of the rotor arm. The set-up illustrated in the output images operates with a text length of 4 characters. The program operates as an endless loop that is synchronized by the Hall switch and delivers 4 characters continuously.

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5.5 Power Comparison

For comparing the power consumption of POV display with the traditional dot-matrix ones we consider an example of displaying characters “24X7” on both the displays.

Calculations:

Considering 24 hours a day and 52 weeks in a year.

Total operating hours (168 hrs. per week) in a year = 52×168 = 8736 hrs.

For POV display

1. Power = 32×0.1W = 3.2 W = 0.0032 kW
2. Power consumption (in kWh) = 0.0032×8736 = 28 kWh

For Dot-matrix display

3. Power = 48×0.1W = 4.8 W = 0.0048 kW
4. Power consumption (in kWh) = 0.0048×8736 = 42 kWh

PARAMETERS	POV DISPLAY	DOT-MATRIX DISPLAY
Power required	3.2 W	4.8 W
Power Consumption (in kWh)	28 kWh	42 kWh

Table 5.5: Power Comparison details

From above table 5.5, the difference of power consumption between both the displays is about 14 kWh. Hence, it is concluded that the POV display consumes a minimum of 33.3% less power than the conventional dot-matrix display.

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Chapter 6

Conclusion

6.1 Conclusion

We have successfully implemented a simple form of the display in which both the pattern and a message can be displayed. The advantages of the developed system over existing one is that it has added benefit of being viewable from all the direction around the display which is not possible in the existing one-dimensional displays and it is easily customizable in terms of the message we want to display as per our need. While our display depends on the resolution we perceive it may cause limitations on the length of characters we want to display. Also, improper alignment of hall sensor with the magnet may lead to distorted image. Overall, the main motive of the power saving is achieved by our system as compared to the existing systems. The possible applications of the display are advertisements, entertainment, novelty decorations, education, animations, etc.

6.2 Future Scope

The major enhancement of the current system would be to allow wireless transmission of images to the system. This would allow for increased processing power, as processing could be achieved on an external computer and the resultant images/frames transmitted to the POV display. Patterns or interactive games, for example, could then be easily implemented within the system: all heavy lifting would be performed at the computer level and the POV system would effectively become a wireless display monitor.

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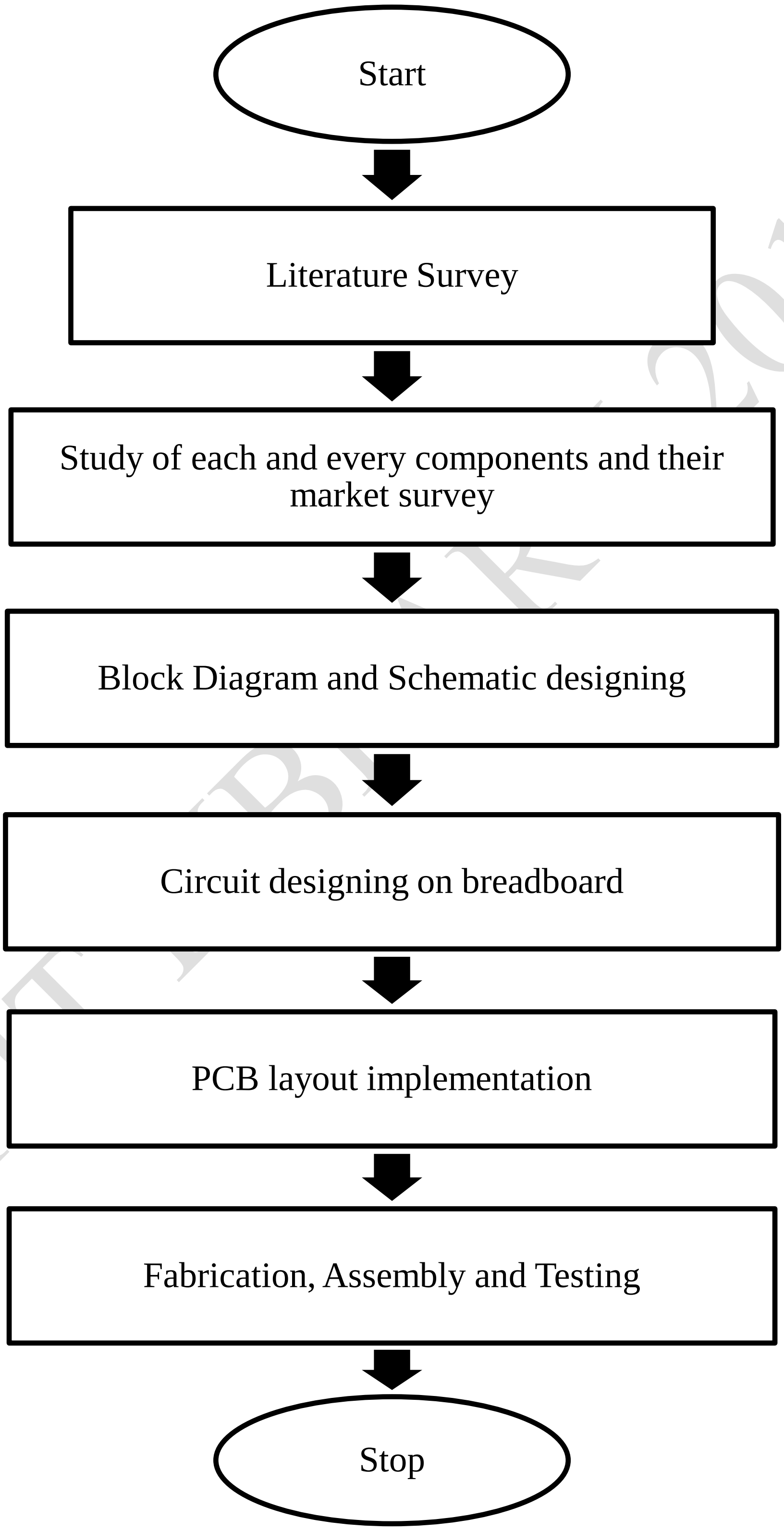
Appendix A


Start
Literature Survey
Study of each and every components and their market survey
Block Diagram and Schematic designing
Circuit designing on breadboard
PCB layout implementation
Fabrication, Assembly and Testing
Stop

Appendix B

Timeline Chart for Semester VII																		
Month	**July**				**August**					**September**				**October**				
Week no.	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**
Task Performed																		
Problem Definition																		
Identifying the goal of the project	■																	
Preparation																		
Gathering Information on Embedded systems		■	■															
Study of related IEEE paper				■	■													
Design of block diagram						■	■											
Hardware Implementation																		
Study of Arduino IDE								■										
Simulation of a single array of LED on breadboard.									■	■								
Presentation																		
Presentation										■								
White book																		
Preparing the white book														■	■	■		

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Timeline Chart for Semester VIII																		
Month	**January**					**February**				**March**				**April**				
Week no.	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**
Task Performed																		
Software Implementation																		
Designing the circuit schematic																		
Presentation																		
Presentation																		
Software Implementation																		
Designing the layout using Eagle CAD.																		
Fabrication																		
Getting the layout fabricated on the PCB.																		
Hardware Implementation																		
Soldering of the components on the PCB.																		
Mechanical implementation of rotor ring and wooden base.																		
Poster																		
Preparing the poster.																		
Poster Presentation.																		
Testing																		
Testing the final circuit.																		
Documentation																		
Preparation of the black book																		

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Signatures of all the students in the group

(Lenin Fonseca)

(Vinit Gaikar)

(Arunlal Gupta)

(Rollins Miranda)

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