PACING SYSTEM FOR SWIMMERS

A Thesis Submitted to

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Towards the partial fulfillment of the Degree of

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Submitted by:
Rahul Garg
(0801EC151049)
Shivang Bakode
(0801EC151066)
Aaditya Patel
(0801EC151001)
Ujjawal Mishra
(0801EC151080)

Guided by:
Prof. Manish Panchal
Prof. Anurag Shrivastava

Department of Electronics and Telecommunication Engineering
Shri G. S. Institute of Technology and Science Indore - 452003 (M.P.)
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SHRI G.S. INSTITUTE OF TECHNOLOGY AND SCIENCE
INDORE

RECOMMENDATION

This thesis entitled, **"Pacing System For Swimmers"**, submitted to the Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, by **Rahul Garg, Shivang Bakode, Aaditya Patel, Ujjawal Mishra** during the academic year **2018-2019** as a partial fulfillment for the award of the degree of **Bachelor of Engineering** in **Electronics and Telecommunication Engineering**, is a record of student's own work carried out by them under our direct supervision, in the **Department of Electronics and Telecommunication Engineering, S.G.S.I.T.S.** Indore.

The work contained in the thesis is a satisfactory account of his project work and is recommended for the award of the degree.

Prof. Manish Panchal **Prof. Anurag Shrivastava**

(Guide) **(Guide)**

Prof. Shekhar Sharma

(Head of Department)

Electronics and Telecommunication Engineering

SHRI G.S. INSTITUTE OF TECHNOLOGY AND SCIENCE, INDORE

CERTIFICATE

This is to certify that the thesis entitled **"Pacing System For Swimmers"**, submitted to the Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, by **Rahul Garg, Shivang Bakode, Aaditya Patel, Ujjawal Mishra** during the academic year **2018-2019**, is a record of their own work and is accepted in the partial fulfillment for the award of the degree of **Bachelor of Engineering** in **Electronics and Telecommunication Engineering**.

Internal Examiner **External Examiner**

Date: Date:

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Rahul Garg
Shivang Bakode
Aaditya Patel
Ujjawal Mishra

ABSTRACT

The purpose of our project is to create an affordable underwater pacing system that can allow swimmers to train faster and better. This project will also add a lot of flexibility and customization for the training as input by the user. We are interested in this light strip because it will be designed as a standalone device that will not interfere with the swimmer in any way yet display a clear signal for the swimmer to train with. We have focused on creating a device that is useable, rugged and safely contained. The LED strip will be placed on the floor of the swimming pool which will help the user to track himself or to maintain the pace. The aim is to increase the efficiency of swimmer and the LED strip will be programmed to maintain the pace and it will be programmed in such a way that the swimmer can take it as a reference.

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LIST OF ABBREVIATIONS

AC	**A**lternating **C**urrent
DC	**D**irect **C**urrent
HMI	**H**uman **M**achine **I**nterface
IP	**I**ngress **P**rotection
LED	**L**ight **E**mitting **D**iode
PWM	**P**ulse **W**idth **M**odulatio
RGB	**R**ed **G**reen **B**lue

LIST OF SYMBOLS

C	Cipher Text
D	Dealer
D_K	Decryption Algorithm
E_K	Encryption Algorithm
g	Generator Polynomial Integer
$h(P)$	Hash Function
K_{AB}	Symmetric Key between A and B
K_A^{Pr}	Private Key Of Principle A
K_A^{Pu}	Public Key Of Principle A
$MAC_k(M)$	Message Authentication Code
N	Nonce a number to be used once
N_A	Nonce of a participant or principle
P	Plain Text
Pr	Probability
S	Secret
$SIG(M)$	Signature of message M
X_i	Input Plain text Stream
Y_i	Output Cipher text Stream
Z_i	Encryption key Stream
$\mathbf{k}$	Boltzman Constant

Chapter 1

Introduction

1.1 Neccesity

The project "Pacing System For Swimmers" would play an important role in the swimming arena. The purpose is to create an affordable underwater swim pacing device that can allow swimmers to train in different modes of operation. The

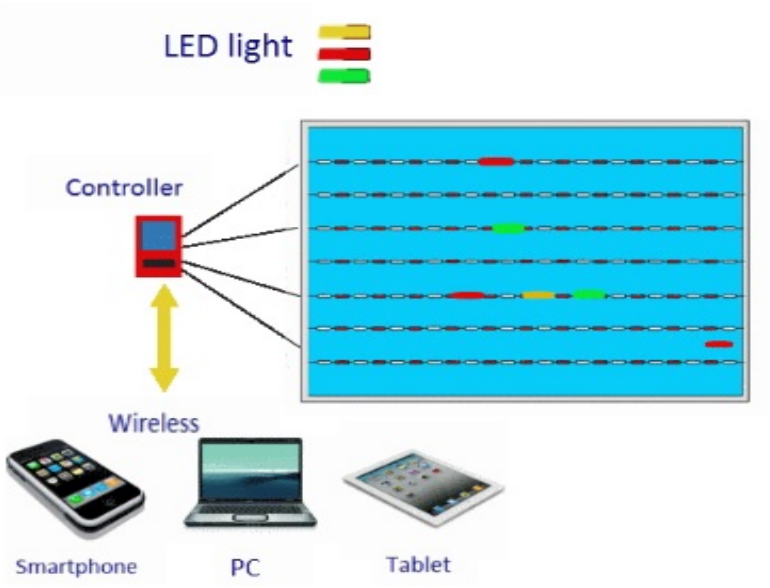

FIGURE 1.1:
Pacing System For Swimmers

project will also add a lot of flexibility and customization for the training as input by the user.Light strip is preferred because it will used as a standalone device that will not interfere with the swimmer in any way yet display a clear signal for the

swimmer to train with. We have focused on creating a device that is use able, rugged and safely contained.

1.2 Function

The primary function of the "Pacing System" is to guide different swimmers in the stay along a specific direction and to time their movement and pacing.This allows them to monitor their performance on real time basis and criticial evaluation of their speed.
The primary functions include:
1. Power converter from AC to DC for safe and constant electric supply.
2. Output function to a digital file/format for record and analysis.
3. Input function via keypad for user-controlled times of the lights.
4. Extendable to be functional in larger pool sizes.
5. Indicator lights to display current mode.

1.3 Advantages

Visual pacing allows swimmer to chase a time, which is much more effective than vibration or audio based pacing devices.
1. Allows user to input second-specific training intervals and speeds
2. Able to be used in different modes for different styles of training
3. Displays and exports data for swimmer lap times
4. Can be manually overridden by user to flash lights
5. Visual-based swim pacing allows user to physically chase and
6. Easy to setup in environment
7. Affordable compared to current visual swim-pacing alternatives

1.4 Features

1. Lights submergible up to 2 meters
2. Export times to digital file

3. Small light spacing for more precise light motion
4. High LED density for increased visibility

Chapter 2

Literature Review

2.1 What is IP (Ingress Protection)?

Almost everything used today has an IP rating, from cameras to phone cases and of course LED Strip lights. The acronym IP stands for Ingress Protection.IP ratings are intended to provide the end-user of a product with a classification that has more meaning than the term waterproof. The ratings indicate the level of protection provided against dust intrusions, accidental contact with dust, and water by mechanical casings and electrical enclosures. The first number from the

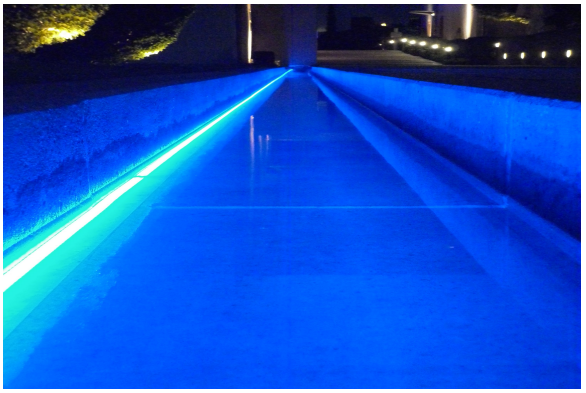

FIGURE 2.1:
Underwater LED

IP rating goes from 0-6 and it classifies how dust resistant the enclosure really is. The number zero means that it has no protection against contact and ingress of objects and the number 6 means its dust tight. The second number of the IP rating ranges from 0-9 and it stands for liquid ingress protection. Zero means that

it is not protected and 9 or 9K is protected against close-range high pressure, high temperature spray downs.

In a nutshell the IP rating is a key component in deciding which product is right for your application.

2.2 IP68 Waterproof LED Light Strip

The IP68 version means the ingress protection is dust tight (number 6) just like our IP67 LED Strip. The number 8 means that it is suitable for continuous immersion in water. It means that the LED Strip is hermetically sealed and can be immersed underwater for a certain amount of time.

This strip is great for fountains or pool decor allowing you to have strong vivid LED lighting effects where you thought it impossible. This strip has the highest ingress protection rating for our LED Strips. Theres an option betweensingle density and double density strips and it comes in a 5M (16.4ft) reel.

2.3 Operation of LED under water

Unlike other sport workouts, swimmers have a hard time accurately and professionally monitoring their training session in real time. Swimmers are currently required not only to focus on the actual training session, but also on measuring times and calculating distances.
Millions of swimmers around the world complete their training sessions with the unanswered questions - Did I improve? How far did I swim? How effective was my workout? What are the next training sessions goals? How do I compare with my friends?
The workout suffers in three ways -
1. In the ability to obtain better results in real time.
2. In the motivation to persevere with the training program.
3. In the sense of accomplishment at the end of the training session.

Our system will help your swimmers not only FEEL but SEE how they are performing in real time. This allows the swimmers to see how changes to stroke, body position and many other factors affect their ability to stay on pace.

Developed with cooperation, input, and feedback from some of the most well known and respected swim coaches in the world. Our system is designed to make workouts more fun and productive, while also providing instant feedback to the swimmers and coaches.Our system will help get the best out of your team and swimmers! "Follow the Light!"
Using your smart phone or tablet (iPhone, iPad or Android) you control LED lights placed on the bottom of the pool. The lights guide the swimmers through a complete workout and provide immediate and effective feedback, freeing up the coach and swimmers to concentrate on technique and efficiency without the need to watch the clock – if the swimmers are staying with the lights, they are on pace. In addition, the system has been developed so that you can set up and run special "games" and "drills": flag-to-flag work, time-to-distance, breakouts, relay starts, tempo training and much more. The system is portable and available for any length pool, and for multiple lanes.

2.4 Addressable RGB 60-LED Strip, 5V, 2m (WS2812B)

2.4.1 Overview

FIGURE 2.2:
LED WS2812B

These flexible RGB LED strips are an easy way to add complex lighting effects to a project. Each LED has an integrated driver that allows you to control the color and brightness of each LED independently. The combined LED/driver IC on

these strips is the extremely compact WS2812B (essentially an improved WS2811 LED driver integrated directly into a 5050 RGB LED), which enables higher LED densities.

In contrast to the APA102C used in some of our other similar LED strips, which uses a standard SPI interface (with separate data and clock signals), the WS2812B uses a specialized one-wire control interface and requires strict timing.

2.4.2 Features and specifications

1. Individually addressable RGB LEDs (30, 60, or 144 LEDs per meter).
2. 24-bit color control (8-bit PWM per channel); 16.8 million colors per pixel.
3. One-wire digital control interface.
4. 5 V operating voltage.
5. Each RGB LED draws approximately 50 mA at 5 V with red, green, and blue at full brightness.
6. 12 mm width, 4.6 mm thickness.
7. Flexible, waterproof silicone rubber sheath (IP65 protection rating).
8. Includes flexible silicone mounting brackets.
9. Black strip color.
10. Power/data connectors on both strip ends for easy chaining, and the input side includes an additional power and ground wire for alternate power connections.
11. Strips can be cut apart along the lines between each RGB LED segment to separate them into usable shorter sections.

2.5 Using the LED strip

Each LED strip has three connection points: the input connector, the auxiliary power wires, and the output connector. The strip uses 3-pin JST SM connectors.

The input connector has three male pins inside of a plastic connector shroud, each separated by about 0.1. The black wire is ground, the green wire is the

signal input, and the red wire is the power line.
The auxiliary power wires are connected to the input side of the LED strip and consist of stripped black and red wires. The black wire is ground, and the red wire is the power line. This provides an alternate (and possibly more convenient) connection point for LED strip power.
The output connector is on the other end of the strip and is designed to mate with the input connector of another LED strip to allow LED strips to be chained. The black wire is ground, the green wire is the signal output, and the red wire is the power line.
All three black ground wires are electrically connected, and all three red power wires are electrically connected.

2.6 Included hardware

These LED strips ship with flexible silicone brackets and screws. Strips with lengths of 1 meter or greater include five brackets and ten screws per meter. Our 0.5 meter high-density strip ships with a total of two brackets and four screws. The brackets fit over the waterproof sheath and can be used to mount the LED strip. The LED strip also ships on a plastic reel.

Chapter 3

Problem Formulation

3.1 Objective

To build a Pacing System for Swimmers which will provide a Real Time Feedback and Guidance to swimmers during Swimming Training.

3.2 Problem Statement

3.2.1 Overview

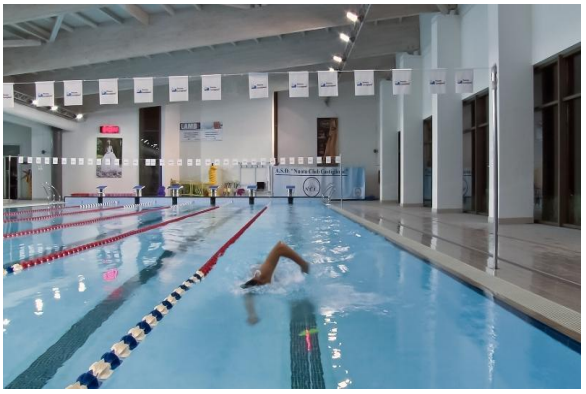

FIGURE 3.1:
Swimmer Training

Runners or Cyclists, who are similar types of athletes, have an advantage over swimmers because they can always keep track of their training pace with the use

of stop watch on wrist or cycling computer on handlebar or LED Clocks on ground / track which let them know of exact pace. Swimmers when they train in water do not have any Real Time feedback while they practice.Swimmers complete their set distance, which may be 100m, 200m or 400m, stop at the wall and then only they come to know what time they clocked either by looking at a timing display at deck from Coachs stop watch. They do not know during the swim whether they are on optimum pace or off pace and by what difference.

3.3 Challenges

3.3.1 Hardware Challenge

1. What is needed is to connect (using water proof connectors) these 5m sections to make 25m or 50m length in a manner which will have sufficient mechanical strength to withstand frequent laying and withdrawing from water when not in use.
2. Ensure proper power supply to longer sections maintaining the waterproof rating of IP68
3. Some weights or other mechanism to keep these LED strips at the bottom of pool securely
4. Make whole arrangement slim in footprint so as to create no obstruction for the swimmer

3.3.2 Programming Challenge

1. To program the LEDs in a manner that it is easy to run the system with little training
2. Dynamic Pacing needed at the deck can be done with easy user interface
3. Communication with Controller unit through a Laptop or Smart Phone using WiFi
4. Capability of creating multiple pacing in single lane up to 10 swimmers per lane

Chapter 4

Proposed Methodology

4.1 Proposed Work

The overall Swim Pacer System takes user input indicating the desired swimming pace and produces an output in the form of a visual indicator which moves at the desired pace. The system also takes power as an input. The system consists of following major subsystems. The physical placement of the system includes a waterproof LED strip secured to the bottom of the pool. The power system will include a switch-mode power supply wired to a ground fault circuit interrupter wall outlet. The user interface will consist of a PCB connected to the system using Bluetooth. The control system will be a Arduino Based platform which performs the computations and algorithm for the system.

In this project we have used LED strips of IPV 68 which is a standard that shows water resistant elements. These LEDs operates at 12V and for the addressing and controlling purpose we are using Arduino Uno, which operates at 5V. Project basically uses 230 volts AC input, which will be stepped down to 12V by using an Adaptor. Now this 12V will be provided to the LED strip and also to the 5V regulating circuit, which will be connected to the controller, the parameters will be fed through the programming of controller and these parameters will be provided to the LED strip as all the LEDs in the strip are programmable so they will receive the power from the adapter and they will also receive the signal from the controller.

FIGURE 4.1: A Single LED (with IP68 Rating).

Above figure shows the LED used in our project, which is of IP68 rating and we have used it in our project. The IP68 version means the ingress protection is dust tight (number 6) just like our IP67 LED Strip. The number 8 means that it is suitable for continuous immersion in water. It means that the LED Strip is hermetically sealed and can be immersed underwater for a certain amount of time. This strip is great for fountains or pool decor allowing you to have strong vivid LED lighting effects where you thought it impossible. This strip has the highest ingress protection rating for our LED Strips. Theres an option between single density and double density strips and it comes in a 5M (16.4ft) reel (generally).

Now to accommodate mostly all the hardware used (like Power Supply, Phase lines, Ground lines etc.) in one board, PCB is designed which will be having connections from input (12V Adapter) to the output(5V controller). Adapter will be connected to the 220V input which will provide a output of 12V and hence for the further 5V requirement another power supply circuit will be implemented that will give the output of 5V, which will be feed to the controller i.e. Arduino Uno. And the LEDs will be given the inputs from the controller (for data) and from the 12V Adapter (for powering purpose). The data will be given to LEDs on the basis of programming and the speed of swimmer, distance from the next swimmer etc. will be feed through programming only.

4.2 Applications

Apart from helping swimmers to gear up their speed, this overall system can be useful in the monitoring purposes, searching operations, to make paths underwater and to observe and monitor diiferent different parameters. It can also be helpful in underwater sports to ensure zero casuality it can be helpful by applying different sensors it can be used for many purposes.

Chapter 5

Hardware Implementation

5.1 Components Used

1. ATtiny85
2. Buck Converter
3. DC Jack male
4. MC34063
5. LED Strip WS2812b
6. RLC Components

5.1.1 ATtiny85

The ATtiny85 is a microcontroller in a similar vein to the Arduino, but with much less IO pins, smaller memory and a smaller form factor. In fact, when we talk about the ATtiny85 we refer to the IC itself rather than the board. The ATtiny85 can be used as a bare chip on a breadboard, as long as you can supply the correct power for the device. But most commonly the ATtiny85 is supplied with a USB interface, either a full USB port such as the DigiStump Digispark or micro USB via a cloned board commonly found on Aliexpress / Banggood etc.

Despite the small package, the ATtiny85 comes with a remarkable number of ways in which we can interface. At the most basic level, we have 5V logic digital I/O

Parametrics

Name	Value
Program Memory Type	Flash
Program Memory Size (KB)	8
CPU Speed (MIPS/DMIPS)	20
SRAM Bytes	512
Data EEPROM/HEF (bytes)	512
Digital Communication Peripherals	1-SPI, 1-I2C
Capture/Compare/PWM Peripherals	5PWM
Timers	2 x 8-bit
Number of Comparators	1
Temperature Range (C)	-40 to 85
Operating Voltage Range (V)	1.8 to 5.5
Pin Count	8

TABLE 5.1: Parameters and their respected values for the given controller.

pins, three of which can also be used as analog pins for use with components such as the TMP36 sensor. Four of the available pins can also be used with Pulse Width Modulation (PWM). Also available is I2C and SPI for use with other types of sensors and devices.

5.1.2 Buck Converter

The Buck Converter is used in SMPS circuits where the DC output voltage needs to be lower than the DC input voltage. The DC input can be derived from rectified AC or from any DC supply. It is useful where electrical isolation is not needed between the switching circuit and the output, but where the input is from a rectified AC source, isolation between the AC source and the rectifier could be provided by a mains isolating transformer.

The switching transistor between the input and output of the Buck Converter continually switches on and off at high frequency. To maintain a continuous output, the circuit uses the energy stored in the inductor L, during the on periods of the switching transistor, to continue supplying the load during the off periods. The circuit operation depends on what is sometimes also called a

Flywheel Circuit. This is because the circuit acts rather like a mechanical flywheel that, given regularly spaced pulses of energy keeps spinning smoothly (outputting energy) at a steady rate.

1. AC or DC Input

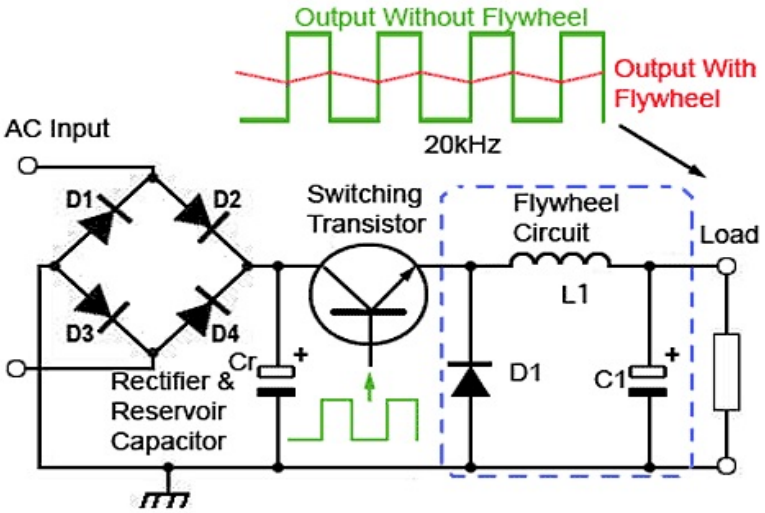

FIGURE 5.1: Basic block diagram of Buck Converter.

The buck converter is a form of DC to DC converter that can take an input directly from a DC source, such as a battery. The input could also be DC derived from the AC mains (line) as shown in Fig. 3.1.1 via a rectifier/reservoir capacitor circuit. The AC input to the rectifier circuit could be AC at high voltage directly from the AC mains supply, or alternatively at a lower voltage via a step down transformer. However the DC applied to the Buck Converter is obtained, it is then converted to a high frequency AC, using a switching or chopper transistor, driven by a (usually pulse width modulated) square wave. This results in a high frequency AC wave, which can then be re-converted to DC in a much more efficient manner than would be possible in the circuits described in Power Supplies Module 1. **2. Buck Converter Operation** The buck Converter circuit consists of the switching transistor, together with the flywheel circuit (Dl, L1 and C1). While the transistor is on, current is flowing through the load via the inductor L1. The action of any inductor opposes changes in current flow and also acts as a store of energy. In this case the switching transistor output is prevented from increasing immediately to its peak value as the inductor stores energy taken from the increasing output; this stored energy is later released back into the circuit as a back e.m.f. as current from the switching transistor is rapidly switched off.

3. Transistor Switch on Period

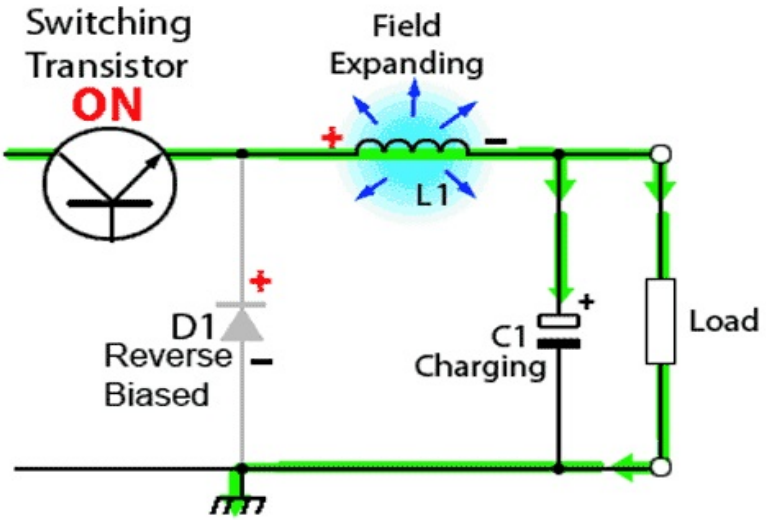

FIGURE 5.2: Switch On mode.

In Fig. 3.1.2 therefore, when the switching transistor is switched on, it is supplying the load with current. Initially current flow to the load is restricted as energy is also being stored in L1, therefore the current in the load and the charge on C1 builds up gradually during the on period. Notice that throughout the on period, there will be a large positive voltage on D1 cathode and so the diode will be reverse biased and therefore play no part in the action.

4. Transistor Switch off Period

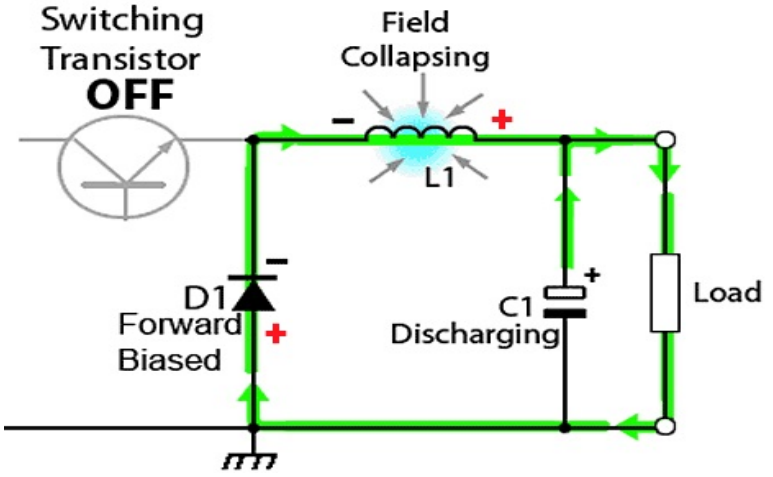

FIGURE 5.3: Switch off mode

When the transistor switches off as shown in Fig 3.1.3 the energy stored in the magnetic field around L1 is released back into the circuit. The voltage across the inductor (the back e.m.f.) is now in reverse polarity to the voltage across L1 during the on period, and sufficient stored energy is available in the collapsing magnetic field to keep current flowing for at least part of the time the transistor switch is open.

The back e.m.f. from L1 now causes current to flow around the circuit via the load and D1, which is now forward biased. Once the inductor has returned a large part of its stored energy to the circuit and the load voltage begins to fall, the charge stored in C1 becomes the main source of current, keeping current flowing through the load until the next on period begins.

The overall effect of this is that, instead of a large square wave appearing across the load, there remains only a ripple waveform, i.e. a small amplitude, high frequency triangular wave with a DC level of:

VOUT = VIN x (On time of switching waveform (tON) / periodic time of switching waveform(T))

Therefore if the switching waveform has a mark to space ratio of 1:1, the output VOUT from the buck Converter circuit will be VIN x(0.5/1) or half of VIN. However if the mark to space ratio of the switching waveform is varied, any output voltage between approximately 0V and VIN is possible.

5.1.3 DC connector

A DC connector (or DC plug, for one common type of connector) is an electrical connector for supplying direct current (DC) power.Compared to domestic AC power plugs and sockets, DC connectors have many more standard types that are not interchangeable. The dimensions and arrangement of DC connectors can be chosen to prevent accidental interconnection of incompatible sources and loads. Types vary from small coaxial connectors used to power portable electronic devices from AC adapters, to connectors used for automotive accessories and for battery packs in portable equipment.

5.1.4 MC34063

MC34063 has a high current output switch, Pulse Width Modulation (PWM) controller with current limiting, compensated reference of internal temperature, a comparator and a driver.

For the inverting, boost and buck applications there is no need of a huge complicated external components, instead they can be performed using minimum external components. MC 34063 operates properly in the temperature ranging from 0 to 70 degree celsius. MC34063 ha s wide range of applications in real life e.g. portable equipment, Human Machine Interface (HMI), test and measurement, telecommunications, computing and consumer, cable solutions etc. MC34063 is basically a monolithic control circuit having all the functions required for the construction of DC to DC converters i.e. buck converter, boost converter or inverters etc. It consists of multiple functions, which are:

1. Comparator.
2. Oscillator.
3. High current output switch.
4. Active Peak Current Limit.

The current, voltage and power ratings of MC 34063 are shown in the table given below:

MC34063 Maximum Ratings				
No.	**Parameter**	**Symbol**	**Value**	**Unit**
1	Power Supply Voltage	Vcc	40	V
2	Comparator Input Voltage Range	Vir	-0.3 to +40	V
3	Switch Collector Voltage	Vc(switch)	40	V
4	Switch Emitter Voltage	Ve(switch)	40	V
5	Switch Collector to Emitter Voltage	Vce(switch)	40	V
6	Driver Collector Voltage	Vc(driver)	40	V
7	Driver Collector Current	Ic(driver)	100	mA
8	Switch Current	Isw	1.5	A

TABLE 5.2: PWM Controller Ratings.

1. MC34063 Pinout These packages of MC 34063 has eight (8) pins each. Each of these pins along with its name is shown in the table given below:

MC34063 Pinout	
Pin No.	**Pin Name**
1	Switch Collector
2	Switch Emitter
3	Timing Capacitor
4	Ground (GND)
5	Comparator Inverting Input
6	Voltage (Vcc)
7	Ipk
8	Driver Collector

TABLE 5.3: Pin Description of MC34063(1)

2. MC34063 Pins Configuration

MC 34063 pins configuration along with the functions associated each of the pin is provided shown in the table.

MC34063 Pinout		
Pin No	**Package Name**	**Description**
1	Switch collector	High current internal switch collector input
2	Switch emitter	High current internal switch emitter output
3	Timing capacitor	Attaching a time capacitor to vary switching frequency
4	Ground (GND)	Ground (GND)
5	Comparator inverting input	Attach a resistor divider network to build feedback loop
6	Voltage (Vcc)	Logic supply voltage
7	Ipk	Current limit sense input
8	Driver collector	Darlington pair driving transistor collector input

TABLE 5.4: Pin Specifications of MC34063(2).

3. MC34063 Packages

MC 34063 has different packages, a few of which are shown in the table given below:

MC34063 Packages			
Sr. No	Package Name	Dimensions	Unit
1	PDIP (8)	9.81×6.35	mm
2	SOIC (8)	4.9×3.91	mm
3	SON (8)	4×4	mm

TABLE 5.5: Packaging Information about MC34063.

The three packages including PDIP, SOIC and SON along with their dimensions are shown in the table.

4. MC34063 Features

The different features associated with MC 34063 are provided in the table shown below:

MC34063 Features	
Feature No	Description
1	Adjustable output voltage
2	Short circuit current limiting
3	Oscillator frequency around 100kHz
4	Low standby current
5	Precision internal reference 2%
6	High output switch current

TABLE 5.6: Features of MC34063.

The description of the features associated with the device MC 34063 are provided in chronological order are shown in the table .

5. MC34063 Applications

There are a lot of applications associated with MC34063, a few of which are given below:

- Human Machine Interfaces (HMI).
- Portable devices.
- Measurement and test.
- Gas and blood analyzer.
- Consumer
- Computing
- Telecommunications.
- Cable solutions.

5.1.5 LED Strip WS2812b

Each LED has an integrated driver that allows you to control the color and brightness of each LED independently. The combined LED/driver IC on these strips is the extremely compact WS2812B (essentially an improved WS2811 LED driver integrated directly into a 5050 RGB LED), which enables higher LED densities. In the picture on the right, you can actually see the integrated driver and the bonding wires connecting it to the green, red, and blue LEDs, which are on at their dimmest setting.

Features and specifications:

- Individually addressable RGB LEDs (30, 60, or 144 LEDs per meter)
- 24-bit color control (8-bit PWM per channel); 16.8 million colors per pixel
- One-wire digital control interface
- 5 V operating voltage

- Each RGB LED draws approximately 50 mA at 5 V with red, green, and blue at full brightness
- 12 mm width, 4.6 mm thickness
- Flexible, waterproof silicone rubber sheath (IP65 protection rating)
- Includes flexible silicone mounting brackets
- Black strip color
- Power/data connectors on both strip ends for easy chaining, and the input side includes an additional power and ground wire for alternate power connections
- Strips can be cut apart along the lines between each RGB LED segment to separate them into usable shorter section

Each LED strip has three connection points: the input connector, the auxiliary power wires, and the output connector. These can be seen in the adjacent picture, from left to right: auxiliary power wires, input connector, output connector. The strip uses 3-pin JST SM connectors.

The input connector has three male pins inside of a plastic connector shroud, each separated by about 0.1. The black wire is ground, the green wire is the signal input, and the red wire is the power line.

The auxiliary power wires are connected to the input side of the LED strip and consist of stripped black and red wires. The black wire is ground, and the red wire is the power line. This provides an alternate (and possibly more convenient) connection point for LED strip power.

The output connector is on the other end of the strip and is designed to mate with the input connector of another LED strip to allow LED strips to be chained. The black wire is ground, the green wire is the signal output, and the red wire is the power line.

All three black ground wires are electrically connected, and all three red power wires are electrically connected.

Chapter 6

Software Used

6.0.1 Eagle

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. EAGLE stands for Easily Applicable Graphical Layout Editor (German: Einfach Anzuwendender Grafischer Layout-Editor) and is developed by CadSoft Computer GmbH.EAGLE 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.

The PCB layout editor stores board files with the extension .BRD. It allows back-annotation to the schematic and auto-routing to automatically connect traces based on the connections defined in the schematic.

EAGLE saves Gerber and PostScript layout files as well as Excellon and Sieb Meyer drill files. These are standard file formats accepted by PCB fabrication companies, but given EAGLE's typical user base of small design firms and hobbyists, many PCB fabricators and assembly shops also accept EAGLE board files (with extension .BRD) directly to export optimized production files and pick-and-place data themselves.

EAGLE provides a multi-window graphical user interface and menu system for editing, project management and to customize the interface and design

parameters. The system can be controlled via mouse, keyboard hotkeys or by entering specific commands at an embedded command line. Multiple repeating commands can be combined into script files (with file extension .SCR). It is also possible to explore design files utilizing an EAGLE-specific object-oriented programming language (with extension .ULP).

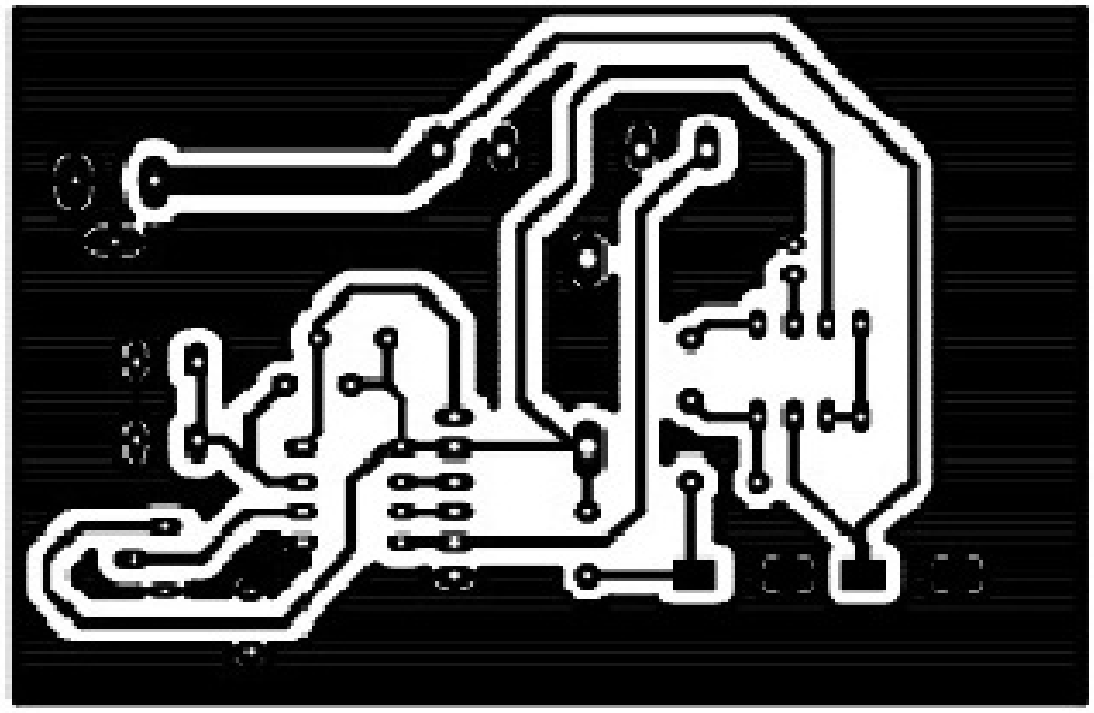

FIGURE 6.1: PCB Layout.

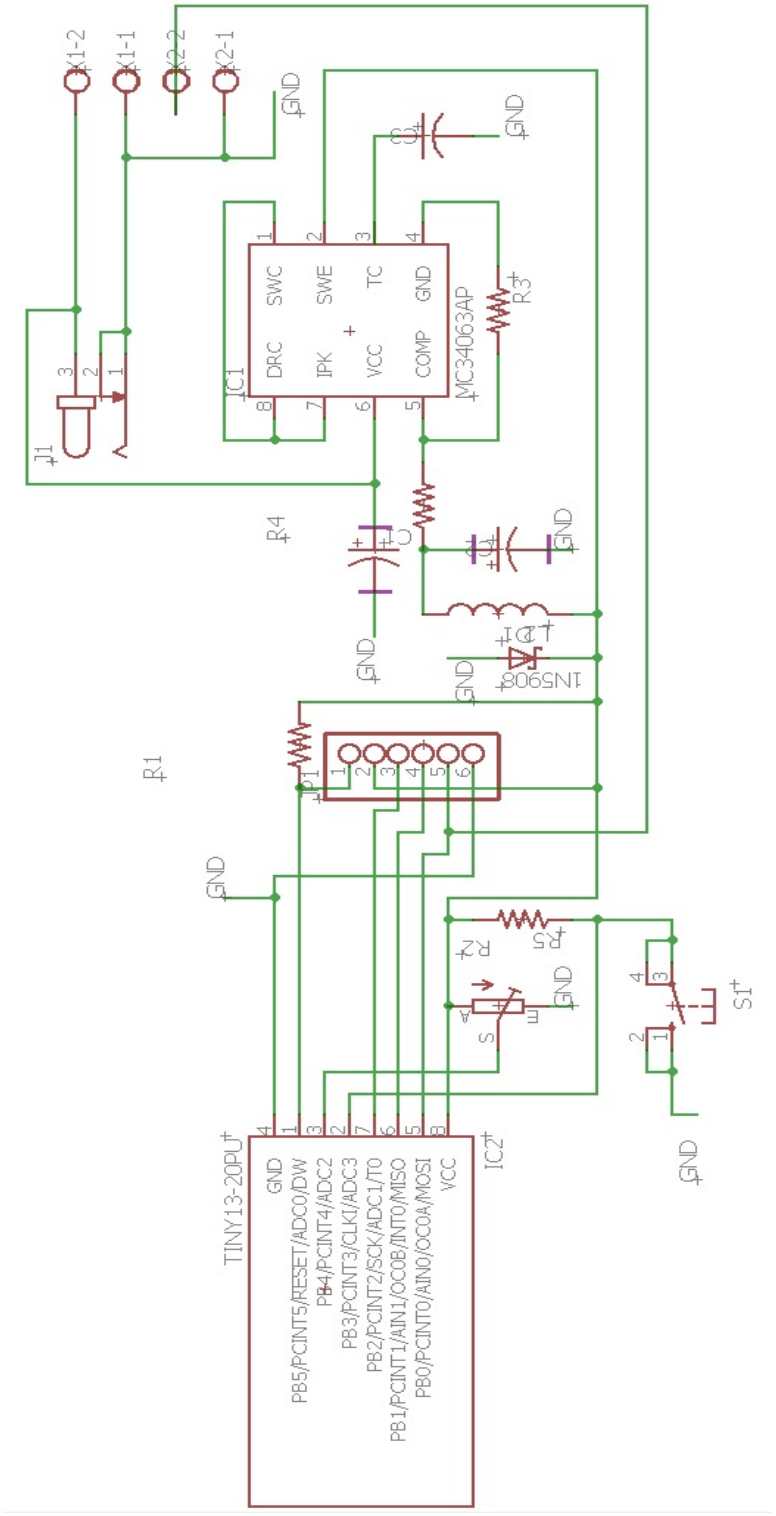

FIGURE 6.2: Schematic View.

6.0.2 Arduino Program

```
#include <Adafruit_NeoPixel.h>

// Since we are using Attiny with arduino
#ifdef __AVR__
  #include <avr/power.h>
#endif

// PB0(0th) pin is used for signal generation of WS2812b
#define PIN 0
// PB4(A2) pin is used to control paceof swimmer with help potentiometer
#define APIN A2
// PB3(3rd) pin is used as counter to take number of persons as Input
#define DPIN 3



// How many NeoPixels are attached to the Arduino?
#define NUMPIXELS 60
// When we setup the NeoPixel library, we tell it how many pixel
// Note that for older NeoPixel strips you might need to change the third
parameter see the strandtest
// example for more information on possible values.
Adafruit_NeoPixel pixels = Adafruit_NeoPixel(NUMPIXELS, PIN,
NEO_GRB + NEO_KHZ800);

// Variable for storing analog value from potentiometer
int analogValue = 0;
// Holds the number of persons currently swimming
int PERSON = 0;

void setup() {

  // Setting the clock for attiny85
  #if defined (__AVR_ATtiny85__)
    if (F_CPU == 16000000) clock_prescale_set(clock_div_1);
```

```
  #endif

  // Interrupt attached with PB3 to track number of persons
  attachInterrupt(digitalPinToInterrupt(DPIN), count, RISING);
  // This initializes the NeoPixel library.
  pixels.begin();

}

void loop()
{
  // Reading the value from PB4 and using it for delay by scaling it with 17
  analogValue = analogRead(APIN);

  // Clearing the Previous data or pattern
  for(int i=0;i<NUMPIXELS;i++)
  {
    pixels.setPixelColor(i, pixels.Color(0,0,0));
    pixels.show();
  }

  for(int i=0;i<NUMPIXELS*2+PERSON*7;i++)
  {
    for(int j=0;j<PERSON;j++)
    {
      if(i<NUMPIXELS+PERSON*4
      )
      {
        switch(j)
        {
    case 0:
pixels.setPixelColor(i-7*j,pixels.Color(0,0,255));
Moderately bright green color.
pixels.setPixelColor(i-7*j-2,pixels.Color(0,0,0));
Moderately bright green color.
pixels.show();
```

```
break;
case 1:
pixels.setPixelColor(i-7*j,pixels.Color(0,255,0));
Moderately bright green color.
pixels.setPixelColor(i-7*j-2,pixels.Color(0,0,0));
Moderately bright green color.
pixels.show();
break;
case 2:
pixels.setPixelColor(i-7*j,pixels.Color(255,0,0));
Moderately bright green color.
pixels.setPixelColor(i-7*j-2,pixels.Color(0,0,0));
Moderately bright green color.
pixels.show();
break;
        }
        delay(analogValue/17);
      }
      else
      {
        switch(j)
        {
 case 0:

pixels.setPixelColor(NUMPIXELS*2-i+7*j+PERSON*4, pixels.Color(0,0,255));
 Moderately bright green color.
 pixels.setPixelColor(NUMPIXELS*2-i+7*j+2+PERSON*4, pixels.Color(0,0,0));
Moderately bright green color.
pixels.show();
break;

case 1:

pixels.setPixelColor(NUMPIXELS*2-i+7*j+PERSON*4, pixels.Color(0,255,0));
Moderately bright green color
pixels.setPixelColor(NUMPIXELS*2-i+7*j+2+PERSON*4, pixels.Color(0,0,0));
```

```
Moderately bright green color.
pixels.show();
break;

case 2:

pixels.setPixelColor(NUMPIXELS*2-i+7*j+PERSON*4,pixels.Color(255,0,0));
Moderately bright green color.
pixels.setPixelColor(NUMPIXELS*2-i+7*j+2+PERSON*4,pixels.Color(0,0,0));
Moderately bright green color.
pixels.show();
 break;
        }
        delay(analogValue/17);
      }
    }
  }

  // Clearing the curent data or pattern
  for(int i=0;i<NUMPIXELS;i++)
  {
    pixels.setPixelColor(i, pixels.Color(0,0,0));
    pixels.show();
  }
}

// Interrupt function for person count and
if person goes over 4 intialise it with 0
void count() {
  PERSON += 1;
  if(PERSON==4)
    PERSON = 0;
}
```

Chapter 7

Results and Conclusion

7.1 Results

For example : If a swimmer wants to pace himself/herself up and the swimmer is unable to recognize where he or she is lagging then in that case our designed system can help the swimmer to gear up their performance, simply by providing the required inputs to the system. In case of multiple swimmers, system can also be useful due to availability of multiple codes in the controller.

7.2 Conclusion

In short, the designed system can serve for both single user as well as for multiple users just by switching between the embedded codes in the controller by push buttons provided on the board, For pacing purpose required speed and dimensions of the pool and taken as input and the swimmer just has to follow the path shown by the LED strip at a speed governed by the glowing LEDs. For multiple swimmers these parameters can vary accordingly.

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