

PROJECT REPORT

ON

IoT Based Voice Controlled Autonomous Robo Car

**(In partial fulfillment of the requirements for the award of the degree of Bachelor of
Technology in Electronics & Communication Engineering
Maulana Abul Kalam Azad University of Technology)**

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**DEPARTMENT OF ELECTRONICS & COMMUNICATION
ENGINEERING**

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CERTIFICATE

This is to certify that the Seminar report entitled “**IoT Based Voice Controlled Autonomous Robo Car**” is a bonafied work carried out by

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in partial fulfillment of the requirement for the award of Bachelor of Technology in **ELECTRONICS & COMMUNICATION ENGINEERING** of the **MAULANA ABUL KALAM AJAD UNIVERSITY OF TECHNOLOGY, KOLKATA** during the year 2019-2020. It is certified that all corrections/suggestions indicated for internal assessments has been incorporated in the report deposited in the Department. The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for Bachelor of Engineering Degree.

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ABSTRACT

The purpose of robotics in commercial & residential intention has come to be quite essential for executing challenging work into more conveniently simple way. There are a lot of researches working on to enhance the connection between humans and robot. The paper presents the research of the designing & development of a voice controlled talking robot using mobile phone based on Arduino Uno microcontroller. The control system of the robot movement will be employed by the voice and the robot will response the commanding persons by generating sounds of human voice with each verbal instruction. The proposed system will be designed based on microcontroller which is connected to smart android phone through Bluetooth module for receiving voice command. The voice command is converted to text by an app of the android phone and sends necessary data to the microcontroller for controlling robot movement. After receiving the data the robot responses according to the command by performing proper movement to the proper direction according to the voice command. A SD card module along with a SD card which will consist some pre-recorded human voice as audio file will be used by the robot for the development of the robot's talking system. After getting each command the robot will act according to the instruction and will be able to speak different sentences.

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Introduction

The Internet of Things (IoT) is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. In simple words, Internet of Things (IOT) is an ecosystem of connected physical objects that are accessible through the internet.

The term “IoT” cannot be clarified without its working principle. IoT works with the help of four basic components: Application, Gateways, Processors and Sensors.

- 1) Application: The applications for internet connected devices are extensive. Multiple categorizations have been suggested, most of which agree on a separation between consumer, enterprise (business), and infrastructure applications. The ability to network embedded devices with limited CPU, memory and power resources means that IoT finds applications in nearly every field.
- 2) Gateways: An Internet of Things (IoT) Gateway provides the means to bridge the gap between devices in the field (factory floor, home, etc.), the Cloud, where data is collected, stored and manipulated by enterprise applications, and the user equipment (smart phones, tablets etc.). The IoT Gateway, provides a communication link between the field and the Cloud and can also offer local processing and storage capabilities to provide offline services and if required real time control over the devices in the field. C, Java, Python and some scripting languages are the preferable choices used by IoT applications.
- 3) Processor: A Processor performs basic operations in the data provided by the storage or memory. In IoT, the work of a processor is to process the code written in C or Java or in any programming language to a machine language which is uploaded to microcontroller boards like Arduino UNO, ESP8266, etc.

- 4) Sensors: IoT loses its distinction without sensors. In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer. Sensors are used in everyday objects which dim or brighten by touching the base, besides innumerable applications of which most people are never aware.

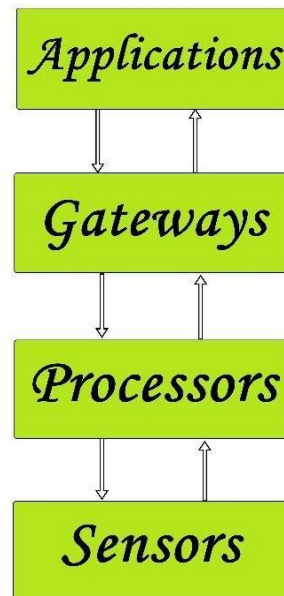


Fig 1.1 : Block diagram of IoT

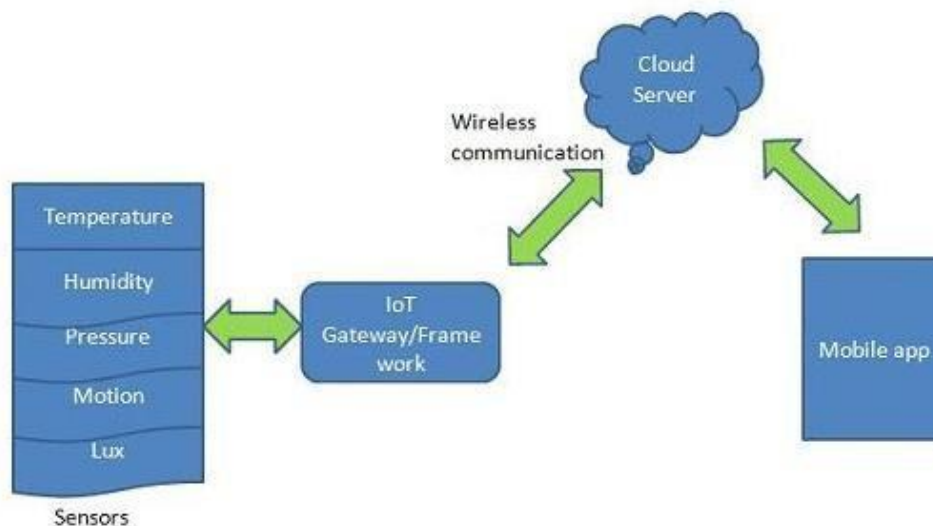


Fig 1.2: Basic IoT Architecture

2. Review of Literature

A. Voice Controlled Data Acquisition Car Based on Zigbee Technology Authors: Dinu Mathew

Description: The objective of the research is to design a voice controlled car and use it as a platform for obtaining feedback from a critically controlled environment. The system comprises of a user interface module and a Robocar. The user interface includes an electret microphone through which the voice commands will be accepted by the voice recognition chip (HM2007).

Microcontrollers (PIC16F877A) in the transmitting and receiving side controls the motion of Robocar. The control commands and data are transmitted and received using ZigBee (IEEE 802.15.4). Sensors and transducers are present in the Robocar for collecting application specific datas.

B. Voice control of dual-drive mobile robots-survey of algorithms

Publisher: IEEE

Description: Presents a survey of the algorithms applied to voice control of electromechanical appliances, especially voice controlled mobile robots or intelligent wheelchairs for handicapped people. The second part of the paper is devoted to voice recognition algorithms. Besides a short voice processing algorithms review, the need of voice recognition results verification method was pointed out. The method proposed by author is presented. In order to improve robotized-wheelchair operation safety and functionality, it is necessary to implement additional environment recognition sensors. Some issues concerning the ultrasonic sensors are referred to. The data acquired from the sensors can be used by obstacle avoidance and path planning algorithms. These categories of algorithms and methods are presented in fifth part of the paper. There is brief review of master control algorithms in the sixth section. In the last part the conclusions from the survey are listed.

3. System Description

This project describes the implementation of a voice-controlled robotic car using Arduino. In this project, the user gives specific voice commands to the robot through an Android app installed on the smart phone. At the receiving side, a Bluetooth transceiver module receives the commands and forwards them to the Arduino on the robotic car.

Arduino controls the movements of the robot according to received commands. The robot moves forwards, backwards, left and right, and stops according to the voice commands forward, backward, left, right and stop, respectively.

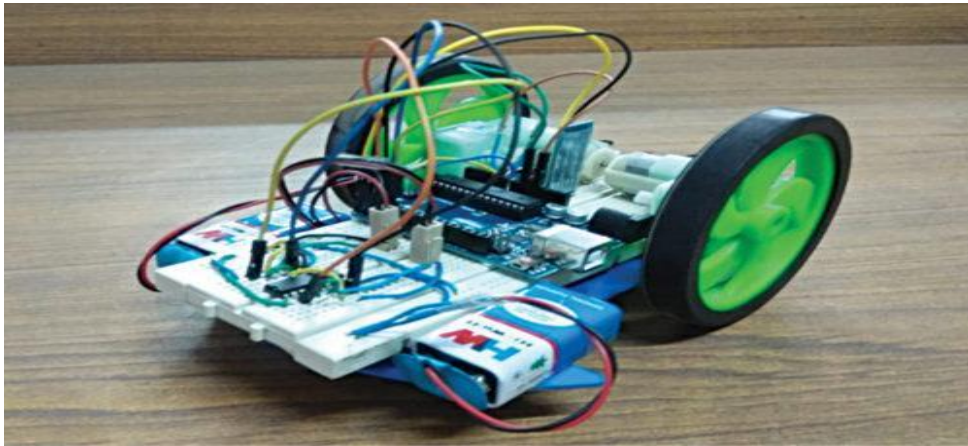


Fig. 3.1: Authors' prototype of the voice-controlled robotic car

FUNCTIONAL BLOCK DIAGRAM:

Given below is the block diagram for the overall connections between the different components used in making the autonomous voice controlled robo car. The L298N module is used to control the rotation of the motors on both sides of the car. The HC-05 module

captures the voice instructions which passes onto the L298N module via Arduino and the required operation is thus performed.

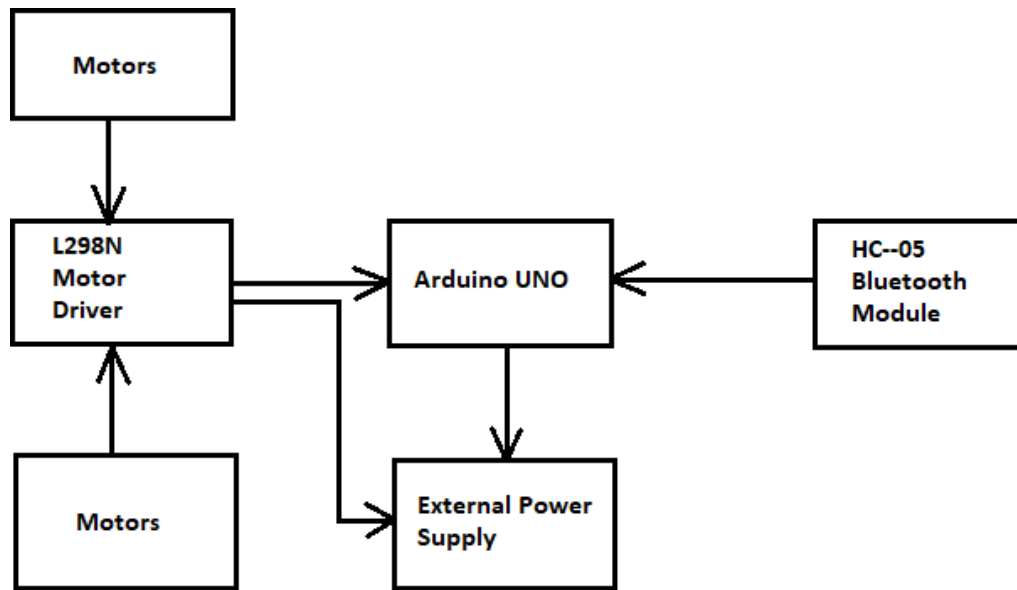


Fig 3.2: Block diagram of our project

HARDWARE REQUIREMENTS:

- 1) 1 Arduino UNO.
- 2) 1 HC-05 Bluetooth Module.
- 3) 1 L298N Motor Driver.
- 4) 1 Chassis.
- 5) 4 100 rpm Motor.
- 6) 4 Wheel.
- 7) Jumper Wires (for connection).
- 8) 1 12V DC power source.

HARDWARE SYSTEM:

a. Arduino UNO:

The **Arduino Uno** is an open source microcontroller board based on the Microchip Atmega 328P microcontroller. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino nano and Leonardo.



Fig 3.3 : Arduino UNO

b. HC-05 Bluetooth Module:

HC-05 module is an easy to use **Bluetooth SPP** (Serial Port Protocol) **module**, designed for transparent wireless serial connection setup. Serial port **Bluetooth module** is fully qualified **Bluetooth V2.0+EDR** (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband.

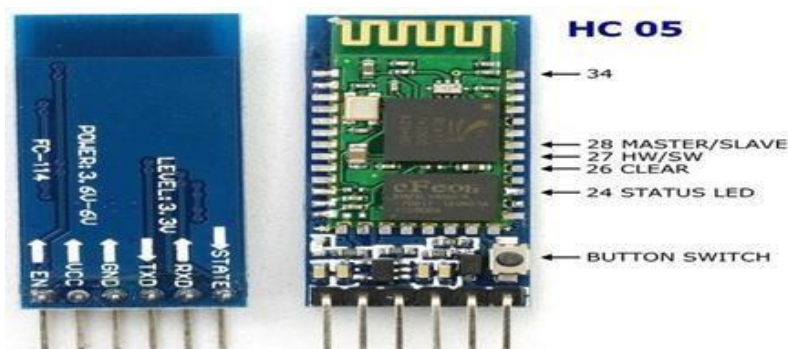


Fig 3.4: HC-05 Bluetooth Module

c. L298N Motor Driver:

The **L298N** is an integrated monolithic circuit in a 15- lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge de-signed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping **motors**.

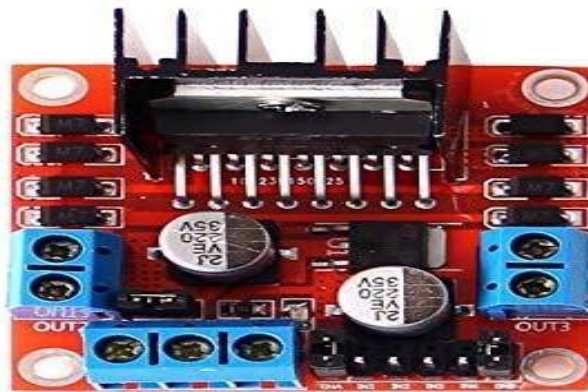


Fig 3.5: L298N Motor Driver

INTERNET PROTOCOLS:

A protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity. The protocol defines the rules, syntax and synchronization of communication and possible error recovery methods. Protocols may be implemented by hardware, software, or a combination of both. Protocols should therefore specify rules governing the transmission. In general, much of the following should be addressed:

- 1) Data formats for data exchange.
- 2) Address formats for data exchange.
- 3) Address mapping.
- 4) Routing.
- 5) Detection of transmission errors.
- 6) Acknowledgements.
- 7) Loss of information - timeouts and retries.
- 8) Direction of information flow.
- 9) Sequence control.
- 10) Flow control

TCP/IP:

The Transmission Control Protocol (TCP) is one of the main protocols of the Internet protocol suite. TCP/IP, or the Transmission Control Protocol/Internet Protocol, is a suite of communication protocols used to interconnect network devices on the internet. TCP/IP can also be used as a communications protocol in a private network (an intranet or an extranet). The Transmission Control Protocol provides a communication service at an intermediate level between an application program and the Internet Protocol. It provides host-to-host connectivity at the Transport Layer of the Internet model.

- **UDP:**

UDP (User Datagram Protocol) is an alternative communications **protocol** to Transmission Control **Protocol** (TCP) used primarily for establishing low-latency and loss-tolerating connections between applications on the internet.

UDP is suitable for purposes where error checking and correction are either not necessary or are performed in the application; UDP avoids the overhead of such processing in the protocol stack. Time-sensitive applications often use UDP because dropping packets is preferable to waiting for packets delayed due to retransmission, which may not be an option in a real-time system.

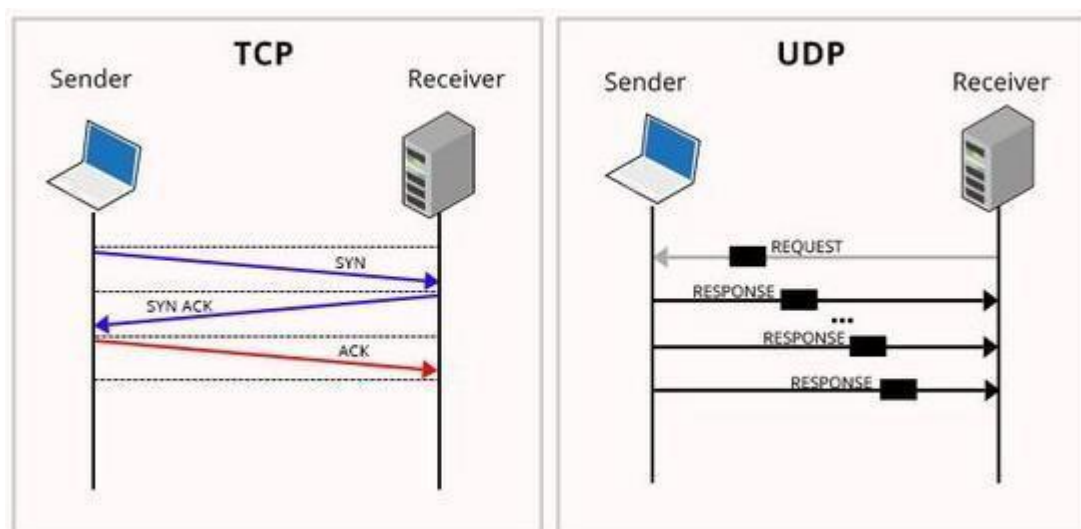


Fig 3.6 : TCP vs UDP communication.

4. Operation

This project describes the implementation of a voice-controlled robotic car using Arduino. In this project, the user gives specific voice commands to the robot through an Android app installed on the smart phone. At the receiving side, a Bluetooth transceiver module receives the commands and forwards them to the Arduino on the robotic car.

Arduino controls the movements of the robot according to received commands. The robot moves forwards, backwards, left and right, and stops according to the voice commands forward, backward, left, right and stop, respectively. Text received via Bluetooth is forwarded to Arduino Uno board using UART serial communication protocol. Arduino program `voice_ctrl.ino` checks the text received and, if it is a matching string, Arduino controls the movements of the robot accordingly. HC-05 module is an easy-to-use Bluetooth Serial Port Protocol (SPP) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module has a fully-qualified Bluetooth V2.0+EDR (enhanced data rate) 3Mbps modulation with complete 2.4GHz radio transceiver and baseband. Pin description. HC-05 Bluetooth module has six pins, as detailed below.

Enable. When enable is pulled low, the module is disabled. This means the module will not turn on and will fail to communicate. When enable is left open or connected to 3.3V, the module is enabled, that is, it will remain on and communication will also take place.

Vcc. Supply voltage 3.3V to 5V.

Gnd. Ground pin.

Txd and Rxd. These pins act as UART interface for communication.

L293D motor driver. This is a dual H-bridge high-current motor driver IC. It is used here because digital pins of Arduino cannot source enough current to drive the motors of the robotic car. H-bridges are also useful in controlling the direction of rotation of a motor. Enable pins 1 and 9 of the IC, being active high, are connected to 5V. Four output pins of L293D IC are connected to motors M1 and M2 on the receiver side. Given below is the

circuit diagram of the project.

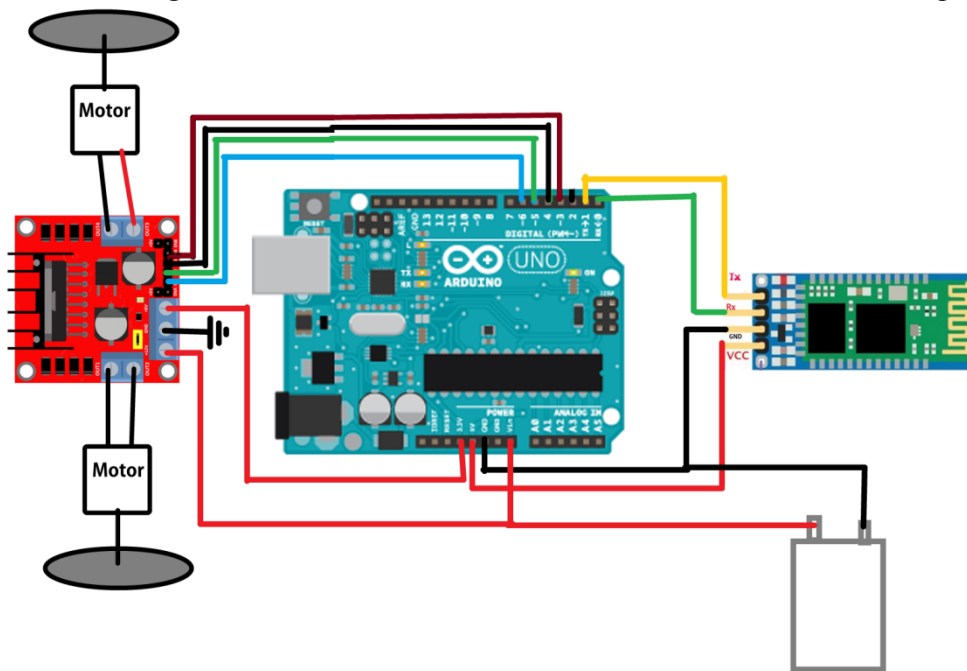


Fig 4.1: Circuit diagram of voice control robo car.

5. Result and Discussion

A. Speech Recognition Process & Movement of the Robot according to the Voice Command

By using the android app, the textual content was transmitted to the Arduino using Bluetooth through mobile phone handsets which had built-in microphones

to process the signal and the robot made movement according to voice command . The robot was able to move forward, backward, left and right according to the input given to L293D from Arduino Uno which gave input according to the command received from user. If user gave the voice command “autonomous” the robot started moving autonomously without hitting any obstacle. The avoidance of the obstacle was guided by the ultrasonic sensor which was able to sense the obstacle. Then it gave command to microcontroller to move in such a way so that the robot did not face any obstacle on its way.

B. Interaction with User by generating human voice recording

Speaking ability of the robot was developed using several prerecorded sound of human voice for different interactions and stored in SD card as wav file which were played through the amplifier circuit when any specific voice command was given. has ability to interact with its user using the prerecorded human voice file. For each command, different individual response’s audio files are recorded and stored as wav files on SD card. When user will command any instruction the robot will generate the related human voice as response on amplifier from micro SD card. Further future development can be conducted by developing a system which will be able to receive voice command through direct voice recognition hardware to recognize the voice command and no android app will be needed for controlling the robot. The developed device used prerecorded human voice sound to communicate with user but artificial intelligence can be implemented for interaction purpose so that the robot will be able to interact more appropriately by analyzing the testing environment and user’s behaviors.

6. Advantage And Future Work

Advantages

1. Voice controlled device

It is controlled using mobile app which is transcieved through Bluetooth module and has LAN coverage.

2. Used for military defense purpose

Can be used for collecting information of the surrounding in defense line.

3. Solar panels can be used as a source of energy

Solar panels can be installed to use as a source of energy to operate the device and hence it can prove to be eco-friendly.

4. Captures images of the surrounding

It can capture images if we install a camera after further modifications made. The images captured can be informative in the defence line, and can spread awareness about the enemies.

5. Can be used in mining areas where toxic gases are found

Toxic gas sensors can be used to detect the toxic gasses found in mining areas where it is injurious and deadly for human beings to go.

7. Future work

Sensor networks are considered as the key enablers for the IoT paradigm. In this project our main focus is to build an autonomous robo car that can work according to human instructions and thus prove itself helpful for the people in need of such innovations. A few features such as camera, toxic gas sensor and solar panel can be installed to modify the device for better adaptability and efficiency. This device can be used in various fields like in defense, in mining areas and places where it is difficult for human being to reach.

A real life, demanding application is selected as a reference to guide. Aspects of sensor network platform considered are: platform structure, flexibility and reusability, optimization of the sensor nodes, optimization of the communication, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. This project can be used to guide the specification, optimization, and development of sensor network Platforms for other IoT application domains.

8. Conclusion

The robotics is becoming more reliable and adopting many new methods as well as development. In this paper development of a prototype is presented although a lot more further future developments and researches are needed to make the developed robot into a complete product for consumers. Commercial production of this robot can be possible of following future researches and updates can be done for more improvement of the robot. The developed robot are able to move in any direction according to the voice command received from the user by android phone and bluetooth .Voice commands has able to control the robot to move forward, backward, left and right. There is a voice command “Autonomous” which can instantly make the robot to move fully automatically without hitting any obstacle using ultrasonic sensor. Instant stopping of the robot from any kind of movement can be done by the voice command “Stop” at any time. The developed robot has ability to interact with its user using the prerecorded human voice file. For each command, different individual response’s audio files are recorded and stored as wav files on SD card. When user will command any instruction the robot will generate the related human voice as response on amplifier from micro SD card. Further future development can be conducted by developing a system which will be able to receive voice command through direct voice recognition hardware to recognize the voice command and no android app will be needed for controlling the robot. The developed device used prerecorded human voice sound to communicate with user but artificial intelligence can be

implemented for interception purpose so that the robot will be able to interact more appropriately by analyzing the testing environment and user's behaviors.

9. Appendix

i. Component required to implement this project:

Sl. No.	Name of Component	Specification	Quantity
1.	Arduino UNO	ESP8266	2
2.	HC-05 Bluetooth Module	YF-S201	1
3.	L298N Motor Driver	HC-SR04	1
4.	Power Supply	12V DC	1
5.	Laptop/Desktop	_____	1
6.	Smart Phone	_____	1
7.	Chassis	_____	As per required
8.	Connecting Wires	_____	As per required
9.	Motor	100 rpm	4
10.	Wheel	_____	4

ii. Source Code/Program :

```
#include <SoftwareSerial.h>
```

```
Software Serial BT (0, 1); //TX, RX respectively
```

```
String read voice;
```

```
void setup () {
```

```

BT.begin(9600);
Serial.begin (9600);
pinMode (4, OUTPUT);
pinMode (3, OUTPUT);
pinMode (5, OUTPUT);
pinMode (6, OUTPUT);

}
//-----//
void loop() {
  while (BT.available()){ //Check if there is an available byte to read
    delay(10); //Delay added to make thing stable
    char c = BT.read(); //Conduct a serial read
    read voice += c; //build the string- "forward", "reverse", "left" and "right"
  }
  if (readvoice.length() > 0) {
    Serial.println(read voice);

  if (read voice == "*forward#")
  {
    digitalWrite (3, HIGH);
    digitalWrite (4, HIGH);
    digitalWrite (5, LOW);
    digitalWrite (6, LOW);
    delay (100);
  }

```



```
else if (readvoice == "*back#")
{
    digitalWrite (3, LOW);
    digitalWrite (4, LOW);
    digitalWrite (5, HIGH);
    digitalWrite (6, HIGH);
    delay (100);
}
```

```
else if ( readvoice == "*left#")
{
    digitalWrite (3, HIGH);
    digitalWrite (4, LOW);
    digitalWrite (5, LOW);
    digitalWrite (6, LOW);
    delay (800);
    digitalWrite (3, HIGH);
    digitalWrite (4, HIGH);
    digitalWrite (5, LOW);
    digitalWrite (6, LOW);
    delay (100);
}
```

```
else if ( reavoice == "*right#")
{
    digitalWrite (3, LOW);
```

```
digitalWrite (4, HIGH);
digitalWrite (5, LOW);
digitalWrite (6, LOW);
delay (800);
    digitalWrite (3, HIGH);
digitalWrite (4, HIGH);
digitalWrite (5, LOW);
digitalWrite (6, LOW);
delay (100);
}

else if (readvoice == "*stop#")
{
digitalWrite (3, LOW);
digitalWrite (4, LOW);
digitalWrite (5, LOW);
digitalWrite (6, LOW);
delay (100);
}

else if (readvoice == "*keep watch in all direction#")
{
digitalWrite (3, HIGH);
digitalWrite (4, LOW);
digitalWrite (5, LOW);
digitalWrite (6, LOW);
delay (100);
}
```

```
else if (readvoice == "*show me Garba#")
```

```
{
```

```
digitalWrite (3, LOW);
```

```
digitalWrite (4, HIGH);
```

```
digitalWrite (5, LOW);
```

```
digitalWrite (6, LOW);
```

```
delay (400);
```

```
    digitalWrite (3, HIGH);
```

```
digitalWrite (4, HIGH);
```

```
digitalWrite (5, LOW);
```

```
digitalWrite (6, LOW);
```

```
delay (600);
```

```
digitalWrite (3, LOW);
```

```
digitalWrite (4, HIGH);
```

```
digitalWrite (5, HIGH);
```

```
digitalWrite (6, LOW);
```

```
delay (500);
```

```
digitalWrite (3, HIGH);
```

```
digitalWrite (4, LOW);
```

```
digitalWrite (5, LOW);
```

```
digitalWrite (6, HIGH);
```

```
delay (500);
```

```
digitalWrite (3, LOW);
```

```
digitalWrite (4, HIGH);
```

```
digitalWrite (5, LOW);
```

```
digitalWrite (6, LOW);
```

delay (400);

digitalWrite (3, HIGH);

digitalWrite (4, HIGH);

digitalWrite (5, LOW);

digitalWrite (6, LOW);

delay (600);

digitalWrite (3, LOW);

digitalWrite (4, HIGH);

digitalWrite (5, HIGH);

digitalWrite (6, LOW);

delay (500);

digitalWrite (3, HIGH);

digitalWrite (4, LOW);

digitalWrite (5, LOW);

digitalWrite (6, HIGH);

delay (500);

digitalWrite (3, LOW);

digitalWrite (4, HIGH);

digitalWrite (5, LOW);

digitalWrite (6, LOW);

delay (400);

digitalWrite (3, HIGH);

digitalWrite (4, HIGH);

digitalWrite (5, LOW);

digitalWrite (6, LOW);

delay (600);

digitalWrite (3, LOW);

```
digitalWrite (4, HIGH);  
digitalWrite (5, HIGH);  
digitalWrite (6, LOW);  
delay (500);  
digitalWrite (3, HIGH);  
digitalWrite (4, LOW);  
digitalWrite (5, LOW);  
digitalWrite (6, HIGH);  
delay (500);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (400);  
    digitalWrite (3, HIGH);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (600);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, HIGH);  
digitalWrite (6, LOW);  
delay (500);  
digitalWrite (3, HIGH);  
digitalWrite (4, LOW);  
digitalWrite (5, LOW);
```

```
digitalWrite (6, HIGH);  
delay (500);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (400);  
    digitalWrite (3, HIGH);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
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digitalWrite (3, HIGH);  
digitalWrite (4, LOW);  
digitalWrite (5, LOW);  
digitalWrite (6, HIGH);  
delay (500);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
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digitalWrite (6, LOW);  
delay (400);
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```
digitalWrite (3, HIGH);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (600);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, HIGH);  
digitalWrite (6, LOW);  
delay (500);  
digitalWrite (3, HIGH);  
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digitalWrite (5, LOW);  
digitalWrite (6, HIGH);  
delay (500);  
digital Write (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (400);  
digitalWrite (3, HIGH);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (600);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);
```

```
digitalWrite (5, HIGH);  
digitalWrite (6, LOW);  
delay (500);  
digitalWrite (3, HIGH);  
digitalWrite (4, LOW);  
digitalWrite (5, LOW);  
digitalWrite (6, HIGH);  
delay (500);  
digitalWrite (3, LOW);  
digitalWrite (4, HIGH);  
digitalWrite (5, LOW);  
digitalWrite (6, LOW);  
delay (400);  
    digitalWrite (3, HIGH);  
    digitalWrite (4, HIGH);  
    digitalWrite (5, LOW);  
    digitalWrite (6, LOW);  
    delay (600);  
    digitalWrite (3, LOW);  
    digitalWrite (4, HIGH);  
    digitalWrite (5, HIGH);  
    digitalWrite (6, LOW);  
    delay (500);  
    digitalWrite (3, HIGH);  
    digitalWrite (4, LOW);  
    digitalWrite (5, LOW);  
    digitalWrite (6, HIGH); delay (500); }
```


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https://www.researchgate.net/publication/313574397_Design_and_Implementation_of_a_Voice_Controlled_Robot_with_Human_Interaction_Ability

[2] <https://searchnetworking.techtarget.com/definition/TCP-IP>

[3] Working video on the model

<https://www.youtube.com/watch?v=fNFVHupdBic>

SILIGURI INSTITUTE OF TECHNOLOGY

CS 892

Smart Traffic Surveillance System

BY

CSE_PROJ_2020_02

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Under the Guidance

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Submitted to the Department of **Computer Science & Engineering** in partial fulfillment of the requirements for the award of the degree Bachelor of Technology in **Computer Science & Engineering**.

Year of Submission: 2020



Siliguri Institute of Technology

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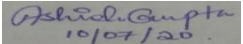
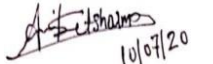
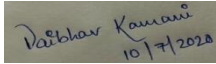
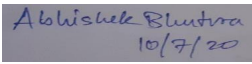
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DECLARATION

-

This is to certify that Report entitled “Smart Traffic Surveillance System “which is submitted by me in partial fulfillment of the requirement for the award of degree B.Tech. in **Computer Science Engineering** at **Siliguri Institute of Technology** under **Maulana Abul Kalam Azad University of Technology**, West Bengal. We took the help of other materials in our dissertation which have been properly acknowledged. This report has not been submitted to any other Institute for the award of any other degree.

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CERTIFICATE

This is to certify that the project report entitled **Smart Traffic Surveillance System** submitted to **Department of Computer Science & Engineering of Siliguri Institute of Technology** in partial fulfilment of the requirement for the award of the degree of **Bachelor of Technology in Computer Science & Engineering** during the academic year **2019-20**, is a bonafide record of the project work carried out by them under my guidance and supervision.

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Name of the Guide:

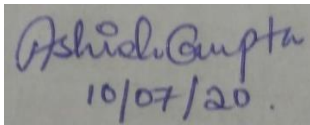
Signature of the HOD

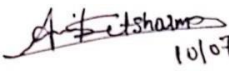
Department of Computer Science & Engineering

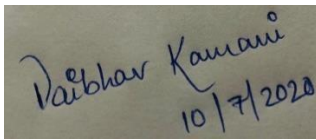
Acknowledgement

We like to share our earnest gratitude to Prof. Ms. Sutapa Bhattacharya (Assistant professor, Dept. Of computer science and engineering), our project mentor who guided us through the project also gave her valuable proposals and guidance for the accomplishment of this project. She helped us to deduce the complex issues involved in the project-making besides effectively presenting it. These difficulties would have been lost otherwise. Our project has been a success only because of her guidance.

Signature of all the group members with date

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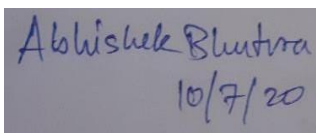
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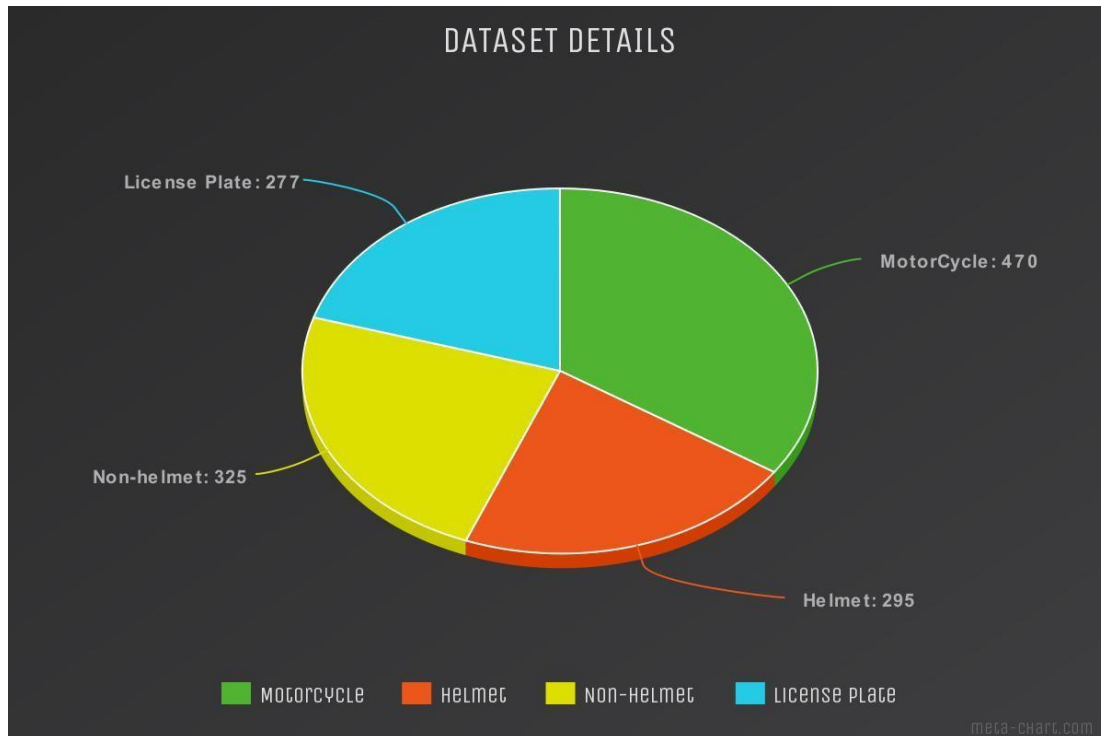
Abstract

As the use of motorcycle has been increased in recent times, the accidents have also increased rapidly. Although the helmet is the main safety equipment for the motorcyclist, many drivers do not use it which leads to a serious casualty in case of an accident. So to ensure safety measures, the detection of traffic rules violator is highly important. For this, we present a framework for automatic detection of motorcyclists driving without helmets in surveillance videos.

In the proposed approach, a custom object detection model is created using a Machine learning-based algorithm called Yolov4 which can detect Motorcycle, helmet and Licence plate. Later, On the detection of a motorcyclist without a helmet, the License Plate is extracted and the Licence Plate number is recognized using an Optical Character Recognizer. This Application can be implemented in real-time using a Webcam or a CCTV as input.

To train the Yolov4 model, we have collected 150 suitable images (470 motorcycles, 295 with helmet, 325 without a helmet, 277 license plate) from the internet and then label those images and convert it to Yolo format. Then feed the images to the Yolo algorithm. After training the model for 8000 epochs we have successfully able to achieve mean average precision(maP) of 99.79%.

Figure 1. Dataset Details



1 Introduction

1.1 Problem Statement

Develop a Smart Traffic Surveillance System that uses traffic cameras to detect whether a motorcycle rider is wearing a helmet while riding or not. If not, the system would send a necessary alert message to the specific rider.

1.2 Project Objective

The purpose of this Smart Traffic Surveillance System is to ensure the motorcycle rider's safety and to ensure minimum accidents that occur on roads due to the carelessness of motorcyclists.

Due to the large number of vehicles in circulation, studies of intelligent traffic systems have increased. The majority of studies focus on the detection, recognition, tracking and counting of vehicles and on the estimation of traffic parameters. Motorcycles are a predominant method of transport in many countries. The main advantages of motorcycles are their low price and operation cost compared with other vehicles. According to DENATRAN (National Department of Traffic), India maintained a fleet of 2,02,81,986 motorcycles in 2018.

The number of accidents involving motorcycles has increased during the last decade. According to the DNIT, a total of 34,635 motorcycles were involved in accidents in India in 2017. According to a study of traffic accidents, 14,666 traffic fatalities occurred in 2017. This global problem is prevalent. According to statistics from 2018, more than 22 million motorcycles were officially registered in India in 2016. This large number of vehicles increased the potential for a large number of traffic accidents.

According to a report on road safety published by the World Health Organization (WHO) in 2019 the estimated rate of deaths per 1,20,000 people in India was 38.1. According to the report, India has the third highest traffic mortality rate in the world. In India, the traffic mortality rate was 22.5; in the United States (US), the rate was 11.4. The report noted that approximately 25 % of traffic fatalities in India involved motorcyclists. The main safety equipment used by motorcyclists is the helmet. Although helmet use is mandatory, some motorcyclists do not use them or incorrectly use them. According to the Indian Department of Transportation's National Highway Traffic Safety Administration (NHTSA), only 66 % of motorcyclists used a helmet in accordance with the law. The Indian Center for Disease Control and Prevention presented a Morbidity and Mortality Weekly Report (MMWR) in 2018, in which the results indicated that 12 % of fatally injured motorcyclists were not using a helmet in states with universal helmet laws. In the states that adopt partial helmet laws, the number increased to 64 %. A total of 79 % of motorcyclists use helmets in states without helmet laws. The motivation of this work is to improve surveillance on the main roads in locations where the use of helmets is mandatory. These data reveal the need for increased enforcement of traffic laws, particularly for offenses for which there are no automatic detection methods. The increase in the number of motorcyclists using helmets causes a decrease in the number of accidents with victims, which is high in those countries.

1.3 Scope of the Project

This study is aimed to develop a computational vision methodology to detect motorcyclists without helmets. A two-stage strategy was developed, namely, the detection of motorcycles and the detection of helmet use. The main contribution of this work is related to a general solution proposed to detect motorcyclists without helmets, not the development of new algorithms for each stage of the system. The proposed methodology has been designed to be applied in American and Asian countries such as Brazil, USA, India, Thailand and others. In these countries the number of motorcyclists and accidents are high.

Scope of the project-

- This system uses various machine learning algorithms, state of the art technologies embedded with Computer Vision and Self Learning Neural Networks.
- Since the system uses Neural Networks, it learns and updates itself on a daily basis, which helps in low maintenance and high confidence, which makes it feasible and reliable.
- The system is aimed to reduce motorcycle accidents which comprises of almost 36% of the road accidents leading to 64% mortality rate of the motorcyclist, and to spread awareness of the importance of wearing helmets while riding the motorcycles.

1.4 Goal of the Project

The main purpose of this paper is to develop an innovative and practical safety helmet wearing detection system for people who use motorcycles for their day to day activities, based on computer

vision, machine learning and image processing. The proposed detection framework focuses on design and implementation of detection of motorcyclists with or without safety helmet on roads. Toward this objective, the Vibe background modeling is employed to track motion objects. Furthermore, the C4 pedestrian detection algorithm is applied to determine motion objects whether human or not. Finally, the specific contribution made here is that utilizing the head location, the color space transformation and the color feature discrimination to detect whether wearing safety helmets or not for workers in power substation. Noticeably, the proposed framework is not only able to accurately realize the detection of whether wearing safety helmets or not for motorcyclists theoretically, but is also well appropriate of the practical application of intelligent surveillance on roads, on account of less dependence on hardware and more quick running speed.

2 System Analysis

2.1 Identification of Need

In recent years, several studies were performed to analyze traffic on public roads, including the detection, classification and counting of vehicles and helmet detection. The detection and segmentation of vehicles on public roads can be considered as the first step to develop any study related to vehicular traffic. For this reason, some relevant studies and why we need better and enhanced systems are discussed in this section.

A system of vehicle segmentation and classification was proposed by Messelodi et al. Eight three-dimensional models were created to classify the objects. These models were calculated based on the size of the vehicle, which varies depending on the type of vehicle. The created models were as follows: cycle (motorcycles and bicycles), small car, car, minibus, closed truck, open truck, bus and pedestrian. Models are generated for each captured vehicle, which are compared with the models created for each class of vehicle. The model that is closer to the model of the captured vehicle defines the vehicle class. A disadvantage of this study is that a single model is employed for motorcycles and bicycles. In addition, only geometric information is utilized to classify the vehicles, which has been proven to be insufficient for describing these types of objects. Another disadvantage of this method is that some parameters, such as the camera height and angle and the lens focal distance, should always have the same values. If these parameters are changed, new models should be created, as no vehicle would correspond to the models. Some public roads that did not have a location, such as described in this study, to position the camera, were unable to operate the system.

Leelasantitham and Wongseeree proposed a technique that consists of detecting moving vehicles using traffic engineering methods. The vehicles were divided into five groups. The first group consisted of bicycles, motorcycles and tricycles. The second group consisted of cars and vans. Minibuses and small-sized trucks comprise the third group. The fourth group included medium-sized trucks and buses. The fifth group was composed of large sized trucks and trailers. The features used for the classification were the length and the width of the image. The database consists of only 76

images, which undermines the validity of the results. Note that the system is very sensitive to the road on which the images are captured, that is, all parameters, such as the length and the width of the image, should be modified if the same system is applied to a different road.

In another study, Zengqiang et al. implemented a system that identifies and segments vehicles if they are partly occluded. The system implements a tracking algorithm, which will continue to identify the detected vehicle even if an occlusion occurs. A tracking algorithm is presented based on the features of the contour points.

Takahashi et al. introduced a computational vision system for the detection of bicycles, pedestrians and motorcycles. The system detects both moving objects and the pedaling movement (cyclists) using the Gabor filter. Compared to other detectors YOLOv3 is extremely fast and accurate. It is a single neural network that works on full image. This network divides the image into regions and predicts the bounding boxes and probabilities for each bounding region. These bounding boxes are weighted by the predicted probabilities.

The network is basically a series of convolution layer followed by maxpool layer. After the input image is provided, the network applies convolution on the image which extracts features such lines, edges etc.

This convoluted image is then provided to maxpool layer which pops out max of pixel values from a range of pixels.

2.2 Preliminary Investigation

The most recent study of the detection of helmet use was proposed by Waranusast et al. The system extracts moving objects from videos using the AGMM algorithm. After the objects are extracted, the system classifies them as motorcycles or other objects. For this purpose, three features are employed: the area of the rectangle that contains the image, the ratio between the width and the height of the rectangle and the standard deviation of the H band in the hue-saturation-value color space around a rectangle at the center of the object. The next step involved the use of YOLO v4 Darknet with the calculated features. The primary advantage of this study is the counting of passengers, which is performed by the number of heads that appear on the image. In the final step, a classification is performed using geometric information of the head region and color information. These features are reapplied by the YOLO v4 Classifier to classify the images of motorcyclists with helmets and without helmets. According to the authors, the motorcycle detection stage obtained a hit rate of 95 %. The passenger counting stage yielded a total of 83.82 % hits. In the helmet detection stage, the hit rate was 89 %. Note that the images of the head region were manually cut in the latter stage. The images were perpendicularly captured by the camera, that is, the images show the side view of motorcycles, which is a flaw of the system for the detection of traffic violations as the vehicle registration plate is difficult to capture in that position. This method facilitates the identification of more than one person on the motorcycle in the images.

If the images had been taken from another angle, one of the persons on the motorcycle would most likely be superimposed on another image, which would generate an occlusion.

Chiverton described and tested an automatic tracking and classification system of motorcyclists with and without helmets. The system employs the Yolo v4 classifier, which is trained with histograms from the image data in the head region of the motorcyclists computed by the Yolo Darknet descriptor. The Yolo Darknet descriptor is executed with the Sobel operator to calculate the edges with a neighborhood of 3×3 pixels. The Yolov4 algorithm is used to calculate the background. In the extraction of the histograms, static photographs and individual frames from video data are utilized. The method obtained a total hit rate of 83 % for the classification of motorcycles and a total hit rate of 85 % for the detection of helmets.

Hence after intensive study and investigation, we have proposed a computational vision methodology for the detection of helmet use by motorcyclists on public roads. The study is divided into two stages: vehicle segmentation and classification, and the detection of helmet use. The stage of vehicle segmentation and classification has the following objectives: determining which objects are moving in the scene and classifying these objects. Similar to the majority of computational vision systems, the proposed system requires a calibration stage. In the calibration stage, parameters that are required for the operation of the system are adjusted. In the calibration stage of the proposed system, a cross line (CL) is defined. This line will be marked by the system operator and should cross the public road where the system will be responsible for capturing the vehicles. The moving objects that cross the CL are subsequently extracted from the video frame. The next step involves extracting the features of the segmented objects. The wavelet transform (WT) was employed. The vectors are the input parameters of the classifier. The random forest classifier was employed to classify the vehicles. The images are grouped into two classes: motorcycle or non-motorcycle. This classification is adopted as it is sufficient for assessing whether an object is a motorcycle in the proposed system. The second stage consists of the detection of helmet use. To reduce the computational cost and to increase the precision, a Region of Interest (RoI) was defined. The Yolov4 Darknet was employed in this stage. The descriptor obtains different vectors for an image of a motorcyclist with a helmet and without a helmet. The extraction of features for the detection of helmet use is considered as a critical step in this study, as helmet detection is the main objective of the proposed system. The Yolov4 classification algorithm was used to classify the images into two classes: with helmet or without helmet.

2.3 Feasibility Study

2.3.1 Operational feasibility

Since we know that motorcycles are a cheap mode of transport and are used daily as a major source of transport, there has been a rapid increase in motorcycle accidents in the last couple of years. The major cause behind these accidents is the violation of traffic safety measures which involves

motorcycle riders to wear a helmet at all times while riding. Most of the accidents results in a severe head injury. This is why wearing helmets are mandatory and violating which attracts heavy fines.

“Smart Traffic Surveillance System” is aimed at automatically monitoring bike riders without helmet using surveillance videos in real-time. Initially the image is fed from surveillance cameras, the footage is checked frame by frame to detect any moving two wheelers and localized head part of the rider to detect whether he is wearing a helmet or not. Then the system will extract the character patterns from the number plates of the motorcycle with the rider not wearing a helmet and run the said plates against the RTO database to fetch the phone number of the customer registered against the said plates and send him/her a warning message requesting them to wear a helmet from the next time or else they'll be liable to a fine or penalty as per the Traffic Regulations of the Government of India.

2.3.2 Financial feasibility

As of now, it will be used on a small system that is trained on a limited data set, so as the system is used in real life on heavy data sets, the neural networks will work basically and it may then need up scaling and maintenance. Also, since computer vision and machine learning algorithms are evolving day to day, if there comes a major update in the technology we used in the market, those appris shall be put to use, provided the cost estimates are feasible.

2.4 Project Planning

For identifying the need of the System, we consider the following:

Performance of the system

The performance of the System basically depends on the System Design, tools used in the system, coding, etc. The performance of the system should be fast, accurate & reliable.

2.5 Project Scheduling

Project scheduling is a process that distributes estimated effort across the project duration by allocating the effort to specific software engineering tasks. It is an important project planning activity. It involves deciding which project tasks would be taken up when.

In order to schedule the project activities, a software project manager needs to do the following:

Identify all the major tasks needed to complete the project.

1. Identify all the major tasks needed to complete the project.
2. Determine the dependency among different tasks.
3. Establish the most likely estimates for the time durations necessary to complete the tasks.
4. Allocate resources to tasks using Gantt chart & Pert chart.

Plan the starting and ending dates for various tasks

Gantt Chart:

The project commenced on 30th March and was scheduled to conclude by May but it finally ended by 18th June. The Gantt chart below describes briefly the different stages of commencement.

Table 1 Describes the Gantt Chart Parameters

Title	Start date	End date	Duration (in days)
Smart Traffic Surveillance System	03-30-2020	06-18-2020	59
Start	03-30-2020	03-30-2020	-
Feasibility Study	03-30-2020	04-04-2020	5
Requirement Analysis and Specification	04-05-2020	04-14-2020	7
Data Set Preparation	04-15-2020	04-28-2020	10
Feature File Preparation	04-29-2020	05-05-2020	5
Coding	05-06-2020	06-03-2020	21
Training	06-04-2020	06-10-2020	5
Testing	06-11-2020	06-17-2020	5
Finish	06-18-2020	06-18-2020	-

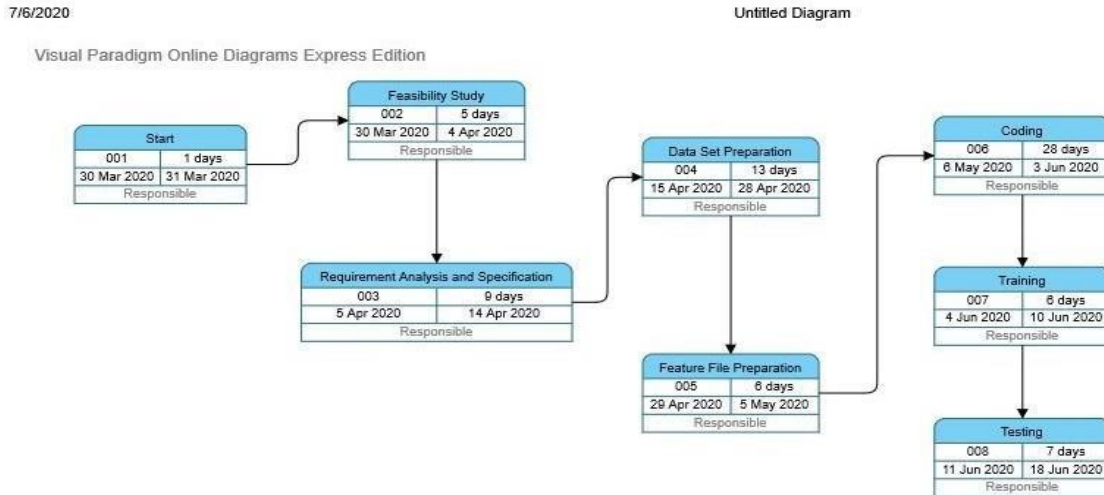
Figure 2. Gantt Chart describing the flow of project.



Pert Chart

The below figure shows the steps demanded to execute this project.

Figure 3. Pert Chart describing briefly different stages of work flow.



2.6 Software Requirement Specification

Software Requirements: -

- ❖ Operating System – Windows 10 / 8.1 / Ubuntu18.04 / Linux
- ❖ Python (with the following included libraries)
 - I. OpenCV
 - II. Darknet framework
 - III. NumPy
 - IV. Google Colab

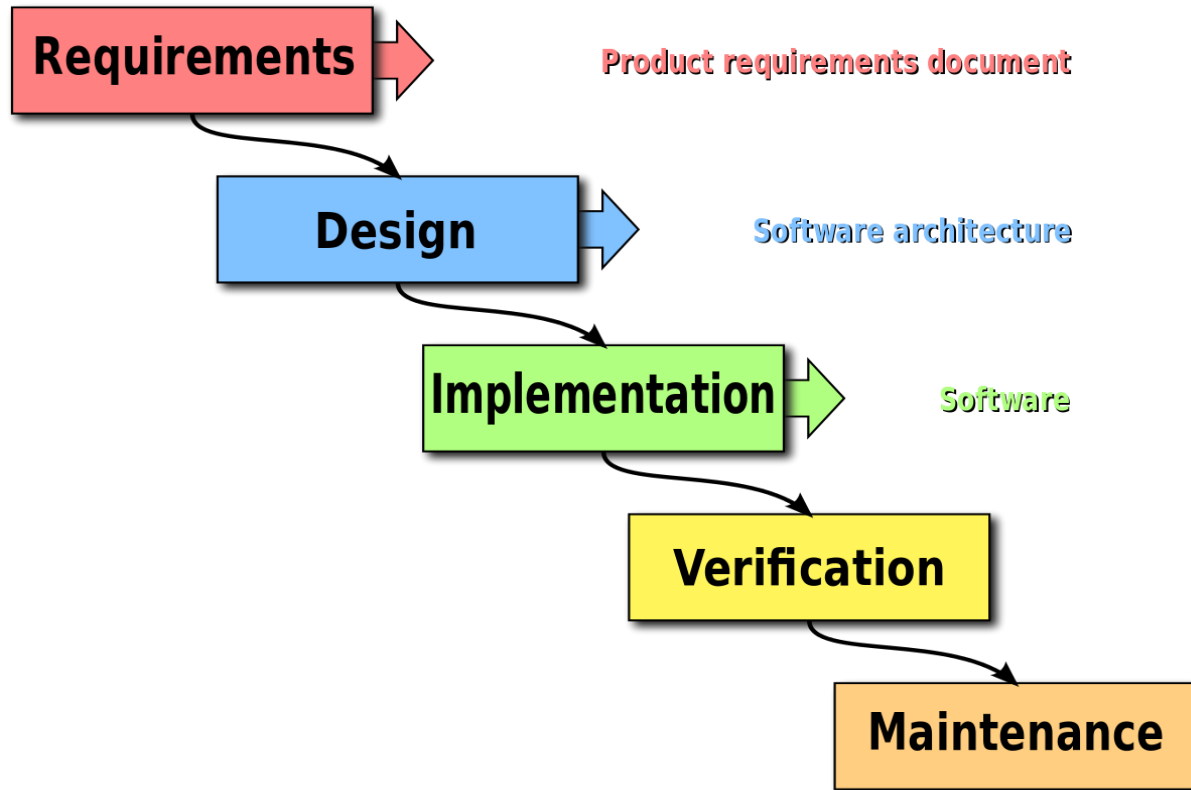
Hardware Requirements: -

- ❖ Camera
- ❖ GPU (Tesla K80)
- ❖ RAM (8GB)

2.7 Software Engineering Paradigm

Software Development Life Cycle Model

Figure 4. Different Stages of Waterfall Model in Brief



Requirements: The first phase involves understanding what needs to design and what is its function, purpose, etc. Here, the specifications of the input and output or the final product are studied and marked.

System Design: System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture.

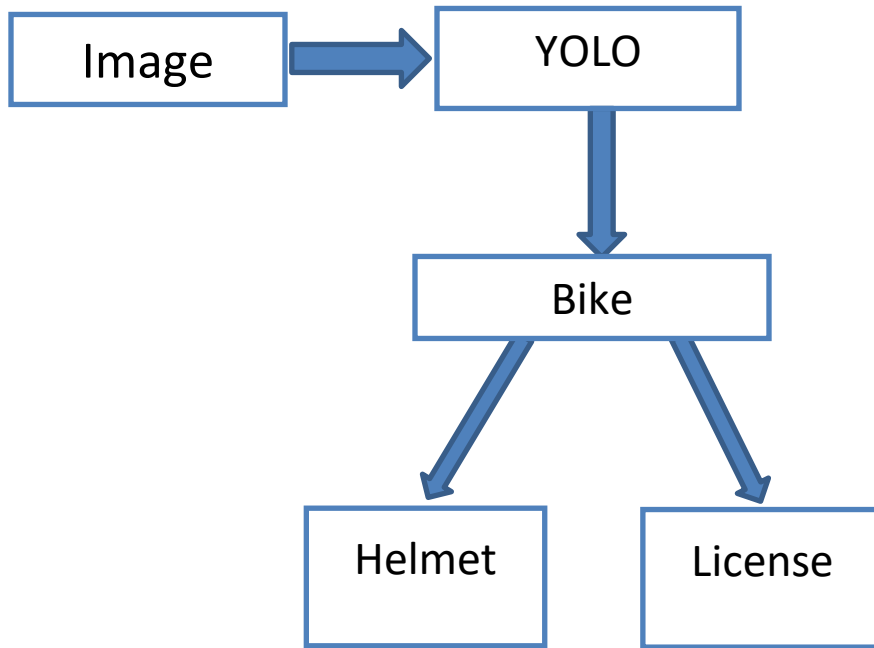
Implementation: With inputs from system design, the system is first developed in small programs called units, which are integrated into the next phase. Each unit is developed and tested for its functionality which is referred to as Unit Testing.

Testing: The software designed, needs to go through constant software testing to find out if there are any flaws or errors. Testing is done so that the client does not face any problem during the installation of the software.

Deployment of System: Once the functional and non-functional testing is done, the product is deployed in the customer environment or released into the market.

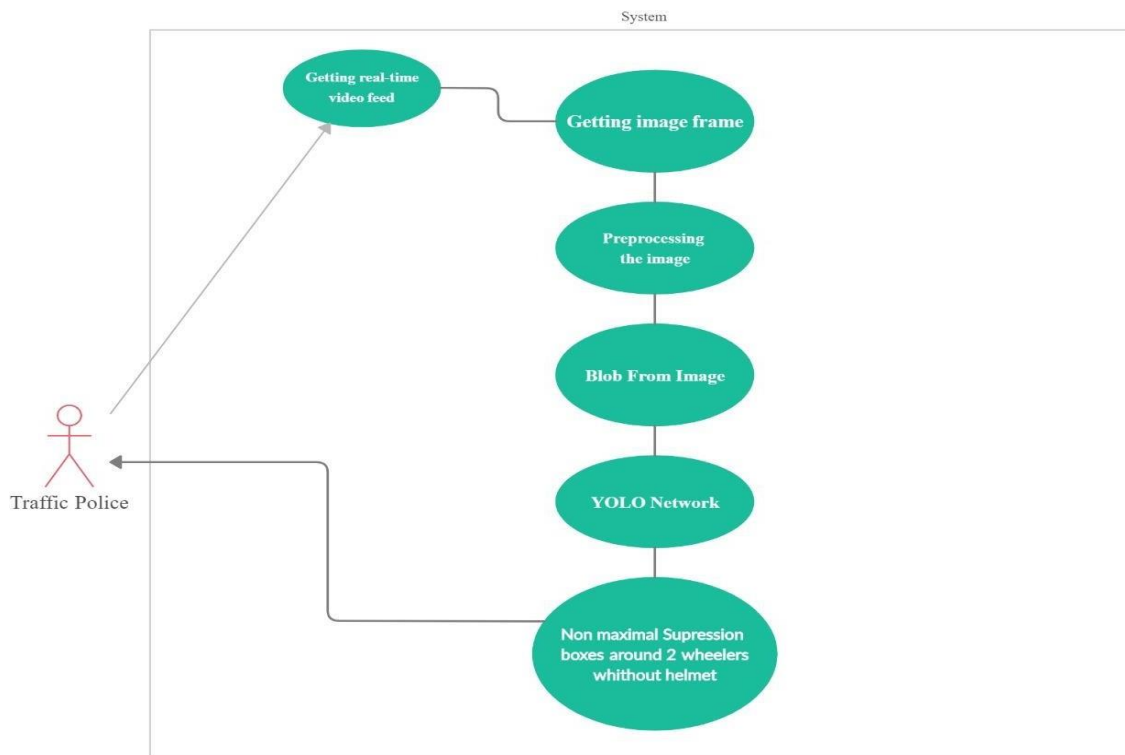
Maintenance: This step occurs after installation, and involves making modifications to the system or an individual component to alter attributes or improve performance. These modifications arise either due to change requests initiated by the customer, or defects uncovered during live use of the system. The client is provided with regular maintenance and support for the developed software.

Figure 5 Software Engineering Paradigm Applied



2.8 Use Case Diagram

Figure 6. Use Case for Traffic Surveillance System.

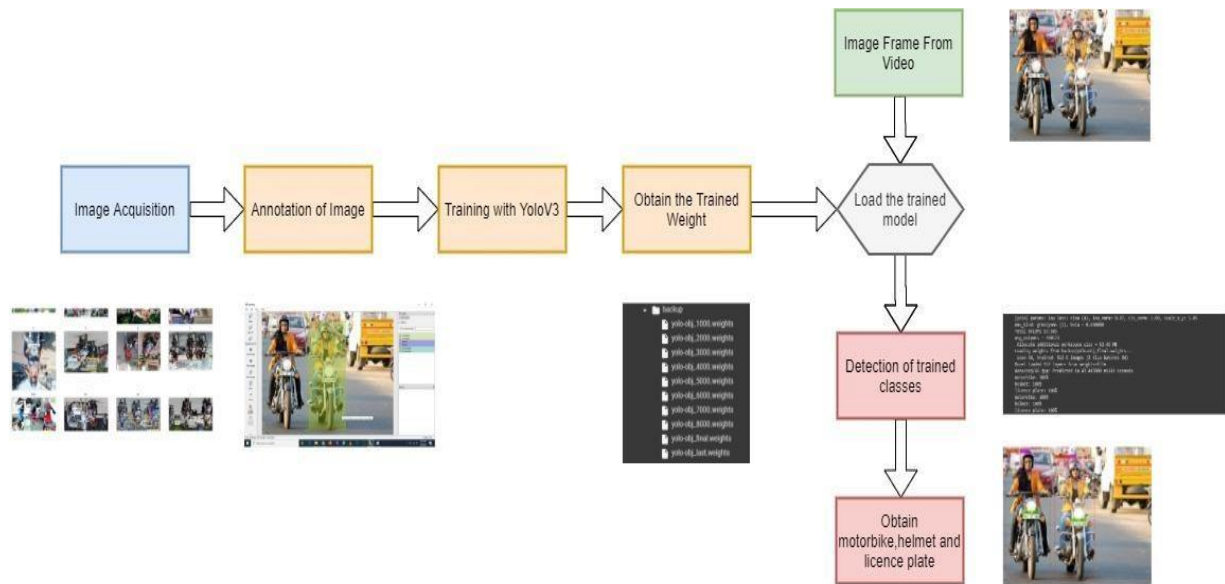


3 System Design

3.1 Modularization Details

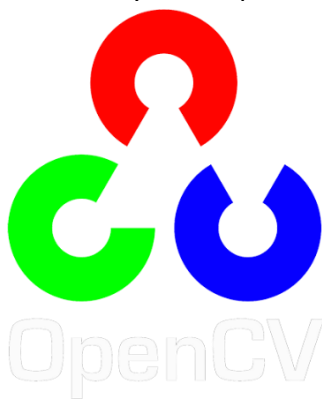
3.1.1 Methodology

Figure 7. Flow Chart of the Project.



3.1.2 Introduction to OpenCV

OpenCV stands for Open Source Computer Vision Library. This is a machine learning software library. It was built to accommodate a common base for computer vision applications and to stimulate the use of machine opinion in commercial products. Being an open-source product makes it easy for corporations to utilize and alter the code accordingly.



This library constitutes more than 2500 optimized algorithms, which includes a broad set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms provide support to detect and identify faces, objects, analyze human actions in videos, follow camera movements, track moving objects, etc. The library is used extensively in companies, research groups and governmental bodies.

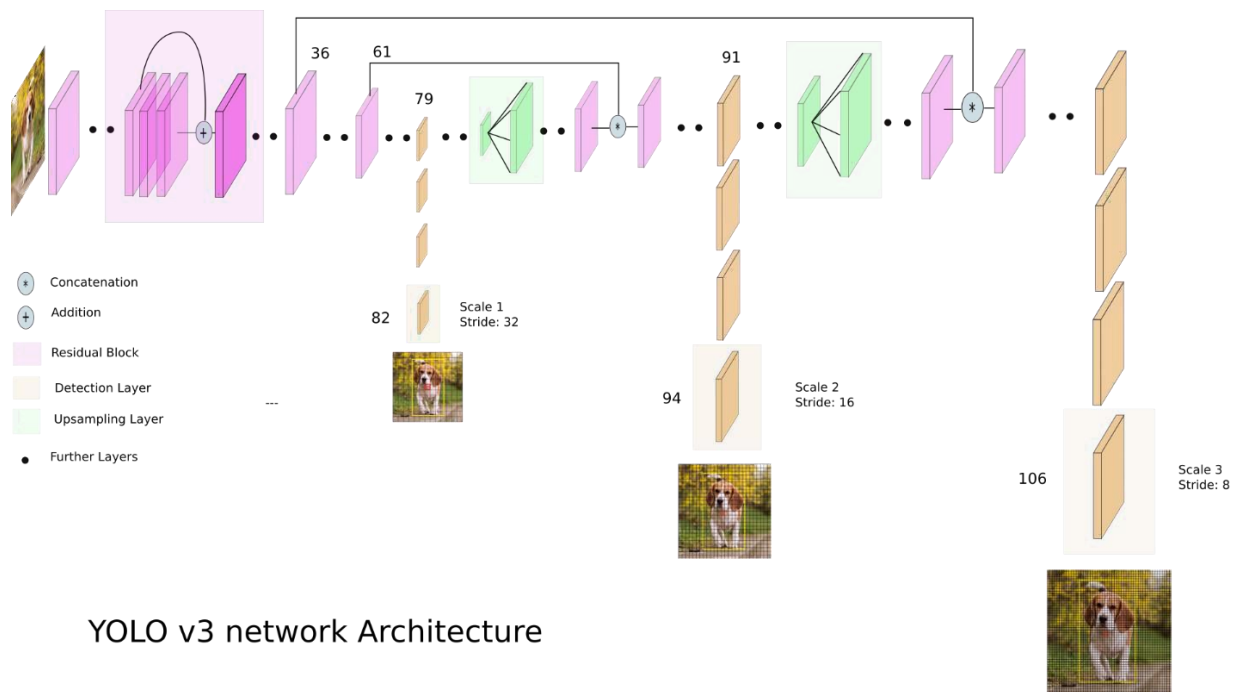
Use Of OpenCV in this Project

Implementing YOLO in Dark net requires expensive hardware tools like GPU. More over the system requires much time to train. Here is where OpenCV comes in, OpenCV has an inbuilt DNN Algorithm for Yolo. This algorithm takes Configuration file and weight file as input and in return outputs the Labeled image/video. The model is trained in Google Colab and the outputs generated by it i.e, Configuration and Weight files, are input to this opencv algorithm which then recognizes objects in real-time.

3.1.3 What is YOLO and how does it work?

Yolo, remarked by Joseph Redmon et al as "You Only Look Once: Unified, Real-Time Object Detection" is one of the most popular Computer Vision techniques. Object Detection has been a Classical Problem in Computer Vision field to which yolo has provided a remarkable solution.

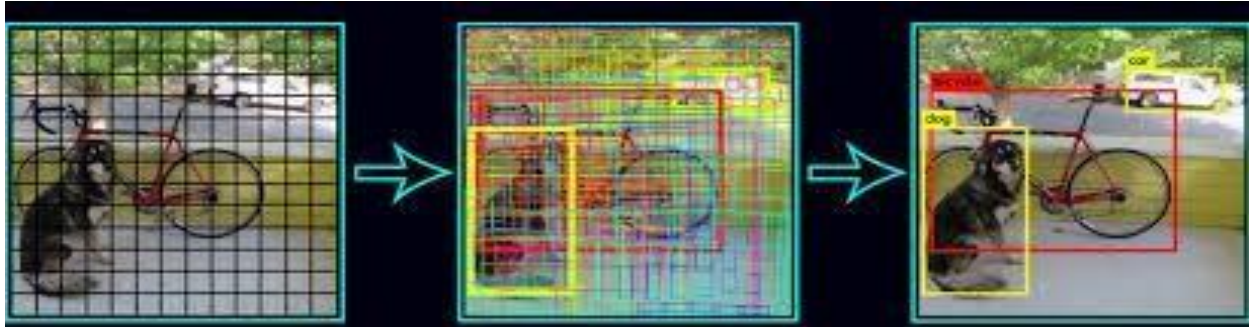
Figure 8. Yolo v3 Network Architecture



YOLO v3 network Architecture

Yolo uses a smarter CNN network to detect objects in real-time. Unlike traditional neural networks, Yolo applies a Single Network to the full image and then divides the image into regions to predict the bounding box that would enclose the object within that region. The network contains a series of Convolutional followed by the max pool layer stacks. It divides the image into a grid of 13 x 13 cells. Each cell is responsible to predict 5 bounding boxes. The final output contains the labeled object with its confidence value.

Figure 9. Yolo in Working.



3.1.4 Creating Yolo Dataset

Creating a custom dataset for yolo involves a series of important steps.

1. Gathering Data.
2. Annotating/Labeling Data.
3. Configuring Dark net and setting up the environment.
4. Training the Model against labeled data.

Gathering Data

Gathering data is the most crucial part of a Machine Learning System. An ML algorithm behaviour is judged by the data it rehearses upon. The training data relevant to this project contains images of two-wheeler without or without a helmet.

Google Image Search is a great tool when it comes to images. Downloading each image is a tedious task. Chrome provides an extension called "Download All Images" which creates a zip of all images and is then available for download. The images used in this project are taken from Google Image Search. This dataset comprises of 150 images.

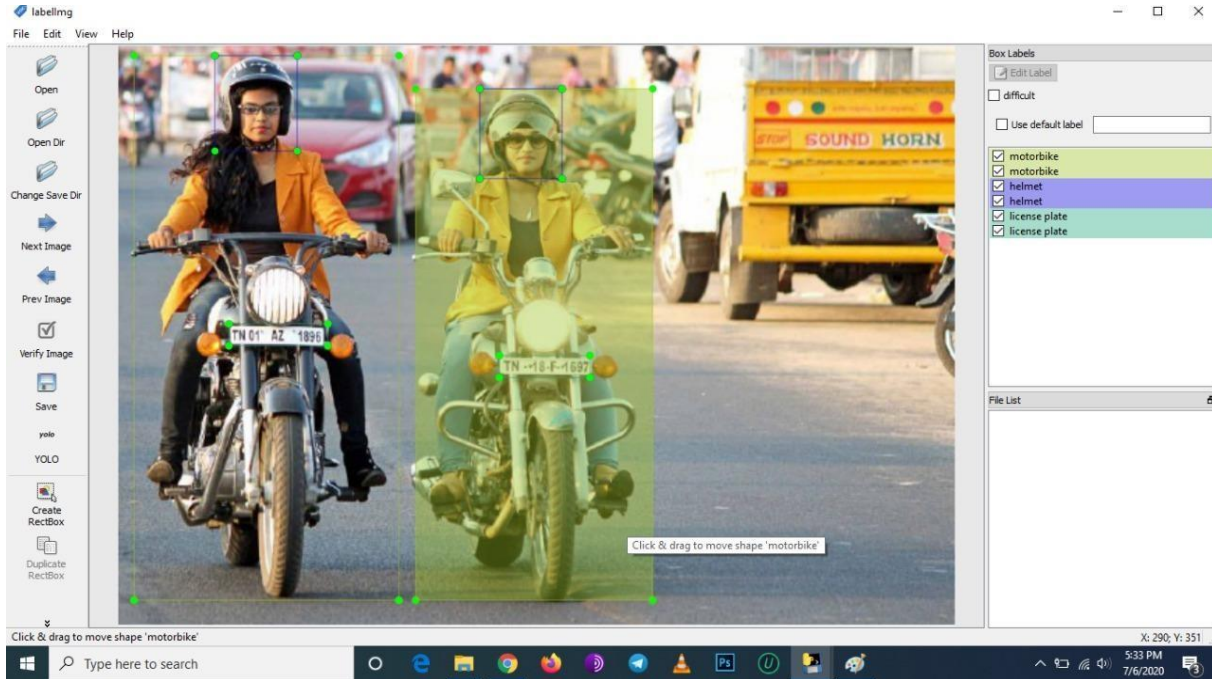
Figure 10. Image Datasets Used to train Yolo.



Annotating Data

Once all images are collected, the next is to label them. Labeling in terms of Computer Vision means creating a bounding box around objects of interest and associate them with the corresponding class. The Tool used in this project is a software called "LabelImg".

Figure 11. Labelling Images in LabelImg.



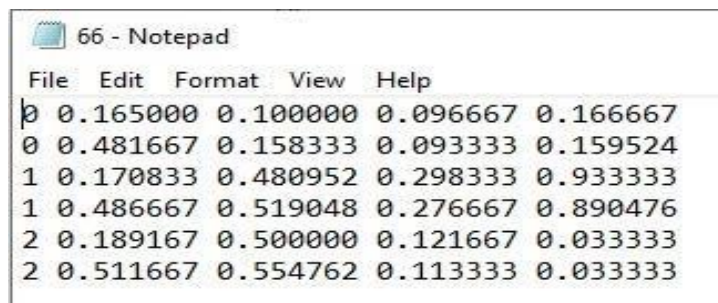
LabelImg annotates the images directly into Yolo format which is of great advantage.

Steps:

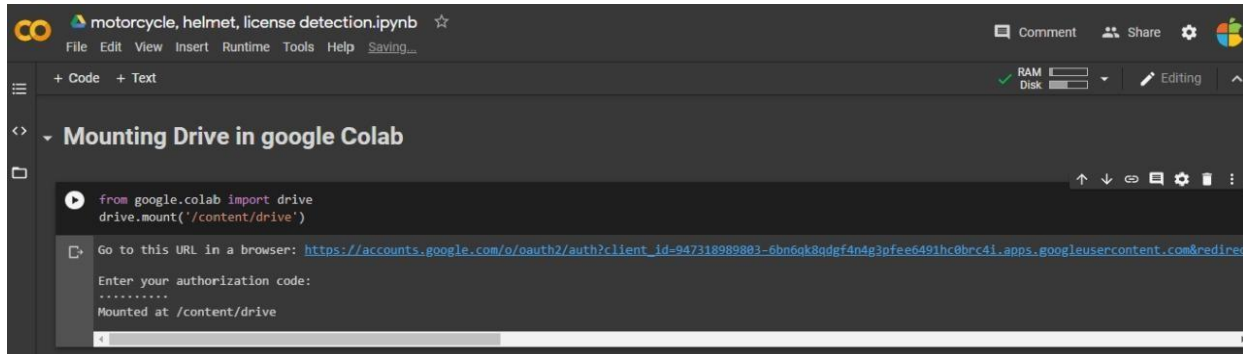
1. Importing relevant images and class files to LabelImg.
2. Changing Annotation Format from PASCLE VOC to YOLO type.
3. Annotating images and labeling them to their corresponding classes.

Once an image is labelled a text file is created containing Object-id, Centre-X, Centre-y, height, width of the labelled object. It is important to store this text file to the same directory which contains the images.

Figure 12. Image Text File.



Once the .txt file is obtained for all of the above images, the complete folder is uploaded into google drive. Further the uploaded into colab notebook via the below command.



```

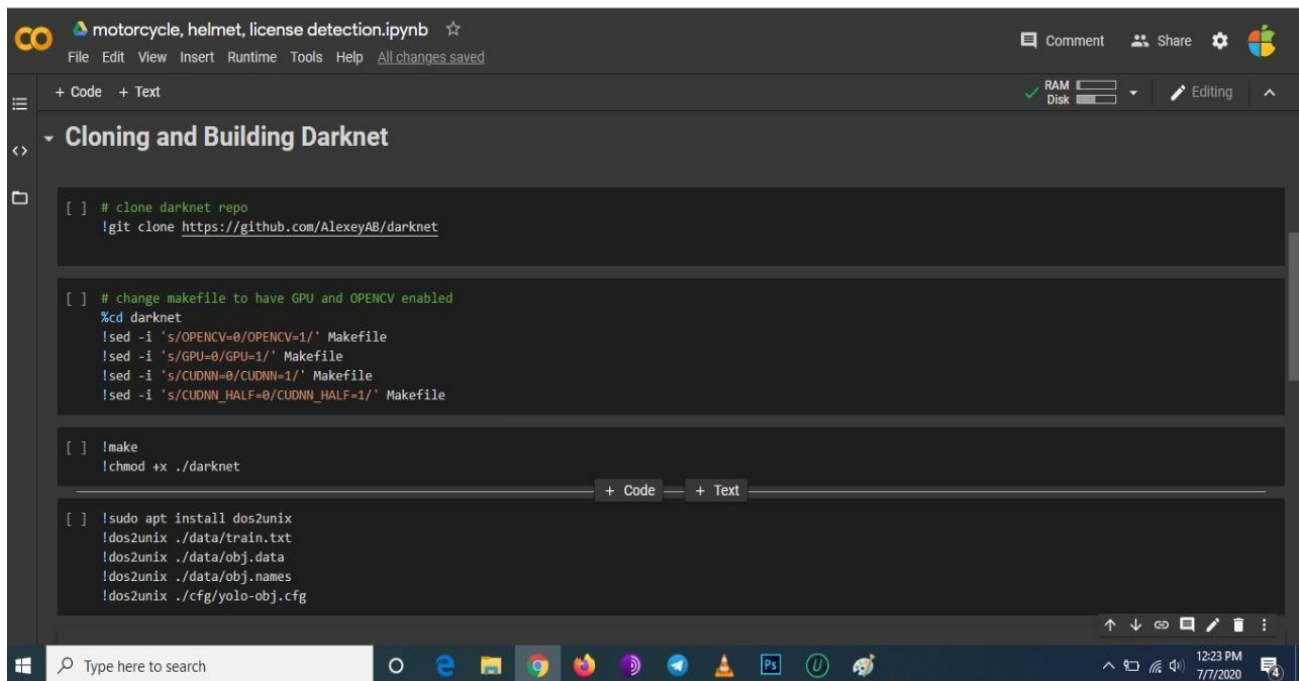
from google.colab import drive
drive.mount('/content/drive')

Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdf4n4g3pfee6491hc0brc4i_apps.googleusercontent.com&redirect_uri=https://colab.research.google.com/notebooks/authorize_redirect?from_ipynb=1
Enter your authorization code:
.....
Mounted at /content/drive

```

Configuring Dark net and setting up environment

Dark net is an open-source framework that supports Object Detection and Image Classification tasks in the form of Convolutional Neural Networks. Dark net is mainly known for its implementation of the YOLO algorithm (You Only Look Once).



```

# clone darknet repo
git clone https://github.com/AlexeyAB/darknet

# change makefile to have GPU and OPENCV enabled
%cd darknet
sed -i 's/OPENCV=0/OPENCV=1/' Makefile
sed -i 's/GPU=0/GPU=1/' Makefile
sed -i 's/CUDNN=0/CUDNN=1/' Makefile
sed -i 's/CUDNN_HALF=0/CUDNN_HALF=1/' Makefile

make
chmod +x ./darknet

sudo apt install dos2unix
dos2unix ./data/train.txt
dos2unix ./data/obj.data
dos2unix ./data/obj.names
dos2unix ./cfg/yolo-obj.cfg

```

The above configuration is done in Google Colab. Google Colab provides an online platform for Data Science Researchers to practice there their code. It provides the user with different processing units like CPU, GPU and TPU. When dealing with Computer Vision problems, a lot of data needs to be processed within a short period of time which is difficult for a CPU to compute. One can configure the processing machine as per requirement.

Processing unit used in this project is 12GB NVIDIA Tesla K80 GPU.

The above codes involve following steps:

1. Cloning the dark net repository from <https://github.com/AlexeyAB/darknet>.
2. Enabling GPU and Opencv.
3. Compiling Dark net files.
4. Converting files into Unix files.

Now the environment is set up.

Training the model against labeled data.

The training process took about 10-12 hrs. to generate weight and configuration files. After about 10000 epoch the model generates the weight and configuration files. The Advantage is once the model is trained, it need not be trained again and again. The weight file simplifies the task.

```

- Check Precision

[8] ! ./darknet detector map data/obj.data cfg/yolo-obj.cfg backup/yolo-obj_final.weights

[8] CUDA-version: 10010 (10010), cuDNN: 7.6.5, GPU count: 1
    OpenCV version: 3.2.0
    valid: Using default 'data/train.txt'
    0 : compute_capability = 370, cudnn_half = 0, GPU: Tesla K80
    net.optimized_memory = 0
    mini_batch = 1, batch = 16, time_steps = 1, train = 0

```

The above code is a dark net command to begin the training process. It takes two parameters

1. Configuration file: yolo-obj.cfg.
2. Weight file: yolo-obj_final.weights

Colab only allows a maximum of 12 hrs. of running time in ordinary accounts. After each subsequent 1000 epoch weights are saved in the backup folder so we could just resume from there.

```

[8] calculation mAP (mean average precision)...
140
[8] detections_count = 1298, unique_truth_count = 1143
    class_id = 0, name = helmet, ap = 100.00%      (TP = 329, FP = 0)
    class_id = 1, name = motorbike, ap = 99.75%   (TP = 402, FP = 1)
    class_id = 2, name = license plate, ap = 99.97% (TP = 231, FP = 4)
    class_id = 3, name = non helmet, ap = 99.44%  (TP = 179, FP = 1)

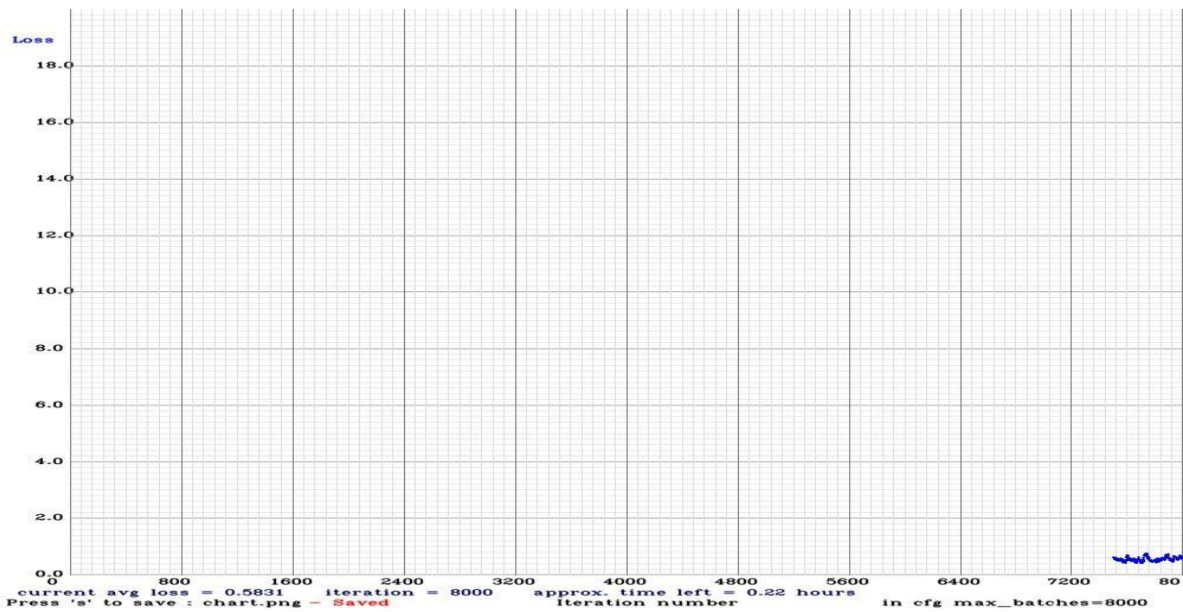
    for conf_thresh = 0.25, precision = 0.99, recall = 1.00, F1-score = 1.00
    for conf_thresh = 0.25, TP = 1141, FP = 6, FN = 2, average IoU = 92.98 %

    IoU threshold = 50 %, used Area-Under-Curve for each unique Recall
    mean average precision (mAP@0.50) = 0.997924, or 99.79 %
    Total Detection Time: 10 Seconds

```

Mean Average Precision for the entire model is 99.79%.

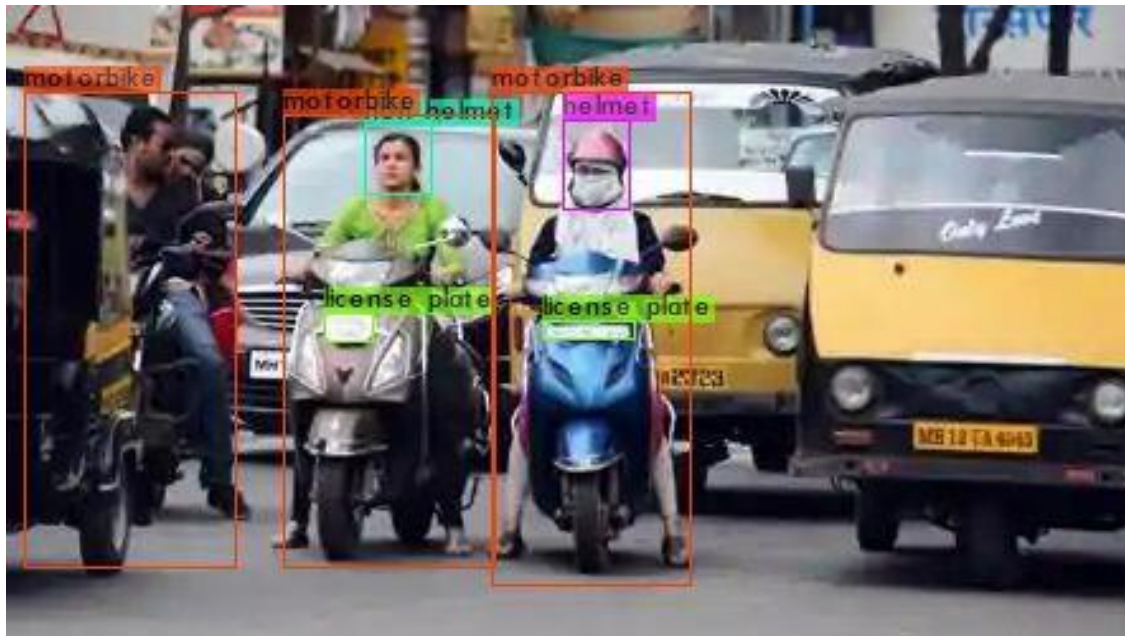
Figure 13 Loss vs Iteration count graph for last batch of 8000 iterations.



The graph above is loss vs epoch graph which determines the loss value on different epoch range. The small curve on right-bottom describes how well the model performs on completion of 8000 iterations. The average loss obtained is 0.5831.

Final Output:

Figure 14. Yolo Sample Output for an image predicting Motorbikes, Helmets, License plates.



The figure above describes the final output generated by the model. It correctly identifies three Two-wheelers with and without helmet.

4 Coding

4.1 Main.py (Implementing Yolov4 using OpenCV)

YOLO is a deep learning algorithm, so itself doesn't need any installation, what we need instead is a deep learning framework (Dark net) were to run the algorithm.

Dark net : It's the framework built from the developer of YOLO and made specifically for yolo.

Opencv: Also OpenCV has a deep learning framework that works with YOLO. Just make sure you have OpenCV 3.4.2 at least.

Let us start with mounting the google drive into google colab to get the required file that is needed for this program

```
1 from google.colab import drive
2 drive.mount('/content/drive')
```

Importing the libraries Opencv and NumPy and then we load the algorithm.

```
4 #load libraries
5 import cv2
6 import numpy as np
```

We

load the algorithm. To run the algorithm we need three files:

Weight file: It's the trained model, the core of the algorithm to detect the objects.

Cfg file: It's the configuration file, where there are all the settings of the algorithm.

Name files: Contains the name of the objects that the algorithm can detect.

Coco.names contains the object names on which the model has been trained, so we are storing them in a list called classes[].

Now to run a forward pass using the **cv2.dnn** module, we need to pass in the names of layers for which the output is to be computed.

net.getUnconnectedOutLayers() returns the indices of the output layers of the network.

```

8 # Load Yolo
9
10 net = cv2.dnn.readNet("yolo-obj_final.weights", "yolo-obj.cfg")
11 classes = []
12 with open("coco.names", "r") as f:
13     classes = [line.strip() for line in f.readlines()]
14
15 layer_names = net.getLayerNames()
16 output_layers = [layer_names[i[0] - 1] for i in net.getUnconnectedOutLayers()]
17 colors = np.random.uniform(0, 255, size=(len(classes), 3))

```

We then load the image where we want to perform the object detection and we also get its width and height.

```

19 # Loading image
20 img = cv2.imread("16.jpg")
21 img = cv2.resize(img, None, fx=0.4, fy=0.4)
22 height, width, channels = img.shape

```

Now that we have the algorithm ready to work and also the image, it's time to pass the image into the network and do the detection.

Keep in mind that we can't use right away the full image on the network, but first, we need it to convert it to a blob.

Blob it's used to extract feature from the image and to resize them. YOLO accepts three sizes:

320×320 it's small so less accuracy but better speed

609×609 it's bigger so high accuracy and slow speed

416×416 it's in the middle and you get a bit of both.

The outs on **line 27** it's the result of the detection. Outs is an array that contains all the information's about objects detected, their position and the confidence about the detection.

We have used the scale factor of 0.00392 which can also be written as 1/255. Hence, we are scaling the image pixels to the range of 0 to 1. There is no need for mean subtraction and that's why we set it to [0, 0, 0] value.

```

24 # Detecting objects
25 blob = cv2.dnn.blobFromImage(img, 0.00392, (416, 416), (0, 0, 0), True, crop=False)
26 net.setInput(blob)
27 outs = net.forward(output_layers)

```

The **net.forward(layer)** function of cv2.dnn module returns a nested list containing information about all the detected objects which includes the x and y coordinates of the center

of the object detected, height and width of the bounding box, confidence and scores for all the classes of objects listed in coco.names. The class with the highest score is considered to be the predicted class.

At this point, the detection is done, and we only need to show the result on the screen. We then loop through the outs array, we calculate the confidence and we choose a confidence threshold.

On **line 39 we set threshold confidence** of 0.5, if it's greater we consider the object correctly detected, otherwise we skip it.

The threshold goes from 0 to 1. The closer to 1 the greater is the accuracy of the detection, while the closer to 0 the less is the accuracy but also it's greater the number of the objects detected.

```

29 # for each detetion from each output layer get the confidence, class id,
30 # bounding box params and ignore weak detections (confidence < 0.5)
31 class_ids = []
32 confidences = []
33 boxes = []
34 for out in outs:
35     for detection in out:
36         scores = detection[5:]
37         class_id = np.argmax(scores)
38         confidence = scores[class_id]
39         if confidence > 0.5:
40             # Object detected
41             center_x = int(detection[0] * width)
42             center_y = int(detection[1] * height)
43             w = int(detection[2] * width)
44             h = int(detection[3] * height)
45             # Rectangle coordinates
46             x = int(center_x - w / 2)
47             y = int(center_y - h / 2)
48             boxes.append([x, y, w, h])
49             confidences.append(float(confidence))
50             class_ids.append(class_id)
51

```

4.1.1 Non Maximum Suppression

At this point, we can pretty much draw the bounding boxes and call it a day. But sometimes what happens is that more than one box points to the same object. In this case, instead of one detection, we would have 2 detections, even though in reality we just have one object.

To counter this problem we will use Non-Max Suppression. In the simplest term, the NMS eliminates the overlapping boxes. It finds the overlapping boxes and then based on their confidence it will pick the max confidence box and suppress all the non-max boxes. So we will use the built-in NMSBoxes function. We have to input the bounding box points, their confidence values, the confidence threshold and the nmsThreshold. The function returns the indices after elimination.

```

53 #Non Maximum Suppression
54 indexes = cv2.dnn.NMSBoxes(boxes, confidences, 0.5, 0.4)

```

Now that we have everything sorted out we can simply draw the bounding boxes and display the object names and confidence values.

We extract all the information and show them on the screen.

Box: Contain the coordinates of the rectangle surrounding the object detected.

Label: It's the name of the object detected

Confidence: The confidence about the detection from 0 to 1.

```

56 #draw bounding box on the detected object with class name
57 font = cv2.FONT_HERSHEY_PLAIN
58 for i in range(len(boxes)):
59     if i in indexes:
60         x, y, w, h = boxes[i]
61         label = str(classes[class_ids[i]])
62         color = colors[i]
63         cv2.rectangle(img, (x, y), (x + w, y + h), color, 2)
64         cv2.putText(img, f'{classNames[class_ids[i]].upper()} {int(confidences[i]*100)}%',
65                     (x, y-10), font, 0.6, (255, 0, 255), 3)
66
67 #Displaying the output
68 cv2.imshow("Image", img)
69 cv2.waitKey(0)
70 cv2.destroyAllWindows()

```

Sample Input

Figure 15. Image Input provided to the algorithm



Output

Figure 16. Output given by the Model



```
[yolo] params: iou loss: ciou (4), iou_norm: 0.07, cls_norm: 1.00, scale_x_y: 1.05
nms_kind: greedynms (1), beta = 0.600000
Total BFLOPS 59.585
avg_outputs = 490173
Allocate additional workspace_size = 52.43 MB
Loading weights from backup/yolo-obj_final.weights...
seen 64, trained: 512 K-images (8 Kilo-batches_64)
Done! Loaded 162 layers from weights-file
data/obj/66.jpg: Predicted in 43.415000 milli-seconds.
motorbike: 100%
helmet: 100%
license plate: 100%
motorbike: 100%
helmet: 100%
license plate: 100%
```

5 Testing

This report is in reference to the output generated by the yolo v4 on respective inputs.

Figure 17. Test Case 1

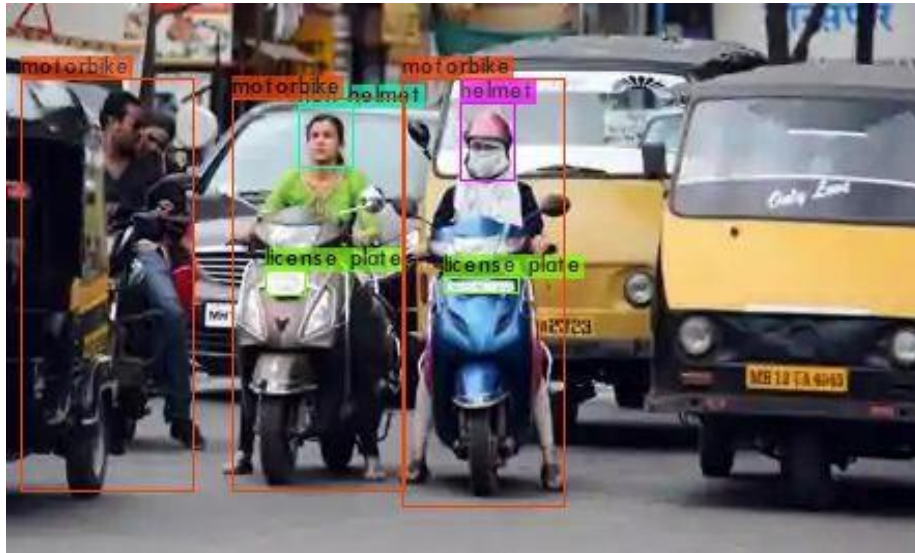


Table 2. Analysis of Test Case 1

Test Case Id	1.	Detected Bike	Detected Helmet	Non helmet count	Detected License plate
	Bike Count	3/3			
	Helmet Count		1/1		
	Non Helmet Count			3/1	
	License Plate Count				2/2

Figure 18. Test Case 2



Table 3. Analysis of Test Case 2

Test Case Id	2.	Detected Bike	Detected Helmet	Non helmet count	Detected License plate
	Bike Count	1/1			
	Helmet Count		0/0		
	Non Helmet Count			1/1	
	License Plate Count				1/1

Figure 19. Test Case 3



Table 4. Analysis of Test Case 3

Test Case Id	3.	Detected Bike	Detected Helmet	Non helmet count	Detected License plate
	Bike Count	3/3			
	Helmet Count		1/1		
	Non Helmet Count			3/1	
	License Plate Count				2/2

Figure 20. Test Case 4



Table 5. Analysis of Test Case 4

Test Case Id	4.	Detected Bike	Detected Helmet	Non helmet count	Detected License plate
	Bike Count	1/1			
	Helmet Count		1/1		
	Non Helmet Count			0/0	
	License Plate Count				1/1

6 Cost Estimation of the project

The most common approach for estimating effort is to make it a function of a single variable. Often these variables are the project size, and the equation of effort is considered:

$$\text{EFFORT} = a * \text{SIZE}^b,$$

Where 'a' and 'b' are constants. Values for these constants for a particular process are determined through regression analysis, which is applied to data about the projects that has been performed in the past.

For determining the cost estimate of the project "Shortest Route Path" (SRC) the COCOMO ("COConstructive COst Model) model has been applied.

The basic steps in this model are:

- i) Obtain an initial estimate of the development effort from the estimates of thousand delivered lines of source code (KDLCOG).
- ii) Determine a set of 15 multiplying factors from different attributes of project.
- iii) Adjust effort estimates by multiplying the initial estimate with all the multiplying factors.

The multiplying factors for all 15 cost drivers are multiplied to get the Effort Adjustment Factor (EAF). The final effort estimate, E, is obtained by multiplying the initial estimate by EAF:

$$E = \text{EAF} * E_i.$$

The overall cost of the project can be estimated. For planning and monitoring purposes, estimates of the efforts required for the different phase is also desirable. In COCOMO, efforts for a phase are considered a defined percentage of the overall effort.

Using the COCOMO Model we can make the Cost-estimation of this project is like as follows:

Project type	–	Organic.	<u>a</u>	<u>b</u>
Constraints for Organic Project is -			3.2	1.05

From the requirements, four major modules in the system are: data entry, data update, query, and summary findings. It is also clear from the requirements that the project category is organic. The sizes for the different modules and the overall system are estimated to be

Now considering the lines of codes of the basic pages (deducting the comment lines, as they will not get executed), **The Lines of Codes=7.03KLOC.**

From the requirements, the ratings of the different cost driver attributes are assessed. These ratings, along with their multiplying factors, are:

Complexity	Nominal	1.00
Storage	Nominal	1.00
Experience	Nominal	1.00
Programmer Capability	Nominal	1.00

All other factor had a nominal rating. From these, the effort adjustment factor (EAF) is

$$\mathbf{EAF (Effort Adjustment Factor) = 1.00 * 1.00 * 1.00 * 1.00 = 1.00}$$

The initial effort (E_i) estimate for the project is obtained from the relevant equation which is:

$$a * KDLOC^b$$

We have, $a = 3.2$ and $b = 1.05$. Now putting into the above mentioned equation we get:

$$\begin{aligned} \mathbf{E_i} &= \mathbf{3.2 * (7.03)^{1.05} PM.} \\ &= \mathbf{24.8 PM.} \end{aligned}$$

Using the EAF, the adjusted effort estimate is

$$\begin{aligned} \mathbf{E} &= \mathbf{EAF * E_i} \\ &= 1.00 * 24.8 PM. \\ &= \mathbf{24.8 PM.} \end{aligned}$$

According to COCOMO model the effort estimated for different phases are:

Plans & Requirement	= .05* 24.8 = 1.24
System Design	= .15*24.8 = 3.72
Detail Design	= .22* 24.8 = 5.46
Code and Unit test	= .40 * 24.8 = 9.92
Integration	= .19 * 24.8= 4.712

The duration for the Staff Months is $2.4*(KLOC)^{1.05}$

$$\begin{aligned} \mathbf{SM} &= \mathbf{2.0*(7.03)^{1.05}} \\ &= \mathbf{15.50} \end{aligned}$$

The nominal productivity for the Project is:

$$\begin{aligned} &(\text{Lines of Code (in thousand) / Effort (PM)}) \\ &= 5000/ 15.50 = 322.58 \end{aligned}$$

Scheduling of the Project is $\mathbf{TDEM=1.7*(15.50)^{0.20}=2.941}$

Average staff required is

15.50 Staff Months/ 2.941

Total = 5 Persons (approx.)

So, at last this has been traced out that to complete this Project the total time will be, **2.941 Months.**

If we assume the uniform wage amount and other installation equipment as the initial cost of the Project, as Rs. 60,000/-.

So, the initial cost of my Project is $=2.941 \times 60,000 = \text{Rs. } 176,460/-$ (Approx.)

If an extra amount of Rs. 500/- is added as the setup cost

Hence, total cost of the project is Rs. 176,960/-.

7 Conclusion

The proposed framework for automatic detection of motorcyclists driving without a helmet makes use of one of the most popular algorithm to solve Computer Vision problems i.e, YOLO(You Only Look Once: Unified Real-time Object Detection). The use of deep learning for automatic learning of discriminative representations for classification tasks improves the detection rate and reduces false alarms resulting in a more reliable system. In this work, a system is developed for detecting the motorcyclists who are violating the laws of wearing the helmet. The system mainly consists of three parts – detection of motorcycle, detection of helmet, and recognition of license plate of motorcyclists riding without a helmet. YOLO makes it possible to analyze all at a single go. The Output generated by Yolo successfully identifies all the three subsequent parts at once with a Mean Average Precision of about 99.79% and an average loss of 0.5831.

8 References

- [1]. K. Dahiya, D. Singh, and C. K. Mohan, "Automatic detection of bike riders without helmet using surveillance videos in real-time," in *Proc.*
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SILIGURI INSTITUTE OF TECHNOLOGY

IT 892

AN IOT BASED SMART MEDICINE BOX

BY

IT_PROJ_2020_02

Name of Students	Roll No.
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Under the Guidance

of

Prof.DEBADITYA KUNDU

Submitted to the Department of **Information Technology** in partial fulfillment of the requirements for the award of the degree Bachelor of Technology in **Information Technology**.

Year of Submission: 2020



Siliguri Institute of Technology

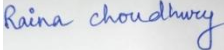
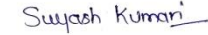
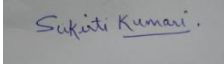

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DECLARATION

This is to certify that Report entitled **AN IOT BASED SMART MEDICINE BOX** which is submitted by we in partial fulfillment of the requirement for the award of degree B.Tech. in **Information Technology** at **Siliguri Institute of Technology** under **Maulana Abul Kalam Azad University of Technology**, West Bengal. We took the help of other materials in our dissertation which have been properly acknowledged. This report has not been submitted to any other Institute for the award of any other degree.

Date:

SN	Name of the Student	Roll No	Signature
1	RAINA CHOUDHURY	11900216022	
2	SUYASH KUMARI	11900216007	
3	SUKIRTI KUMARI	11900216008	
4	PRATIK BOSE	11900216027	

CERTIFICATE

This is to certify that the project report entitled **AN IOT BASED SMART MEDICINE BOX** submitted to **Department of Information Technology of Siliguri Institute of Technology** in partial fulfilment of the requirement for the award of the degree of **Bachelor of Technology in Information Technology** during the academic year **2019-20**, is a bonafide record of the project work carried out by them under my guidance and supervision.

Project Group Number : IT_PROJ_2020_02			
SN	Name of the students	Registration No	Roll No
1.	RAINA CHOUDHURY	161190110132	11900216022
2.	SUYASH KUMARI	161190110147	11900216007
3.	SUKIRTI KUMARI	161190110146	11900216008
4.	PRATIK BOSE	161190110127	11900216027

Signature of Project Guide

Name of the Guide:

Department of Information Technology

Acknowledgement

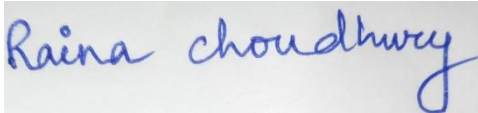
It is great pleasure to present this report on the project named “AN IOT BASED SMART MEDICINE BOX” undertaken by us as a part of our B.Tech (IT) curriculum.


It is pleasure that we find ourselves penning down these line to express our sincere thanks to the people who helped us along the way in completing our project. We find adequate words to express our sincere gratitude towards them.

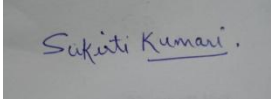
First and foremost we would like to express gratitude towards our project guide **Prof. DEBADITYA KUNDU** for placing complete faith and confidence in our ability to carry out this project and providing us time, inspiration, encouragement, help and valuable guidance. Without his sincere and honest guidance we would not have been able to reach the present stage.

Once again we would like to thank all those people who gave their valuable support by helping us in this project which is a great learning experience.

Signature of all the group members with date

1. 

2. 

3. 

4. 

ABSTRACT

This project proposes the design of IOT based Smart Medicine Box which will help the patients to take their medicines in the correct quantity and at the prescribed time. Assistive technology is one such technology which can help an individual tremendously. But today only 2 out of 50 people are using assistive technology due to high cost, lack of knowledge on the subject and availability. By 2050, every 10 out of 20 households will need one assistive product with many elderly needing 2 or more. It is also seen that people give more attention to work than health. This system aims to reduce this problem by reminding them to take the medicine on time within the prescribed time. It is a combination of physical and digital reminder for a patient that will be helpful for people of any age, but especially helpful for geriatrics who forget taking their medicines.

The main aim is to keep the system easy to handle and make it cost-efficient. This system uses Arduino, LCD display and Real Time Clock (RTC) module and an alarm system used to intimate the patients to take proper dosage according to the prescription at right time. This portable and economical system would help aged patients, especially to the illiterate patients. Our, smart pill box can reduce elderly family member's responsibility towards by reminding them to take the medicine on time. It proposes a smart pillbox with remind and consumption function. Which is used to give alert the user to take pills at a particular time and the pills required to take at that time comes out to the user to avoid confusion among medicines. Smart pill box can reduce elderly family member's responsibility towards giving the correct and timely consumption of medicines.

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1. INTRODUCTION

Capturing and sharing of vital data of the network connected devices through a secure service layer is what defines IOT. In simple terms, Internet of things can be defined as the wireless network of devices which are connected to each other to share information and data in order to communicate and produce new information so as to record and analyze it for future use. Collection of real-time data and recording database of patients has become easy due to the use of Internet of Things.

One of the most common reasons for the failure of a method to cure a patient is because of not taking the medicine at the prescribed time. People aged 50 or above are prone to diseases such as high blood pressure, diabetes, Alzheimer's and Parkinson's to name a few. Missing a dose for such a patient can prove to be very harmful. Hence it is vital for the patients to take the medicines on time. It has been observed that people in general neglect their health and give preference to other things than taking their medicines.

This project will be helpful for people who forget to take their medicines or even to those who have to take a lot of medicines and get confused about which medicine to take at what time. So this project will help people provide information about the patient's status whether he has taken the medicine or not. In this era, it is difficult for the family members to be present all the time for the aged. Today, most of the families in our society are a nuclear family. Elderly prefer staying independent, but it is a worry for their children. Sometimes despite their best efforts, the aged fail to take the medicine on time. This device is one approach to help them take the medicines effectively.

2. SYSTEM ANALYSIS

2.1.IDENTIFICATION OF NEED

At the behind of any project, there are mainly two important parts i.e. Proper Plans and Right execution of those plans. This is the key to success. That will always help to win any battle.

The SMART MEDICINE BOX Using IOT is an easy to maintain, affordable, reliable medicine box and can monitor health of patient by keeping track of daily dose of medicines taken. The major reason to bring medical field and technology field closer to make something innovative to reduce the current medical problem.

Features and Benefits

- Dispense of medicines from pill box at scheduled time.
- Medical alerts to care taker and retailer.
- Cost efficient and user-friendly.
- Provide comfort and health.
- Highly reliable.
- Easy to use and manufacture.
- Long-Lasting.
- Easy to maintain.

The proposed system can even be used by the naive users and it does not require any educational level, experience and can be fit for the elders and their limited knowledge and experience to implement the ease of use.

2.2. PRELIMINARY INVESTIGATION

Preliminary investigations involve collecting, gathering, preparing, preserving and analyzing information that helps to evaluate the merits of a project and make an informed judgement about the feasibility of the proposed project.

When this project was being conceptualized one of the prime considerations was the capability that technology has to offer to the present day solution designers.

One of the first things that the designer needs to consider pertains to the target user group and profiles. Some of the questions that need to be considered at this stage are :-

- Who will be the possible customer for this box?
- What will be the target profile of my customer?
- What is my customer's expectation in this kind of service?

While planning about **SMART MEDICINE BOX Using IoT**, on the internet a lot of consideration was given to all these issues. We also spoke with some sample use groups. Extensive thought was given to the various minimum-offering levels that can be provide against the possible returns from such offerings.

2.3.FEASIBILITY STUDY

A feasibility study is made to see whether a project can be successfully developed and deployed within the given time frame and the available resources. It looks for possible areas of risk and whether the risks are acceptable, whether the final outcome of the project would justify the cost involved and makes a study of the function, performance and constraints involve that may affect the ability to achieve an acceptable system.

Technical Feasibility: All the technical resources needed in the project are easily available. All the hardware used are open source.

Financial Feasibility: There is start-up investment needed for the project. Advertisement, communication and awareness amongst users are also the expenses to begin with.

Operational Feasibility: Simple to use and self-explanatory interface. Any user with basic knowledge can understand its functionality in few minutes.

2.4. PROJECT PLANNING

Project planning is a discipline for stating how to complete a project within a certain timeframe, usually with defined time stages, and with designated resources. It helps to look at where you are, where you want to go and how you will get there. This evaluation process will help in setting up a project which is needed in the community and helps a group to be successful.

Without a proper plan one can easily get lost in the crowd. Even small scale project should be planned thoroughly and lined with milestones; otherwise, that molehill and turn into a mountain.

Project planning is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. It is accomplished through the application and integration of the project management processes of initiating, planning, executing, monitoring and controlling, and closing.

Here are few reasons why a project plan is essential:-

1. Improve communication with clients.
2. Increase the transparency of the work.
3. Become more organized.
4. Focus on the project goal.

Project planning is an iterative process that starts when you create an initial project plan during the project start-up phase. Plan changes are inevitable. Development of project is a managed and planned process. Our project follows the following sequence of plan:-

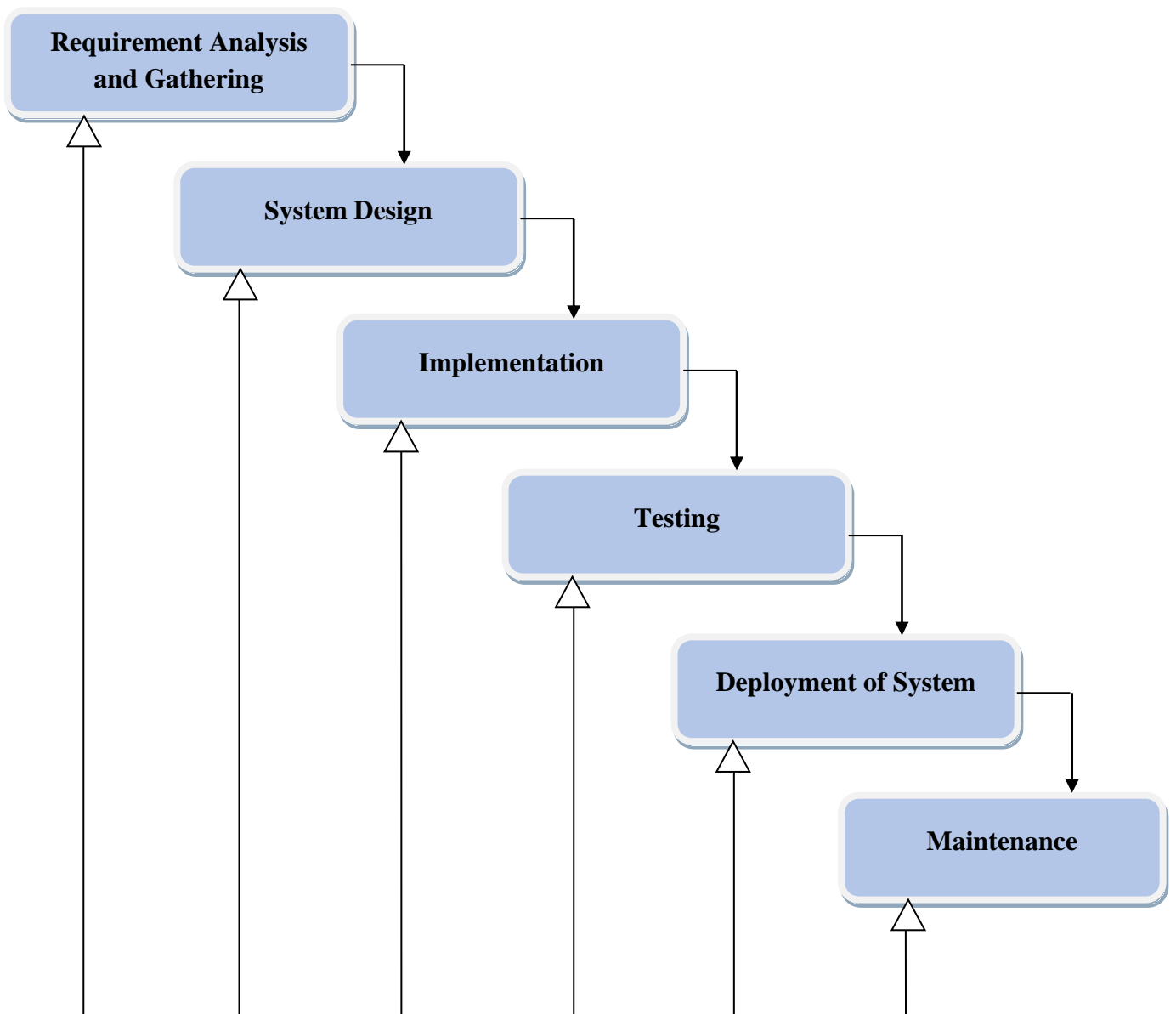
1. **Products:** Identification of the project's product—the product breakdown structure.
2. **Resources:** Listing the resources needed to deliver each product.
3. **Effort:** Calculating the effort and costs associated with each product.
4. **Timescales:** Setting time-scales for the project.

2.5. PROJECT SCHEDULING

Project scheduling is the process of deciding how the work in a project will be organized as separate tasks, and when and how these tasks will be executed. You estimate the calendar time needed to complete each task, the effort required and who will work on the tasks that have been identified. You also have to estimate the resources needed to complete each task, the time required on specialized hardware, and what the budget will be. Project scheduling activities:

- Split project into tasks and estimate time and resources required to complete each task.
- Organize tasks concurrently to make optimal use of workforce.
- Minimize task dependencies to avoid delays caused by one task waiting for another to complete.
- Dependent on project managers intuition and experience.

2.5.1. Life Cycle Model: Iterative Waterfall Model



2.6.SOFTWARE REQUIREMENT SPECIFICATION (SRS)

A Software requirement specification (SRS) describes the intended purpose, requirements, and nature of application/project to be developed. It is a detailed description of a software system to be developed with its functional and non-functional requirements.

2.6.1. External Interface Requirements

- **System Interface:**
Box would be a self-contained system. Neither will it access data of any other system nor will its data be accessed by other system.
- **User Interface:**
User of the system will be provided with the User Interface, though it is typically not as complex as a software interface.
- **Hardware Interface:**

TOOLS REQUIRED-

- **Arduino microcontroller:**
Arduino is an open-source electronics platform for both hardware and software. Arduino is an electronics bread boarding platform based on very flexible, easy-to-use system. One can read inputs on Arduino boards which contain inputs like light on a sensor, a finger on a button which turns into an output like activating a motor, turning on an LED lamp etc.
- **RTC:**
A **real-time clock (RTC)** is a computer clock (most often in the form of an integrated circuit) that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time.
- **Power Supply:**
The power supply design will provide the necessary power requirements of the Automated Pill Dispenser. The design requirements are 5mA at 5VDC for the microprocessor, 12VDC is necessary for the motor and motor controller, the GSM module requires 2A peak current at 12V DC.
- **Alarm module:**
This module is a combination of devices including an ultrasonic sensor, a buzzer and a GSM modem. The buzzer is sounded before the medicine is dispensed, the ultrasonic sensor keeps a track on if the medicine is taken or not.

2.7. SOFTWARE ENGINEERING PARADIGM

In our project we have used iterative waterfall model. This model is used when the requirements of the complete project are clearly defined and understood. In our project “**SMART MEDICINE BOX Using IOT**” all the requirements are clearly defined and understood.

The Iterative Waterfall Model is the most widely used Software Development Life Cycle (SDLC) model. This model is easy to understand and use, it suggests a systematic sequential approach that begins with customer specification of requirements and progress through planning, modelling, construction and deployment with on-going support to complete the hardware. The main advantage of this model is that we build and improve the hardware step by step for which we can track the defects at an early stage.

In iterative waterfall model we do not deliver the final product completely. Instead we deliver the product in parts, which can be reviewed in order to identify further requirements. This process is then repeated, producing a new version of the software for each cycle of the model, until the complete product is delivered.

This model is appropriate for our project as we have ample amount of time for designing it. This model generally takes more time to complete the software life cycle as when a stage completes it is signed off and the development goes to the next stage.

2.8. BLOCK DIAGRAM

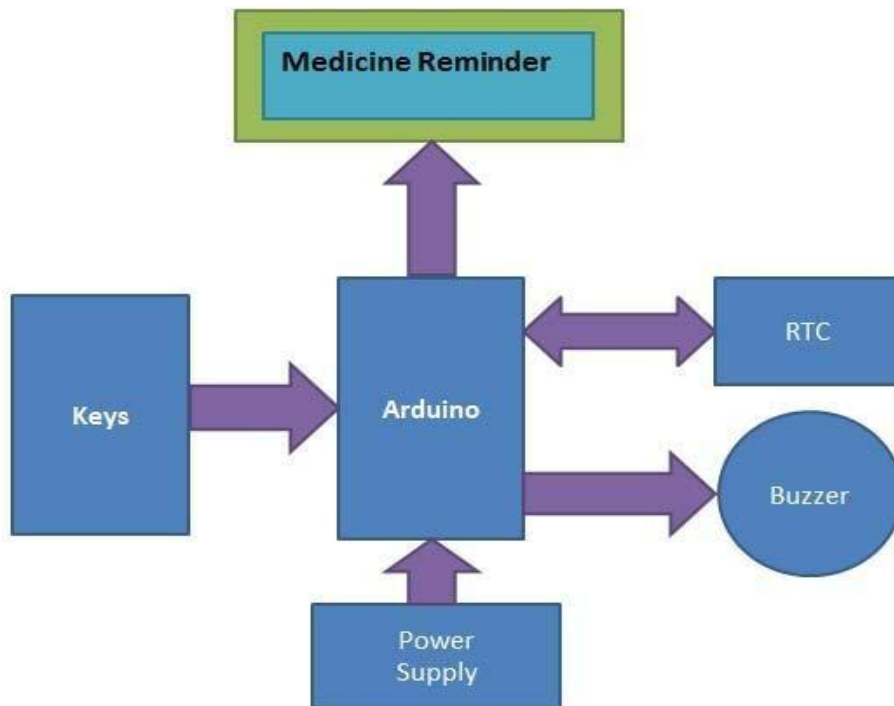


Fig:-Block Diagram of Smart Medicine Box

2.9. FLOW CHART

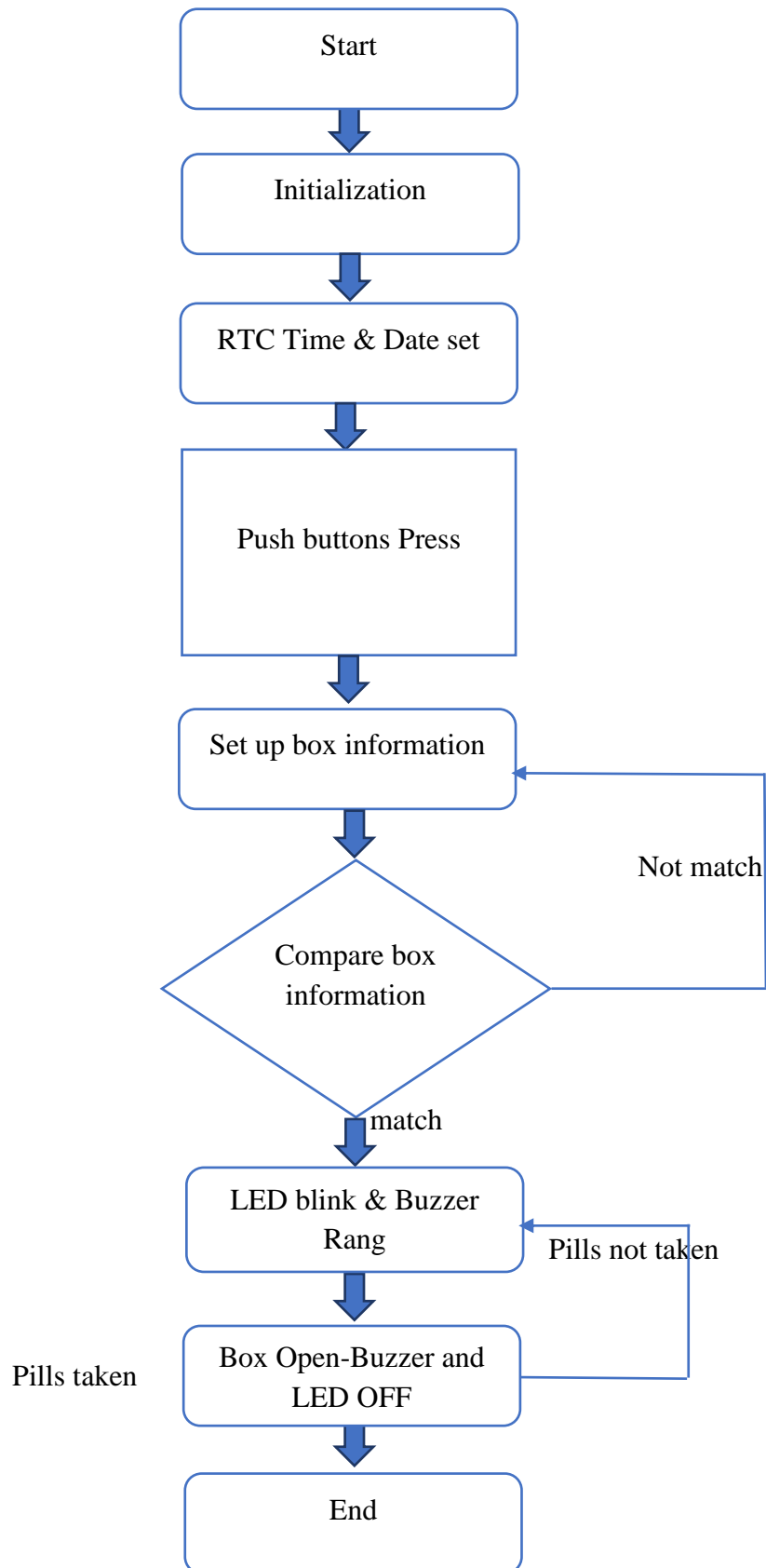


Fig:-Flowchart of Smart Medicine Box

2.10. CONNECTION CIRCUIT

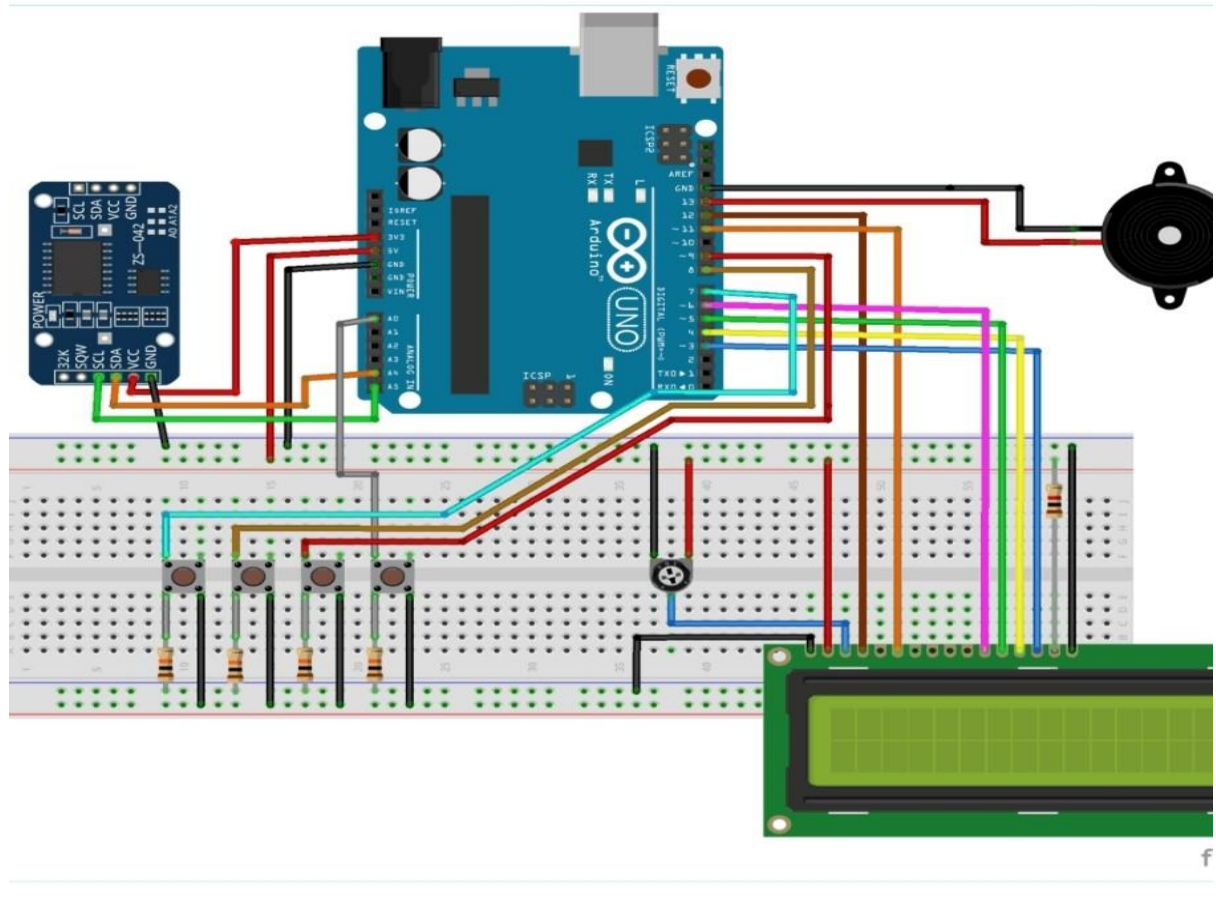


Fig:-Connection circuit of Smart Medicine Box

3. SYSTEM DESIGN

3.1. WORKING PRINCIPLE

In this **Medicine Reminder**, RTC DS3231 is interfaced through I2C protocol with Arduino Uno. RTC DS3231 also has inbuilt 32k memory which can be used to store additional data. RTC module is powered through the 3.3V pin of Arduino uno. A 16x2 LCD display is interfaced using SPI. A **buzzer** is used to alert and remind that it's time to take medicine. **Four push buttons** are used where each has distinct select feature. The first push button is used for reminding to take medicine once per day. The second push button is used to remind twice per day and the third push button is used to remind thrice per day. The fourth push button is used to stop the buzzer when user has heard the alert.

The **Pill Reminder Alarm** is powered using 5V supply. When it first boots up, it shows a welcome message as *"Welcome"*. The LCD screen is set to cycle in three screens. The 1st screen shows message as *"Stay Healthy, Get Well Soon"*. The second screen is a help screen which tells to press select push button to select any one time-slot to remind (once/twice/thrice in a day). The time slot is changeable in program and can be configured accordingly. Right now we have fixed this into three durations i.e. 8am, 2pm, and 8pm.

We have divided time slots into three modes. Mode 1 selects to take medicine once/day at 8am when user presses 1st push button. Mode 2 selects to take medicine twice/day at 8am and 8pm when user presses 2nd push button. Mode 3 selects to take medicine thrice/day at 8am, 2pm and 8pm if user presses 3rd push button.

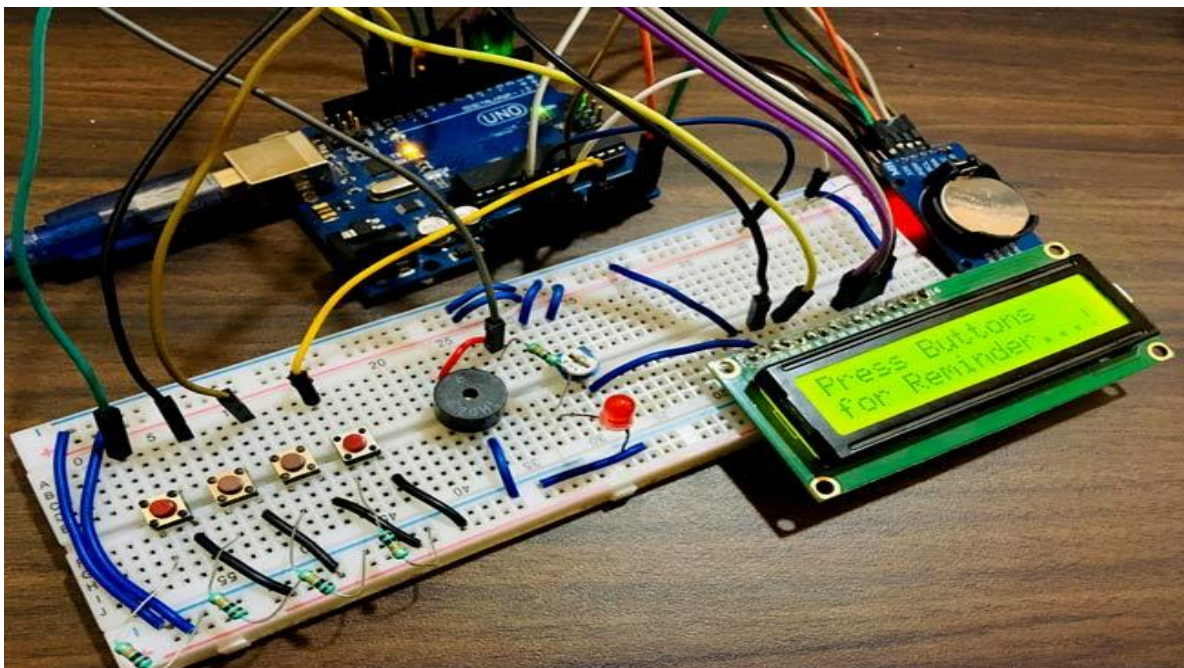


Fig: Physical Representation

When user selects desired slots by pressing push buttons, the user input is recorded and the time is taken from RTC. When time is matched with selected time slot then the buzzer starts buzzing. User can stop the buzzer by pressing STOP button.

3.2. PIN CONNECTIONS

Arduino Pins	Peripheral Pins
▪ 2	-----> D7 of 16x2 LCD Display
▪ 3	-----> D6 of 16x2 LCD Display
▪ 4	-----> D5 of 16x2 LCD Display
▪ 5	-----> D4 of 16x2 LCD Display
▪ 7	-----> 3rd push button
▪ 8	-----> 2nd push button
▪ 9	-----> 1st push button
▪ 11	-----> EN pin of 16x2 LCD Display
▪ 12	-----> RS pin of 16x2 LCD Display
▪ 13	-----> +ve Pin of Buzzer and Led
▪ A0	-----> Stop Push Button
▪ A4	-----> SDA of DS3231
▪ A5	-----> SCL of DS3231
▪ 3.3V	----->Vcc of DS3231
▪ Gnd	----->Gnd

4. CODING

Code To Include Libraries:

The EEPROM library is used to keep the track of user select input if Arduino is not turned on. And when user power on the Arduino it gets the previous state of push buttons using EEPROM library. The Wire.h library is used since the RTC DS3231 module is communicated using I2C.

```
<LiquidCrystal.h>
<RTClib.h>  (https://github.com/adafruit/RTClib)
<EEPROM.h>
<Wire.h>
```

Code to check RTC is properly connected or not:

```
if (! rtc.begin()) {                // check if rtc is connected
  Serial.println("Couldn't find RTC");
  while (1);
}
if (rtc.lostPower()) {
  Serial.println("RTC lost power, lets set the time!");
}
```

Code to set Date and Time:

```
rtc.adjust(DateTime(F(__DATE__), F(__TIME__)));
//rtc.adjust(DateTime(2019, 1, 10, 7, 59, 52));
```

Switch statement is used to read the previously saved state of the push button and resuming the state for appropriate and accurate reminder time:

```
val2 = EEPROM.read(addr); // read previously saved value of push button to start
from where it was left previously

switch (val2) {

  case 1:

Serial.println("Set for 1/day");

  push1state = 1;

  push2state = 0;

  push3state = 0;
```

```
pushVal = 01;

    break;

    case 2:
Serial.println("Set for 2/day");

    push1state = 0;

    push2state = 1;

    push3state = 0;

pushVal = 10;

    break;

    case 3:
Serial.println("Set for 3/day");

    push1state = 0;

    push2state = 0;

    push3state = 1;

pushVal = 11;

    break;

}
```

This statement is used to get the millis to use for timing control of the defined interval screen cycling:

```
currentMillisLCD = millis(); // start millis for LCD screen switching at defined interval of time
```

Code to read the digital pins connected to push buttons:

```

push1state = digitalRead(push1pin);
push2state = digitalRead(push2pin);
push3state = digitalRead(push3pin);
stopinState = digitalRead(stopPin);

```

Below function is used to read the push button state and write it to EEPROM:

```

void push1() { // function to set reminder once/day
  if (push1state == 1) {
    push1state = 0;
    push2state = 0;
    push3state = 0;
  }
  // pushPressed = true;
  EEPROM.write(addr, 1);
  Serial.print("Push1 Written : "); Serial.println(EEPROM.read(addr)); // for debugging
  pushVal = 1; //save the state of push button-1
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Reminder set ");
  lcd.setCursor(0, 1);
  lcd.print("for Once/day !");
  delay(1200);
  lcd.clear();
}
}

```

Function is used to stop the buzzer and led:

```

void stopPins() { //function to stop buzzing when user pushes stop push button

  if (stopinState == 1) {
  // stopinState = 0;
  // pushPressed = true;
  pushpressed = 1;
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Take Medicine ");
  lcd.setCursor(0, 1);
  lcd.print("with Warm Water");
  delay(1200);
  lcd.clear();
  }
}

```

Function for Screen Cycling:

```

void changeScreen() { //function for Screen Cycling

// Start switching screen every defined intervalLCD

  if (currentMillisLCD - previousMillisLCD > intervalLCD) // save the last time you
  changed the display

```

```

{
previousMillisLCD = currentMillisLCD;

screens++;

if (screens >maxScreen) {

    screens = 0; // all screens over -> start from 1st

}

isScreenChanged = true;

}

// Start displaying current screen

if (isScreenChanged)// only update the screen if the screen is changed.

{

isScreenChanged = false; // reset for next iteration

switch (screens)

{

    case getWellsoon:

gwsMessege();// get well soon message

        break;

    case HELP_SCREEN:

helpScreen();// instruction screen

        break;

    case TIME_SCREEN:

timeScreen();// to print date and time

        break;

    default:

        //NOT SET.

        break;
}
}

```

```
    }  
  }  
}
```

Function is used to start buzzing and blinking the LED simultaneously if the selected time has reached.

```
void startBuzz() { // function to start buzzing when time reaches to defined  
interval  
  
// if (pushPressed == false) {  
  
if (pushpressed == 0) {  
Serial.println("pushpressed is false in blink");  
    unsigned long currentMillis = millis();  
  
if (currentMillis - previousMillis >= interval) {  
previousMillis = currentMillis; // save the last time you blinked the LED  
Serial.println("Start Buzzing");  
if (ledState == LOW) { // if the LED is off turn it on and vice-versa:  
ledState = HIGH;  
    } else {  
ledState = LOW;  
    }  
digitalWrite(ledPin, ledState);  
    }  
}  
  
else if (pushpressed == 1) {
```



```
Serial.println("pushpressed is true");
```

```
ledState = LOW;
```

Function is used to compare the user selected time slot at 8am:

```
void at8am() { // function to start buzzing at 8am
  DateTime now = rtc.now();
  if (int(now.hour()) >= buzz8amHH) {
    if (int(now.minute()) >= buzz8amMM) {
      if (int(now.second()) > buzz8amSS) {
        //////////////////////////////////////
        startBuzz();
        //////////////////////////////////////
      }
    }
  }
}
```

5. TESTING

Testing is the process of executing a software program or application for finding the bugs. It is the process of validating and verifying that a software program, application or product meets business and technical requirements.

Testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test. Hardware testing can also provide an objective, independent view of the hardware to allow the business to appreciate and understand the risks of product implementation. Test techniques include the process of executing a program or application with the intent of finding and verifying that the product is fit for use.

TESTING OBJECTIVES:-

Testing has different goals and objectives. The major objectives of testing are as follows:

- Finding defects which may get created at the time of designing the product.
- Gaining confidence in and providing information about the level of quality.
- To prevent defects.
- To make sure that the end result meets the business and user requirements.
- To ensure that it satisfies the BRS that is Business Requirement Specification and SRS that is System Requirement Specifications.
- To gain the confidence of the customers by providing them a quality product.

Testing helps in finalizing the software application or product against business and user requirements. It is very important to have good test coverage in order to test the hardware application completely and make it sure that it's performing well and as per the specifications.

TYPES OF TESTING ADOPTED IN OUR PROJECT:-

There are different types of testing such as Unit Testing, Integration Testing, System Testing, Validation Testing, etc...

The types of testing adopted in this project are :-

- **Functionality Testing:** The general purpose of hardware functionality testing is to verify if the product performs as expected and documented ,typically in technical or functional specifications.
- **Compatibility Testing:** This testing is performed to make sure that product functions in its targeted use environment.
- **Performance Testing:** This testing ensures the independent analysis of the product in terms of how easy or difficult it is to use.

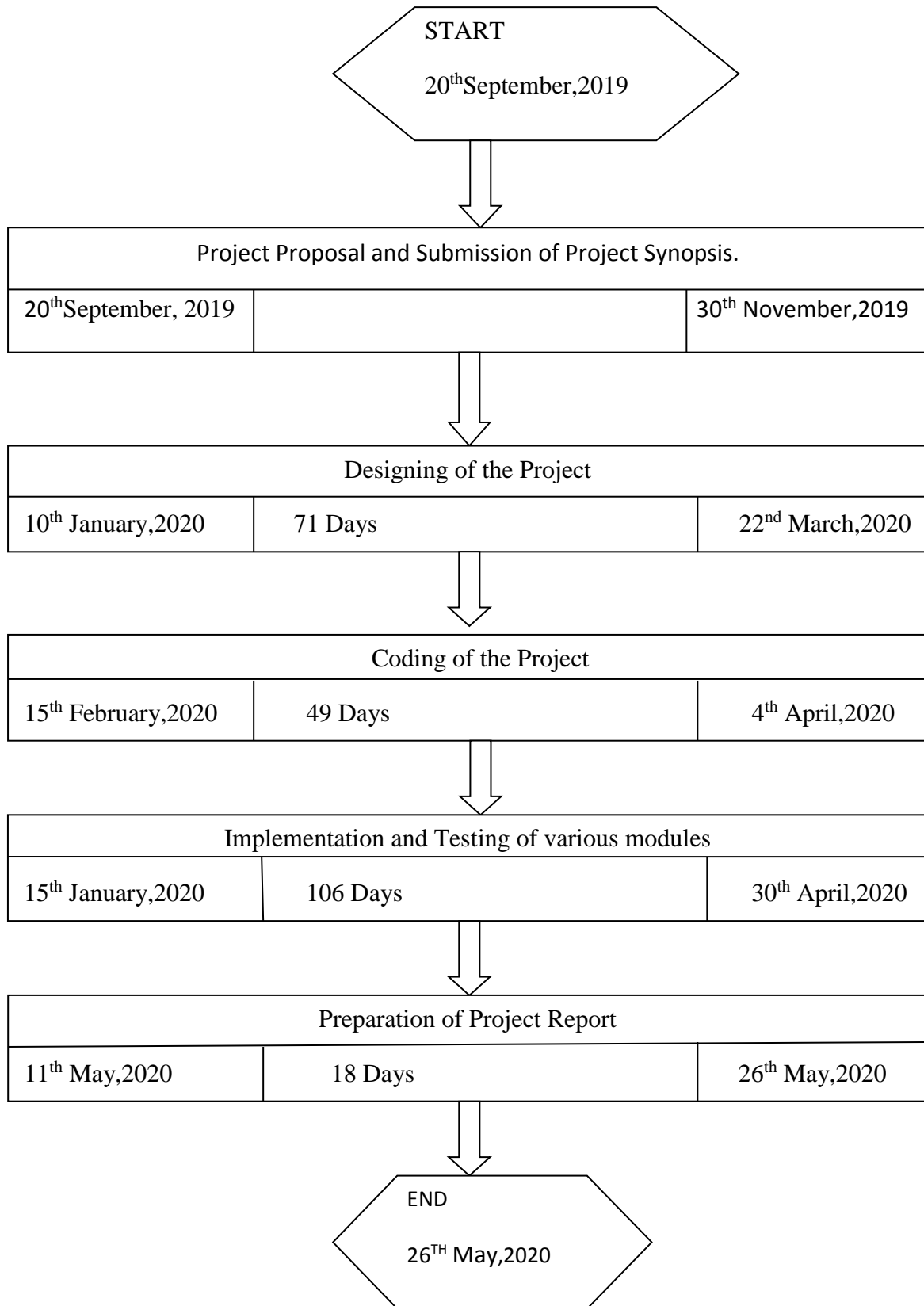
6. COST ESTIMATION OF THE PROJECT

Approximate cost of the components used in this project are:

1. Arduino Uno-Rs.300
2. RTC DS3231 module-Rs.125
3. 16*2 LCD Display-Rs.125
4. Buzzer-Rs.20
5. Led-Rs.40
6. Breadboard-Rs.120
7. Potentiometer and Resistors-Rs.20
8. Push Buttons-Rs.50
9. Jumper Wires-Rs.200

Total Cost=Rs.1000

7. PERT CHART



8. CONCLUSION AND RECOMMENDATIONS

There are many systems that are serving the same purpose. But these systems are difficult to use, non-mobile, expensive and a complex process. The proposed system overcomes all of the above problems and it is simply affordable with better accuracy. This system is helpful to every age group. It is helpful for tracking regular medicine intake and reduces manual supervision and human effort. With the simple circuitry and cheap device comes as a boon for the young and elderly, a simple solution for mothers for their adolescents and caretakers for the aged and suffering. It can find its use in every household or hospital that has medical supervision and can be marketed as an efficient solution for us. The main goal of the system is to provide healthy, tension free life to those who are taking pills regularly.

This system can help the doctors monitor a large number of patient's health with great ease and also keep a track of their daily medical doses. This medicine box is an active assistive project which overcomes the passive techniques used to help a patient and keep track of his/her health.

To improve medication safety and to avoid confusion in taking tablet among the elderly, this project proposed a smart pillbox with remind and confirm functions. The proposed pill box can reduce family member's responsibility towards ensuring the correct and timely consumption of medicines. Because the proposed pillbox containing an alert sound to the user for a particular time and real-time clock gives continuous time as an output.

9. FUTURE SCOPE

Future scope of the project are:-

- **Touch screen:** Touch screen facility can be added which is not available in any of the smart pill boxes till date.
- **Hospital applications:** The pill boxes can be used in hospitals where huge manpower is not available for a group of patients.
- **Security:** With the addition of facial recognition technology, biometric or retina scanning, this pill box can be made more secure so that no unauthorized person can handle the pill boxes or exchange the medicines without authentication.

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Solar Powered Smart Water Purification System

A PROJECT REPORT

Submitted by

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*In partial fulfillment for the award of the degree
of*

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING



SILIGURI INSTITUTE OF TECHNOLOGY

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July 2020

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*We owe our deep gratitude to our project guide Prof **Jayanta Bhusan Basu**, who took a keen interest in our project work and guided us all along, till the completion of our project work by providing all the necessary information for developing a good system.*

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DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I 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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BONAFIDE CERTIFICATE

Certified that this project report “**Solar Powered Smart Water Purification System**” is the bonafide work of “**Suman Dutta, Aniruddha Chaki, Sayantani Dey, Sajan Pradhan**” working under my supervision.

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ABSTRACT

In this project, we have designed a water purification system that works on solar energy. An ultraviolet water treatment system is designed and built to demonstrate the capability of water treatment. The system is specifically designed for the destruction of bacterial contaminants. Solar energy will be utilized to power the purification system. The solar radiations are collected by solar panels. This energy is then stored in a battery. The purification unit consists of a high-pressure motor, ultraviolet purification system, ultrafiltration purification system, and the water tank. Also, the system is equipped with Total Dissolved Solids (TDS) Sensor to detect and notify the quality of purified water through an LCD screen attached. This device would balance cost and efficiency to be marketable and for lower-income groups and is suitable for the developing countries that suffer from shortages of clean water.

1.0 INTRODUCTION

The scarcity of water and the quality of water is a major concern nowadays. The population is increasing on an exponential scale which leads to a greater need for water reserves. With the increase in population, there is a substantial increase in pollutants in the environment contaminating many streams, lakes, and rivers. Water scarcity is the lack of freshwater resources to meet the standard water demand. Water scarcity can also be caused by droughts, lack of rainfall, or pollution. This was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade. It is manifested by partial or no satisfaction of expressed demand, economic competition for water quantity or quality, disputes between users, irreversible depletion of groundwater, and negative impacts on the environment. Two-thirds of the global population (4 billion people) live under conditions of severe water scarcity at least 1 month of the year. Half a billion people in the world face severe water scarcity all year round. Half of the world's largest cities experience water scarcity. Contaminated water can carry different types of waterborne diseases. Drinking from untreated water increases the health risks and may be fatal in various cases. Even water sources that are away from densely populated areas can also be detrimental to human health. As such we need a solution to make the

polluted water potable. Figure – 1 shows the percentage of the population using contaminated drinking water.

Some important facts as noted below:

- In 2017, 71% of the global population (5.3 billion people) used a safely managed drinking-water service – that is, one located on-premises, available when needed, and free from contamination.
- 785 million people lack even a basic drinking-water service, including 144 million people who are dependent on surface water.
- Globally, at least 2 billion people use a drinking water source contaminated with feces.
- Contaminated water can transmit diseases such as diarrhea, cholera, dysentery, typhoid, and polio. Contaminated drinking water is estimated to cause 485000 diarrhoeal deaths each year.
- Climate change, increasing water scarcity, population growth, demographic changes, and urbanization already pose challenges for water supply systems. By 2025, half of the world’s population will be living in water-stressed areas. Re-use of wastewater, to recover water, nutrients, or energy, is becoming an important strategy.

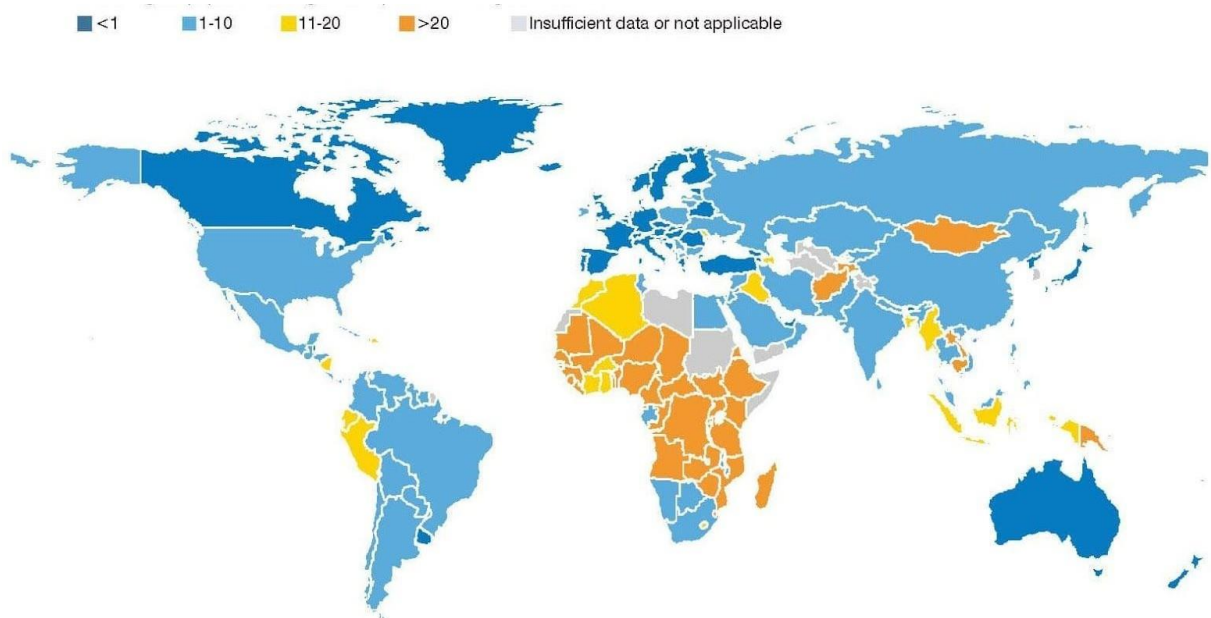


Figure 1: Percentage of population using contaminated drinking water.

It may be noted that even areas that currently do not need a way to provide safe drinking water may need it in the future with the rapid increase in pollution and scarcity of water.

Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids, and gases from water. The goal is to produce water fit for specific purposes. Most water is purified and disinfected for human consumption (drinking water), but water purification may also be carried out for a variety of other purposes, including medical, pharmacological, chemical, and industrial applications. The methods used include physical processes such as filtration, sedimentation, and distillation; biological processes such as slow sand filters or biologically active carbon; chemical processes such as flocculation and chlorination; and the use of electromagnetic radiation such as ultraviolet light.

Water purification is the process to remove the contaminants from the water for specific purposes. The contaminants like particulate matter, dissolved minerals. This are various technologies available in the market to purify the water such as filtration, ultraviolet (UV) radiation, or a combination of more than one and more technology. The most used technology is Ultrafiltration and UV radiation.

The goal of this project is to design a dependable way to purify water in locations that are off the grid and don't have constant sources of clean water. The design also needs to be able to be built on a low budget. In our project, we will use solar power for the operation of the purifier. In most rural areas there is a lack of availability of electricity. Without electricity, we cannot operate the purifier plant. Hence we can use solar power for the processing of purifiers. It is a clean source of electricity and also it will be environmentally friendly.

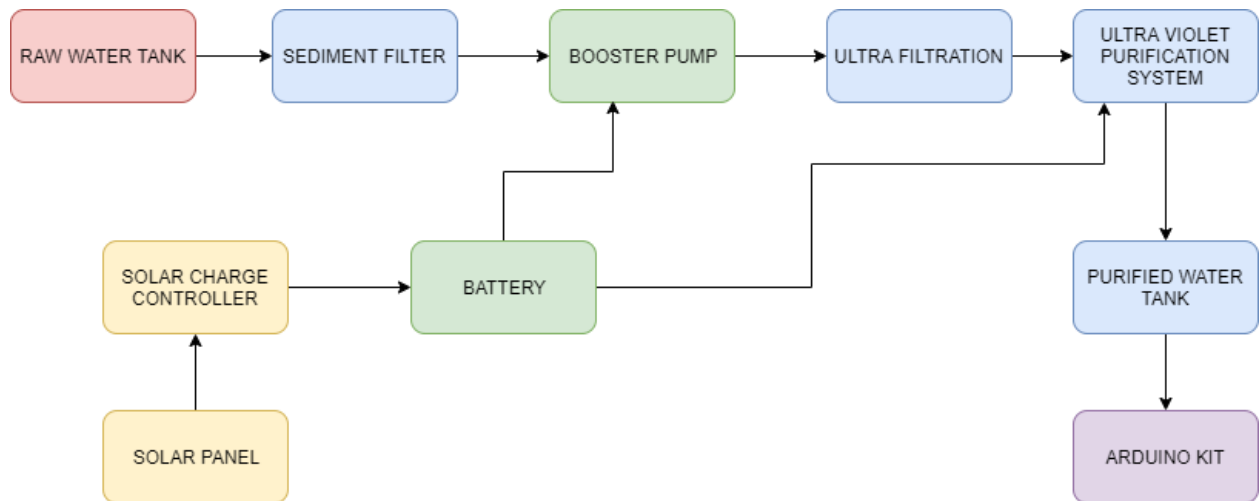


Figure 2: Block Diagram of Solar Water Purification System

2.0 REVIEW OF LITERATURE

There are many existing solar panel systems that are implemented across the world. Most of which are used to produce electricity to homes or small gadgets. Other forms of solar systems can also be used to heat water or homes. It has become a recent concern and idea to use solar panels as an energy source for cleaning water in developing countries where most of their large water supplies have become contaminated from human activity. Developing countries tend to use more polluting processes to generate power and have lower standards for keeping the environment clean and healthy. This pollution is disposed of into clean water sources and contaminates them. Over time this pollution adds up and these clean and drinkable bodies of water become completely useless and a great place for harmful organisms to thrive off of. People in some developing countries also use streams to wash and clothes if they do not have a stable supply of water provided for them. This water flows downstream where others drink from. All of these activities worsen the problem of decreasing sources of natural potable water.

Solar panels are clean energy systems that can cut down the pollution problem and still give the opportunity to generate a reliable source of potable water. One of the main concerns about solar panels is its lower efficiency. Solar efficiency is measured at about 15-20% on average.^[1] PV panels produce electricity, but in the form of a direct current (DC). Most of the common appliances require an alternating current (AC) to work properly. An inverter converts the produced DC electricity into AC electricity. The process of PV panels capturing energy from the sun and converting it into usable electricity with the help of an inverter.^[1]

Ultraviolet (UV) sanitizing units are used in many water purification systems to control bacteria. Ultraviolet or UV energy is found in the electromagnetic spectrum between visible light and x-rays and can best be described as invisible radiation. In order to kill microorganisms, the UV rays must actually strike the cell. UV energy penetrates the outer cell membrane, passes through the cell body, and disrupts its DNA preventing reproduction.^[5]

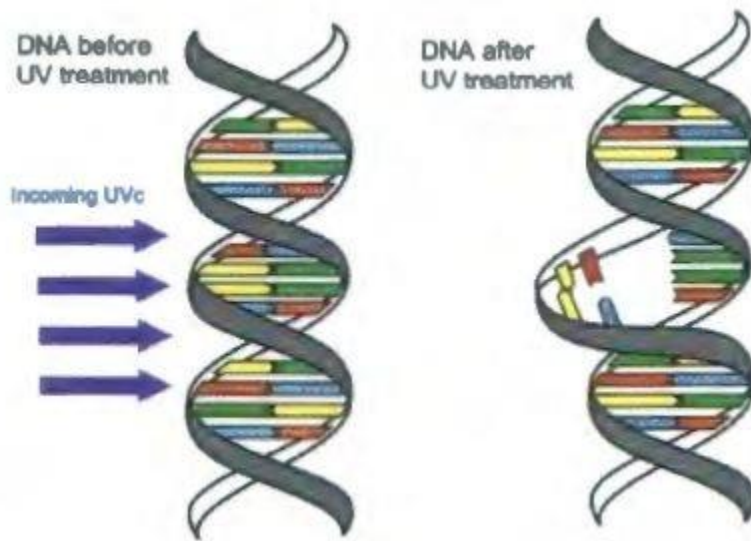


Figure 3: Disruption of DNA strand from UV energy

UV treatment does not alter water chemically; nothing is being added except energy. The sterilized microorganisms are not removed from the water. UV disinfection does not remove dissolved organics, inorganics, or particles in the water. The degree of inactivation by ultraviolet radiation is directly related to the UV dose applied to the water. The dosage, a product of UV light intensity and exposure time, is measured in microwatt second per square centimeter ($\mu\text{ws}/\text{cm}^2$). Table-1 lists dosage requirements to destroy common microorganisms.

Table -1 Ultraviolet Dosage Required For 99.9% Destruction of Various Organisms^[6]*(μ W-s/cm² at 254 nanometer)*

Bacteria	Mold Spores
Bacillus anthracis 8,700	Aspergillus flavus 99,000
B. enteritidis 7,600	Aspergillus glaucus 88,000
B. Megatherium sp. (vegetative) 2,500	Aspergillus niger 330,000
B. Megatherium sp. (spores) 52,000	Mucor racemosus A 35,200
B. paratyphosus 6,100	Mucor racemosus B 35,200
B. subtilis (vegetative) 11,000	Oospora lactis 11,000
B. subtilis (spores) 58,000	Penicillium digitatum 88,000
Clostridium tetani 22,000	Penicillium expansum 22,000
Corynebacterium diphtheria 6,500	Penicillium roqueforti 26,400
Eberthella typhosa 4,100	Rhizopus nigricans 220,000
Escherichia coli 7,000	Algae / Protozoa
Leptospira interrogans 6,000	Chlorella vulgaris (algae) 22,000
Micrococcus candidus 12,300	Nematode eggs 92,000
Micrococcus sphaeroides 15,400	Paramecium 200,000
Mycobacterium tuberculosis 10,000	Virus
Neisseria catarrhalis 8,500	Bacteriophage (E. coli) 6,600
Phytomonas tumefaciens 8,500	Hepatitis virus 8,000
Proteus vulgaris 6,600	Influenza virus 6,600
Pseudomonas aeruginosa 10,500	Polio virus 6,000
Pseudomonas fluorescens 6,600	Rotavirus 24,000
Salmonella enteritidis 7,600	Tobacco mosaic 440,000
Salmonella paratyphi 6,100	Yeast
Salmonella typhimurium 15,200	Baker's yeast 8,800
Salmonella typhosa (Typhoid) 6,000	Brewer's yeast 6,600
Sarcina lutea 26,400	Common yeast cake 13,200
Serratia marcescens 6,200	Saccharomyces cerevisiae 13,200
Shigella dysenteriae (Dysentery) 4,200	Saccharomyces ellipsoideus 13,200
Shigella paradysenteriae 3,400	Saccharomyces sp. 17,600
Spirillum rubrum 6,160	

Staphylococcus albus 5,720	
Staphylococcus aureus 6,600	
Streptococcus hemolyticus 5,500	
Streptococcus lactis 8,800	
Streptococcus viridans 3,800	
Vibrio cholerae 6,500	

UV-C rays will destroy a minimum of 99.99% of harmful microorganisms, including E. coli, Cryptosporidium and Giardia. Most UV units are designed to provide a dosage greater than 30,000 $\mu\text{W-s/cm}^2$ after one year of continuous operation. It can be noted that UV does not effectively disinfect some organisms (most molds, protozoa, and cysts) since they require a higher dose.

UV lamps do not burn out as normal fluorescent lamps do. Instead, the UV lamps will solarize, reducing their intensity to about 60% of a new lamp after about one year of continuous use. When lamps are new, they will generate a dosage level near 60,000 $\mu\text{W-s/cm}^2$. When the dosage drops to 30,000 $\mu\text{W-s/cm}^2$ (the minimum dosage needed to effectively kill bacteria) lamps should be replaced. Lamp life will be shortened significantly if the lamp is turned on and off more frequently than once every eight hours.

An ultraviolet lamp is one of the manufactured products that will need an alternating current to function properly. The mercury within the bulb goes through mercury migration if DC is used. Mercury migration is when mercury moves in one direction to the same electrode which causes it to fall out of the arc. If this occurs, the intensity of the bulb is drastically reduced.

The Advantages of UV Disinfection

- *Effective* – Destroys 99.99% of microorganisms
- *Chemical-free* – no harmful chemicals need to be added
- *Environmentally Friendly* –Go green! UV is an environmentally friendly alternative to chlorine disinfection and has no disinfection by-products
- *Essentially trouble-free* – once installed, annual service is usually all that is required
- *Reliable* – works night and day, 24/7, consistently keeping water safe

- *Safe* – no handling of chemicals
- *Cost-Effective* –only lamp & sleeve replaced annually
- *Clean* – no dirty parts to dispose of
- *Quick Process* – water flows through the system without the need for holding tank or reaction times
- *More effective than chlorine or chloramines* – especially on some waterborne cysts
- *Low energy usage* – low electrical needs
- *FDA Approved* – one of only 4 methods approved for disinfection by US Food & Drug Administration (FDA)
- *Conserves water* – The UV purification process does not waste any water
- *Taste and odour* – Chemical disinfection methods (such as chlorine) change the taste & odour of water and produce by-products. UV does not.

The Disadvantages of UV Disinfection

- *UV light is only able to eliminate microorganisms in water.* UV technology does not remove any other contaminants from water such as heavy metals, salts, chlorine, or man-made substances like petroleum products or pharmaceuticals. Other filtration methods should be employed with UV to ensure that all contaminants are removed from the water.
- *UV light is only able to work if the water is clear.* If the water is murky or contains “floaties,” a pre-filter should be used; UV light cannot effectively reach microorganisms because the rays are blocked by the other particles.
- *UV water systems need electricity to operate.* A UV may not be suitable for all applications such as rural, emergency needs, or survival needs if electricity is not available.

3.0 DESIGN PARAMETERS AND METHODS

Many different types of purification processes were considered during the design process of this project. In order to design a system that can be used anywhere in the world, it is important to use reusable resources. Constructing a system that will purify water using UV bulbs includes determining how much contact time is necessary to destroy all present microorganisms in the water and make it safe for consumption.

Type of purification:

There are many methods that can be used for purifying water. Saltwater can be desalinated and bacteria-infected water can be decontaminated. The areas that would be in need of this system are not always along the ocean so the system was designed with a focus on destroying bacteria and viruses. The method that was selected for this project was ultraviolet radiation for the inactivation of microorganisms. UV filtration doesn't alter the flavoring of the water as some chemicals do. A UV bulb can purify a large volume of water without the need for continually purchasing and applying chemicals to the tanks. UV rays at a calculated distance from the bulb with a determined contact time can disrupt microorganisms unseen by the human eye and make the water drinkable. A pre-filter screen placed at the top of the settling tank will separate larger particles before the water is pumped into the UV tank. The hand pump pulls water from the low part of the side panel to allow for any particles to settle out at the bottom of the tank and not get pulled into the UV tank.

Solar panel:

Photovoltaic Panel. A photovoltaic panel generates power for the ultraviolet bulbs and charges the battery. The panel generates the most amount of electricity when it is in direct sunlight and angled perpendicular to the sun. A single panel can provide more than enough electricity for one UV bulb. The battery is charged to store power in case of cloudy days or for use during the night. Photovoltaics (PV) comprise the technology to convert sunlight directly into electricity. The term “photo” means light and “voltaic,” electricity. A photovoltaic (PV) cell, also known as “solar cell,” is a semiconductor device that generates electricity when light falls on it. Although the French scientist Edmund Becquerel observed photovoltaic effect in 1839, it was not fully

comprehensible until the development of the quantum theory of light and solid-state physics in the early to middle 1900s. Since its first commercial use in powering orbital satellites of the US space programs in the 1950s, PV has made significant progress. While most PV cells in use today are silicon-based, a cell made of other semiconductor materials are expected to surpass silicon PV cells in performance and cost and become viable competitors in the thePV marketplace. This paper surveys the major types of PV cell materials including silicon-and non-silicon-based materials, providing an overview of the advantages and limitations of each type of materials.

Photovoltaic and Photovoltaic Cells

When sunlight strikes a PV cell, the photons of the absorbed sunlight dislodge the electrons from the atoms of the cell. The free electrons then move through the cell, creating and filling in holes in the cell. It is this movement of electrons and holes that generates electricity. The physical process in which a PV cell converts sunlight into electricity is known as the photovoltaic effect. One single PV cell produces up to 2 watts of power, too small even for powering pocket calculators or wristwatches. To increase power output, many PV cells are connected to form modules, which are further assembled into larger units called arrays. This modular nature of Fundamentals of Photovoltaic MaterialsPV enables designers to build PV systems with various power output for different types of applications. A complete PV system consists not only of PV modules, but also the “balance of system” (BOS)-the support structures, wiring, storage, conversion devices, etc. i.e. everything else in a PVsystem except the PV modules. Two major types of PV systems are available in the marketplace today: flat plate and concentrators. As the most prevalent type of PV systems, flat plate systems build the PV modules on a rigid and flat surface to capture sunlight. Concentrator systems use lenses to concentrate sunlight on the PVcells and increase the cell power output. Comparing the two systems, flat plate systems are typically less complicated but employ a larger number of cells while the concentrator systems use smaller areas of cells but require more sophisticated and expensive tracking systems. Unable to focus diffuse sunlight, concentrator systems do not work under cloudy conditions.

Types of PV cell material

PV cells are made of semiconductor materials. The major types of materials are crystalline and thin films, which vary from each other in terms of light absorption efficiency, energy conversion efficiency,

manufacturing technology and cost of production. The rest of the paper discusses the characteristics, advantages and limitations of these two major types of cell materials. The solar cells that we see on calculators and satellites are photovoltaic cells or modules (modules are simply a group of cells electrically connected and packaged in one frame). Photovoltaics, as the word implies (photo = light, voltaic = electricity), convert sunlight directly into electricity. Once used almost exclusively in space, photovoltaics are used more and more in less exotic ways. They could even power our houses. Photovoltaic (PV) cells are made of special materials called semiconductors such as silicon, which is currently the most commonly used. In fact, Over 95% of the solar cells produced worldwide are composed of the semiconductor material silicon (Si). Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. PV cells also all have one or more electric fields that act to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off to use externally. For example, the current can power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce

Arduino kit:

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header, and a reset button. This board is designed with a set of input and output pins that interface with various expansion boards. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

Arduino is used for controlling purposes. If the raw water tank is empty that time booster pump will be off this provision is made through the Arduino. Water level indicators indicate the storage status of the water store in the tank.

Also, a TDS (Total Dissolved Solids) meter indicates the total dissolved solids in the purified tank and notifies the same to us. The drinking water that we get today is flushed with hazardous chemicals from the different water treatment plants. As a result, the natural minerals present in water are taken away. In such a situation, it is essential to use the proper filtration processes to remove the contaminants and make water safe for consumption. The main contaminant present in water is total dissolved solids (TDS) that are left in the water after the normal filtration process. Contaminants that are larger than 2 microns are termed as total dissolved solids. A fine filter generally removes particles that are 0.45 microns in size and originates from different sources. The remaining contaminants in water after the filtration process consist of charged atoms and ions. Moderate to high TDS in water not only changes the taste of water but also poses a lot of health hazards. The water that you receive exceeds the maximum level of TDS that needs to be present in water. Water that has a TDS level of more than 1000mg/L is unfit for consumption. A high level of TDS in water can lead to a number of health problems. The presence of potassium, sodium, chlorides increases the TDS level in the water. A TDS water meter is a tool that indicates the amount of total dissolved solids (TDS) in the water. The hand-held product measures electrical conductivity (EC). EC concentration increases by the presence of ionized solids like salts and minerals. It does not detect dissolved organic solids as they do not affect the conductivity of the solvent. The palatability of drinking- water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than 300 mg/litre; good, between 300 and 600 mg/litre; fair, between 600 and 900 mg/litre; poor, between 900 and 1200 mg/litre; and unacceptable, greater than 1200 mg/litre.

The circuit diagram can be referred below where the Arduino UNO is connected to an LCD Display Panel and a TDS Sensor which then is connected to the Water Tank. The LCD panel displays the Total Dissolved Solids in the purified water tank. This ensures that purity is guaranteed every time.

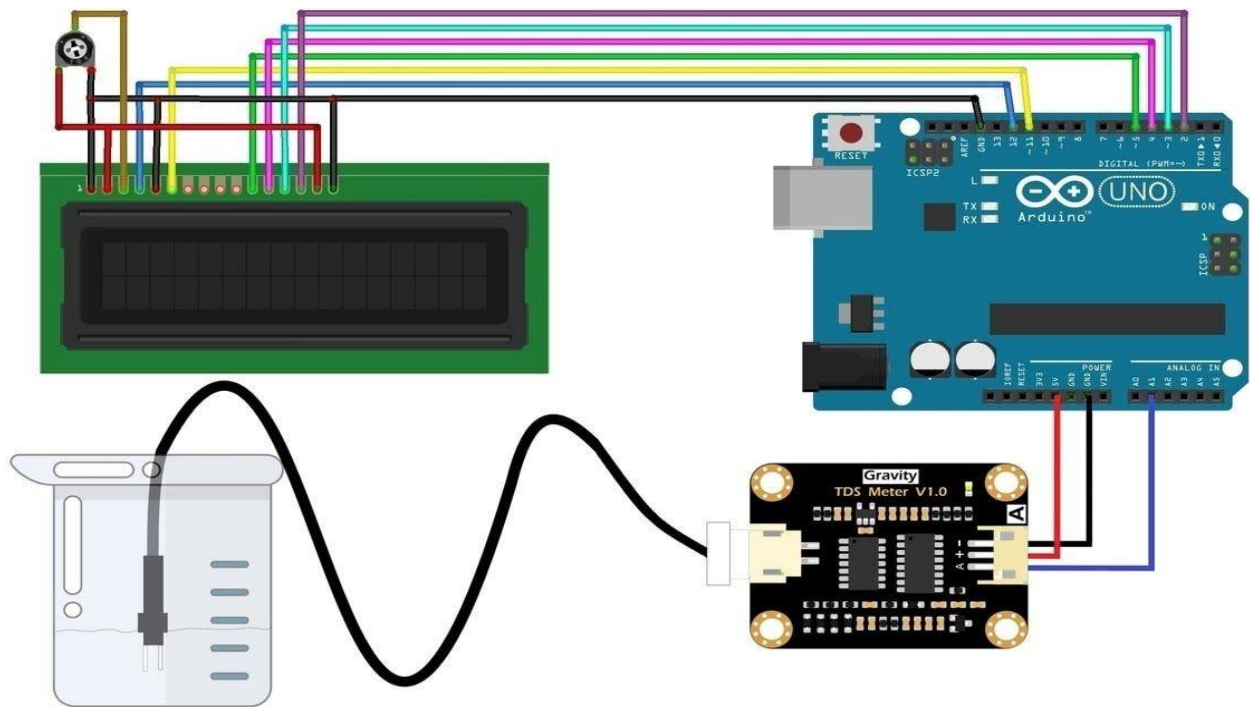


Figure 4: Arduino Circuit Schematic of the Project

Solar charge controller:

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life.

A solar charge controller is fundamentally a voltage or current controller to charge the battery and keep electric cells from overcharging. It directs the voltage and current hailing from the solar panels setting off to the electric cell. Generally, 12V boards/panels put out in the ballpark of 16 to 20V, so if there is no regulation the electric cells will damage from overcharging. Generally, electric storage devices require around 14 to 14.5V to get completely charged. The solar charge controllers are available in all features, costs, and sizes. The range of charge controllers is from 4.5A and up to 60 to 80A.

Ultra-violet purification system:

Ultraviolet or “UV” is a type of energy found in the electromagnetic spectrum, lying between x-rays and visible light. Although we cannot see UV light or rays, we are exposed to them every time we step out into the sun. In fact, UV light is responsible for causing sunburns.

UV Water Purification systems use special lamps that emit UV light of a particular wavelength that has the ability, based on their length, to disrupt the DNA of microorganisms. These UV light waves are also referred to as the Germicidal Spectrum or Frequency. The frequency used in killing microorganisms is 254 nanometers (nm). As water passes through a UV water treatment system, living organisms in water are exposed to UV light which attacks the genetic code of the microorganism and rearranges the DNA /RNA, eliminating the microorganism's ability to function and reproduce. If a microorganism can no longer reproduce, it cannot replicate, therefore it cannot infect other organisms with which it has contact. This process of exposing water to UV light is simple but so effective that it can eliminate up to 99.99% of bacteria and viruses, including those associated with water-borne illnesses such as Typhoid, Gastroenteritis, Hepatitis, Flu, and Cholera. UV water purification can be used to treat water whether it's from a municipal water supply, a drinking-water well, lake, or a spring.

Ultra-filtration system:

Ultrafiltration (UF) is a variety of membrane filtration in which forces like pressure or concentration gradients lead to a separation through a semipermeable membrane. Suspended solids and solutes of high molecular weight are retained in the so-called retentate, while water and low molecular weight solutes pass through the membrane in the permeate (filtrate). This separation process is used in industry and research for purifying and concentrating macromolecular (103 - 106 Da) solutions, especially protein solutions.

Ultrafiltration is not fundamentally different from microfiltration. Both of these separate based on size exclusion or particle capture. It is fundamentally different from membrane gas separation, which separates based on different amounts of absorption and different rates of

diffusion. Ultrafiltration membranes are defined by the molecular weight cut-off (MWCO) of the membrane used. Ultrafiltration is applied in cross-flow or dead-end mode.

Many ultrafiltration systems use a hollow fiber membrane, which filters water from the inside out. This provides a large surface area for particles to adhere to. Other membranes, like the spiral, wound RO membrane, filter from the outside in. The hollow fiber membrane has a high chemical resistance to oxidants and chlorine, but a TFC reverse osmosis membrane cannot tolerate any chlorine.

A reverse osmosis system provides the most extensive filtration because the RO membrane has the smallest pore size, but this level of filtration is not always necessary or preferred. A UF system retains beneficial minerals that an RO system removes. However, this means that an ultrafiltration system does not remove salts, fluoride, or TDS dissolved in water. An ultrafiltration system also operates on low water pressure, but a reverse osmosis system needs a booster pump to increase water flow.

Filtration Spectrum

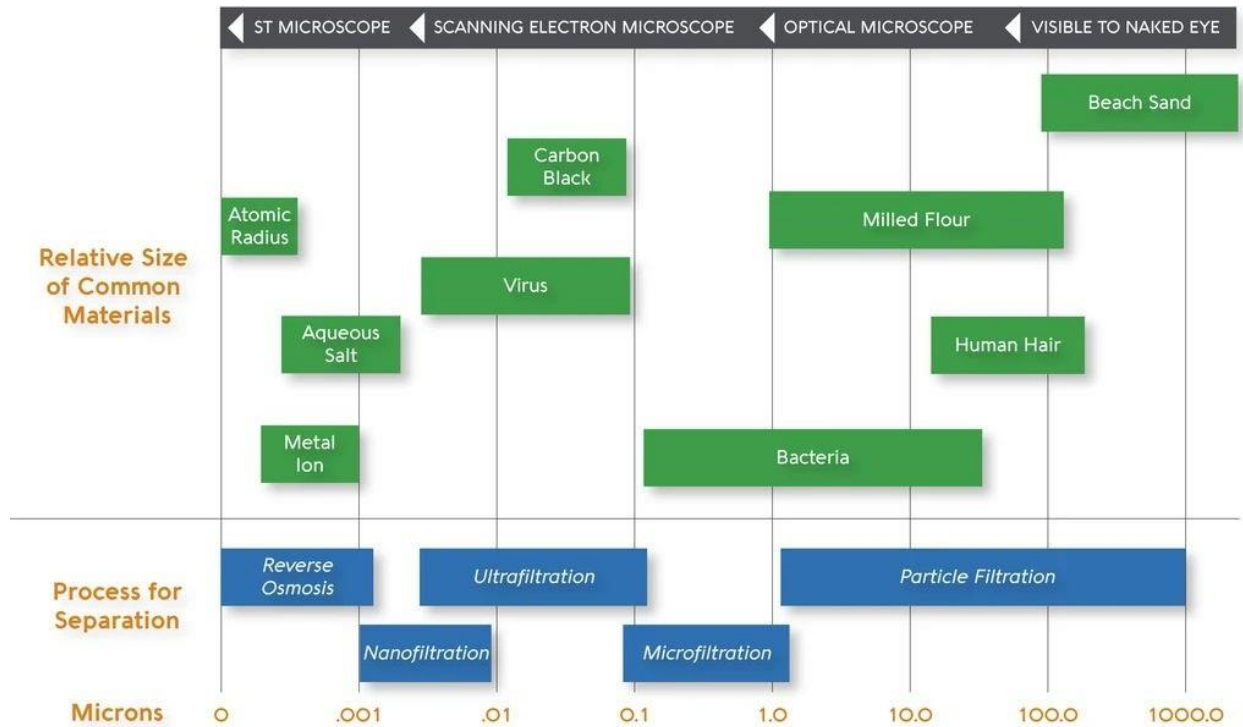


Figure 5: An Overview of UV ultrafiltration Spectrum

4.0 SYSTEM COMPONENTS

Solar panel specifications:

The photovoltaic panel collects the energy from the sun and converts it to electricity that can be used by the UV bulb. A single panel is able to power the entire system.

Peak Output Power: 20W

Operating Voltage: 12V

Type: Polycrystalline



Figure 6: A Standard 12V, 20W Solar Panel

Number of Cells: 36

Voltage at maximum power: 8.20V

Current at Maximum Power: 1.10 A

Open Circuit Voltage: 22.40 V

Short Circuit Current: 1.45 A

Weight = 2.5 Kg

Dimensions (L*W*H) = 450 * 350 * 22 mm

Battery specifications:

Sealed Maintenance Free(SMF) Battery

Rating: 12V, 7.5 Ah



Figure 7: A Standard 12V, 7.5Ah

Solar charge controller specifications:

Power Rating: 100W

Voltage Rating: 12/24V

Current Rating: PWM 6A



Figure 8: Solar Charge Controller

Ultra-violet system specifications:

Ultra Violet Lamp:-

Power Rating: 11 W

Dimension: 8 inch

Dose : 16,000 $\mu\text{W}\cdot\text{s}/\text{cm}^2$

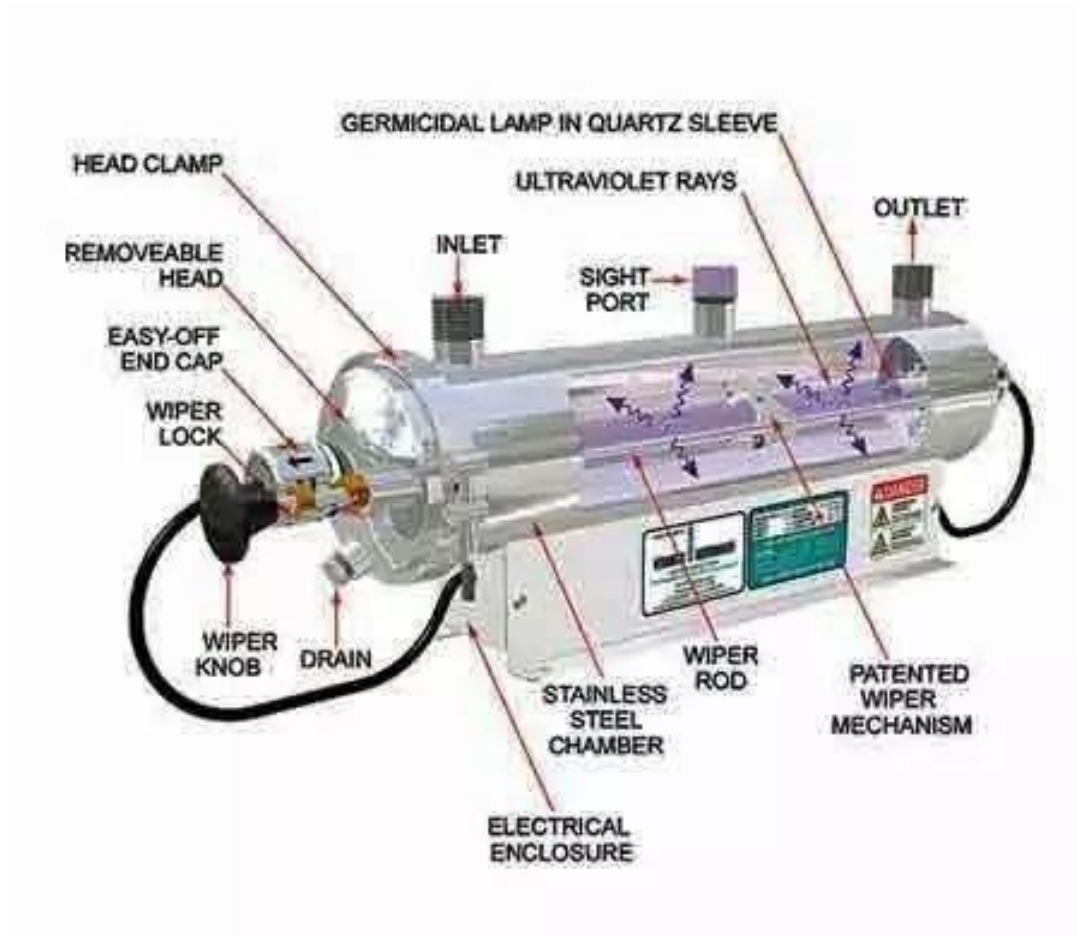


Figure 9: UV Purification System

Ultra Violet Choke:-

Current Input: 220V AC

5.0 RISKS AND MITIGATIONS

One of the main risks for this project is the weather. The system was designed to operate during a sunny day with an average solar irradiance of 850 W/m². The system can only run in sunny conditions; therefore, the system was designed for coastal communities with abundant sunlight. Another risk involved with the project would be contaminants and high salinity in the water. We must be able to guarantee that the dangerous contaminants are removed and the water is safe to drink and use. By boiling the saltwater, the system will remove all contaminants, making the condensed vapor safe to drink.

6.0 POTENTIAL MARKET

Clean water is not an unlimited resource and it is something most developed nations take for granted. Only 3% of the World's water is actually fresh water, leaving the rest as undrinkable ocean water. Fresh water is even scarcer in developing countries and areas destroyed after natural disasters, such as the Haiti earthquake. Therefore, our system was designed with the intent of helping developing coastal communities that have a limited supply of fresh water. The targeted communities would be in developing countries, on the coast, and in sunny regions. This would be ideal because the communities could use the ocean water and sun to power the system and produce clean water. We would, therefore, sell our system to non-profit organizations that could implement the system in developing coastal communities and for disaster relief. Due to the fact that the Solar-Powered Water Purification System is scalable, the system can produce more water with additional solar troughs. The system could, therefore, be marketed in developed countries that have a much higher demand for clean water. This would include residential areas, large-scale desalination plants, military locations, and "green" businesses that want to implement our technology. These potential buyers should be in sunny areas to yield maximum efficiency of the system.

7.0 SOCIETAL INFLUENCE

The Solar-Powered Water Purification System has widespread implications on the wellbeing of society through the vast improvement of public health in various portions of the world. The system utilizes a comprehensive distillation process, by which the dirtied water is shed of both its organic and inorganic contaminants. The World Health Organization (WHO) estimates that 4.1% of the total global burden of disease can be attributed to waterborne diseases, leading to an average of 1.8 million deaths per year. 88% of these deaths can be directly attributed to waterborne diseases, due specifically to poor water sanitation and hygiene practices. The most prominent illness comes in the form of diarrheal disease, which accelerates dehydration in areas that already lack an adequate supply of clean water. This form of illness is the result of protozoal infections such as: Amoebiasis, Cryptosporidiosis, and Giardiasis, which have a strong presence in untreated water. Similarly, a number of familiar types of bacterial infection like, E. coli, Dysentery, Leptospirosis, and Typhoid fever, are all attributed to the consumption of unsafe water. A number of more serious illnesses, such as the parasitic Guinea Worm, Hepatitis A, and Polio, can be contracted from untreated water and very commonly lead to death. The Solar-Powered Water Purification System deals with these organic contaminants through the use of

high-temperature water pasteurization. The goal of pasteurization is different from sterilization. Instead of focusing on the complete degradation of all contaminants, pasteurization aims to reduce the number of viable contaminants to a level where they are unable to cause sickness. In the milk industry, it is common practice to heat milk up to 71°C for a duration of 15 seconds, resulting in a 99.999% reduction in harmful microorganisms, with an overall effectiveness of around 90% in the elimination of harmful bacteria within milk . The Solar-Powered Water Purification System progressively heats unpurified water up throughout the day to temperatures in excess of 100°C, while the water itself is sustained at temperatures above 71°C for anywhere from 45-90 minutes. This vastly exceeds the accepted pasteurization procedures carried out in the milk industry. However, just the removal of microbial infection is not enough to adequately purify water. Untreated water is also subject to a number of inorganic contaminants, which can cause a wide variety of unwanted illnesses, making the water undrinkable. These contaminants include: salt, silt, lead, nitrate, and volatile organic compounds . The distillation process serves to separate any inorganic compounds with a higher boiling point than dihydrogen oxide exclusively through its evaporation and recollection. The once dissolved heavy metals and nitrates are left behind in solid form, where they can be safely disposed of. In addition, highly volatile and dangerous organic compounds, including a number of pesticides and herbicides, are quickly vaporized; and, thus, removed from the water in the early stages of the distillation process. The system is aimed at providing an average of 30 L of water per day resulting in a cost of rs 10 per liter of water. However, the system is not limited to a 30 L production and can be scaled to accommodate any communal water requirement. Similarly, the cost of producing clean water is 50% lower than the average rs 100 fee for an 18.9 L jug of chlorine treated water. The low price and high level of self-sustainability create an attractive option for communities in need of a medium to large scale method of purifying water, and ultimately makes the acquisition of clean water more accessible to everyone. By providing a self-sufficient, comprehensive, and scalable solution to the world's shortage of clean water, the quality of life for many people around the world can immediately be improved with only a minor financial investment.

8.0 ENVIRONMENTAL IMPACT

Water distillation requires a large quantity of energy to take place. This energy can be supplied from a variety of sources, such as electricity and fossil fuels. However, burning fossil fuels result in large quantities of carbon dioxide emissions to the atmosphere. To minimize the environmental impact of the water distillation system, solar energy, a renewable clean source of energy, was used. Solar parabolic troughs are used to collect heat from the sun by reflecting its rays onto a central focal length, and transferring its heat

to a non-toxic HTF. PV panels are used to produce the electricity necessary for operation of the system's electrical components. By implementing a control system, these electrical components can be turned on and off as needed to minimize the power consumption and size of the PV panel. A 120-W monocrystalline PV panel is used to power the entire system, making it completely off-grid. A single axis tracking system is used to minimize the cosine loss that is typical of static panels, thereby increasing its efficiency. In addition to having no carbon dioxide emissions, the Solar-Powered Water Purification System produces very little noise. The loudest component in the system is the HTF pump. By controlling its speed using PWM and variable frequency, both the duty cycle and noise are lowered. By producing a system that uses only the energy captured from the sun to power its components and to distill water, carbon dioxide emissions will be minimized. In addition, no power lines will be needed to operate the low-noise system.

9.0 SUSTAINABILITY IMPACT

The Solar-Powered Water Purification System is designed with sustainability as one of its main design requirements. The operation of the system has been designed to be based solely on energy provided from the sun; thus, the entire heating process of the water, circulation of the vapor and HTF of the system, and the positional tracking of the solar collectors is done without the need for external electric or fuel sources. This results in the system having zero emissions, and relatively minor amounts of by-products. These by-products would generally be limited to salt cakes that form in the boiler after extended periods of distillation. However, these salt cakes could potentially be used or sold as salt licks for livestock, or even used as a means for nutrition and food preservation.

10.0 HEALTH AND SAFETY IMPACT

The Solar-Powered Water Purification System poses many safety and health risks since it reaches very high temperatures and produces its own electricity. Many of the surfaces on the system are at temperatures that sometimes exceed 100°C. These surfaces include the HTF circulation piping and the boiler. To improve system efficiency, these hot surfaces are insulated to prevent heat loss. The insulation doubles as a safety buffer, preventing these surfaces from being touched by its users. Similarly, the envelopes placed over each of the parabolic trough collector tubes insulate the system while preventing users from touching its surface. The system uses a 12 V, 120-W PV panel to produce electricity for component operation. To prevent overcharging of the battery, a solar charge controller is used. Severely overcharged batteries can explode, leaving its surroundings covered in

battery acid. The charge controller shuts off current flow to the battery when its maximum capacity has been reached. To protect users from potential electrical shock, the system must be properly grounded, using the grounding rod. The electrical components are all housed in insulated, weatherproof boxes, and the wires are run through conduit to minimize exposed wire. In addition, proper selection of materials and components will prevent electrical components from overheating and causing potential burn hazards.

11.0 CONCLUSION

Water is important for life and one of the elements of human existence. Safe drinking water is the basic need of human beings. The presence of water also makes earth the only place where there are life forms. Although a natural resource, the presence of many harmful contaminants makes water unfit for consumption. Misuse of water bodies, growing population, industrial development, and environmental degradation cause water pollution. Also, Microbial contamination of drinking water is a major health hazard. Considering these factors, it is essential to install a water purifier to remove the impurities from water and make it suitable for consumption. We can use UV purifiers for clean and freshwater. A smart controller is used to get pure drinking water with the optimum use of renewable energy sources for the wide application of the system. It is cheaper as compared to other UV purification systems available in the market.

In these hard times the demand of purified water has seen a major surge resulting in the scarcity of water. The need for a great water management system is very crucial at this moment. We are devoted to our project and hoping to work and develop on this for a complete successful application on masses. However, due to the unavoidable circumstances resulting from the global Covid-19 Pandemic, we could not use our Institution's laboratory and research facilities. We have the concept map, theory and components ready and hoping to work on it as soon as the pandemic situation improves.

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**Study on Marble Powder as Partial
Replacement of Cement in Normal
Compacting Concrete**

PROJECT GUIDE

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ABSTRACT

In this study, the investigation of performance on the strength parameter of concrete mix by partial replacing the cement with marble powder is done. Along the rapid growth of human needs in many sectors, a significant decrease in the availability and viability of the natural resources was always faced. Neither the less, the high volume production is always associated with considerable amount of waste materials. The waste generated from the industries cause environmental problems. Hence the reuse of this waste material can be emphasized. Marble Dust Powder (MDP) is a developing composite material that will allow the concrete industry to optimise material use, generate economic benefits and build structures that will strong, durable and sensitive to environment. MDP is by-product obtained during the quarrying process from the parent marble rock; which contains high calcium oxide content of more than 50%. The potential use of marble dust can be an ideal choice for substituting in a cementitious binder as the reactivity efficiency increases due to the presence of lime. A total of five concrete mixes, containing 0%, 5%, 10%, 15% and 20% partial replacement of cement with marble powder are investigated in the laboratory. These mixes were tested to determine compressive strength for 7,14,28 days and then compared with Conventional concrete. The results of the laboratory work showed that replacement of cement with MDP increase, up to 10% for compressive strength.

Keywords—Marble Dust Powder (MDP), cement, Compressive strength.

INTRODUCTION

It has been estimated that several million tons of MDP are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. The purity of the marble is responsible for its colour and appearance it is white if the limestone is composed solely of calcite (100% CaCO_3). Marble is used for construction and decoration; marble is durable, has a noble appearance, and is consequently in great demand. Chemically, marbles are crystalline rocks composed predominantly of calcite, dolomite or serpentine minerals. The other mineral constituents vary from origin to origin. The main impurities in raw limestone (for cement) which can affect the properties of finished cement are magnesia, phosphate, leads, zinc, alkalis and sulfides. A large quantity of MDP is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons.

Before this study, different investigations are found the solutions on concrete composite materials. Natural resources are decreasing from the earth and increasing wastes from in powderries generated simultaneously. The eco friendly and consistent enhancement for construction includes the utilization of non conventional and unusual waste materials, and use of waste material for reducing emissions in environments and decreasing the utilization of environmental resources. In this experiment, and mixed with Marble powder is employed as fractional replacement with Cement. Marble powder is the waste which is generated from Marble finishing In powderries in construction which has similar physical and chemical actions of sand and utilized as replaced with cement.

LITERATURE REVIEW

The aim of this research is to develop high strength concrete with the utilization of a waste product MDP. Although deep interest in studies of MDP utilization has been developed during last six to seven decades, the .latest research work is given below.

- A. **Manju Pawar et.al (2014)** :- A Study has been conducted on Periodic Research, The Significance of Partial replacement of Cement with Waste Marble Powder. They found that the effect of using marble powder as constituents of fines in mortar or concrete by partially reducing quantities of cement has been studied in terms of the relative compressive, tensile as well as flexural strengths. Partial replacement of cement by varying percentage of marble powder reveals that increased waste marble powder (WMP) ratio result in increased strengths of the mortar and concrete .Leaving the waste materials to the environment directly can cause environmental problem. Hence the result, The Compressive strength of Concrete are increased with addition of waste marble Powder up to 12.5 % replace by weight of cement and further any addition of WMP the compressive strength decreases. The Tensile strength of Concrete are increased with addition of waste marble powder up to 12.5 % replace by weight of cement and further any addition of WMP the Tensile strength decreases. Thus they found out the optimum percentage for replacement of MDP with cement and it is almost 12.5 % cement for both compressive & tensile strength.

B. V.M. Sounthararajan et.al (2013) :- A Study has been conducted on Effect of the Lime Content in MDP for Producing High Strength Concrete. They found that the MDP up to 10% by weight of cement was investigated for hardened concrete properties. Furthermore, the effect of different percentage replacement of MDP on the compressive strength, splitting tensile strength and flexural strength was evaluated. It can be noted that the influence of fine to coarse aggregate ratio and cement-tototal aggregate ratio had a higher influence on the improvement in strength properties. A phenomenal increase in the compressive strength of 46.80 MPa at 7 days for 10% replacement of MDP in cement content was noted and also showed an improved mechanical property compared to controlled concrete.

C. Corinaldesi V et al., (2010) :- Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world.

DETAILS OF THE PROJECT

It was proposed to investigate the properties of concrete, cast with partial replacement of cement with 0%, 5%, 10%, 15%, 20% proportions of marble powder and cured in water for 7, 14, 28 days. In this experimental work, physical properties of materials used in the experimental work were determined. M25 grade of reference concrete was mixed and cured in potable water.

Properties of the materials:-

Cement: Ordinary Portland Cement (OPC) of 53 Grade (Deccan cement) from a single lot was used throughout the course of the investigation. It was fresh and without any lumps. The specific gravity of cement obtained is 3.12.

Fine Aggregate:- Normal river sand locally available in the market and conforming to Zone II as per BIS (IS 383:1970).

Coarse Aggregate:- Crushed granite angular aggregate of size 20mm and 10mm are used at a percentage of 60% and 40% and the aggregates are free from dust before used in the concrete. The specific gravity and fineness modulus are 2.70 and 8.62 respectively.

Water:- This is the least expensive but most important ingredient of concrete. A good thumb rule to follow is that if water is pure enough for drinking it is suitable for mixing concrete. Locally available portable water was used for mixing and curing.

Marble powder:- It is collected from marble processing industry, Kakinada, Andhra Pradesh. Specific gravity and fineness tests were conducted for marble powder and the results obtained are 2.44 and 6.0.

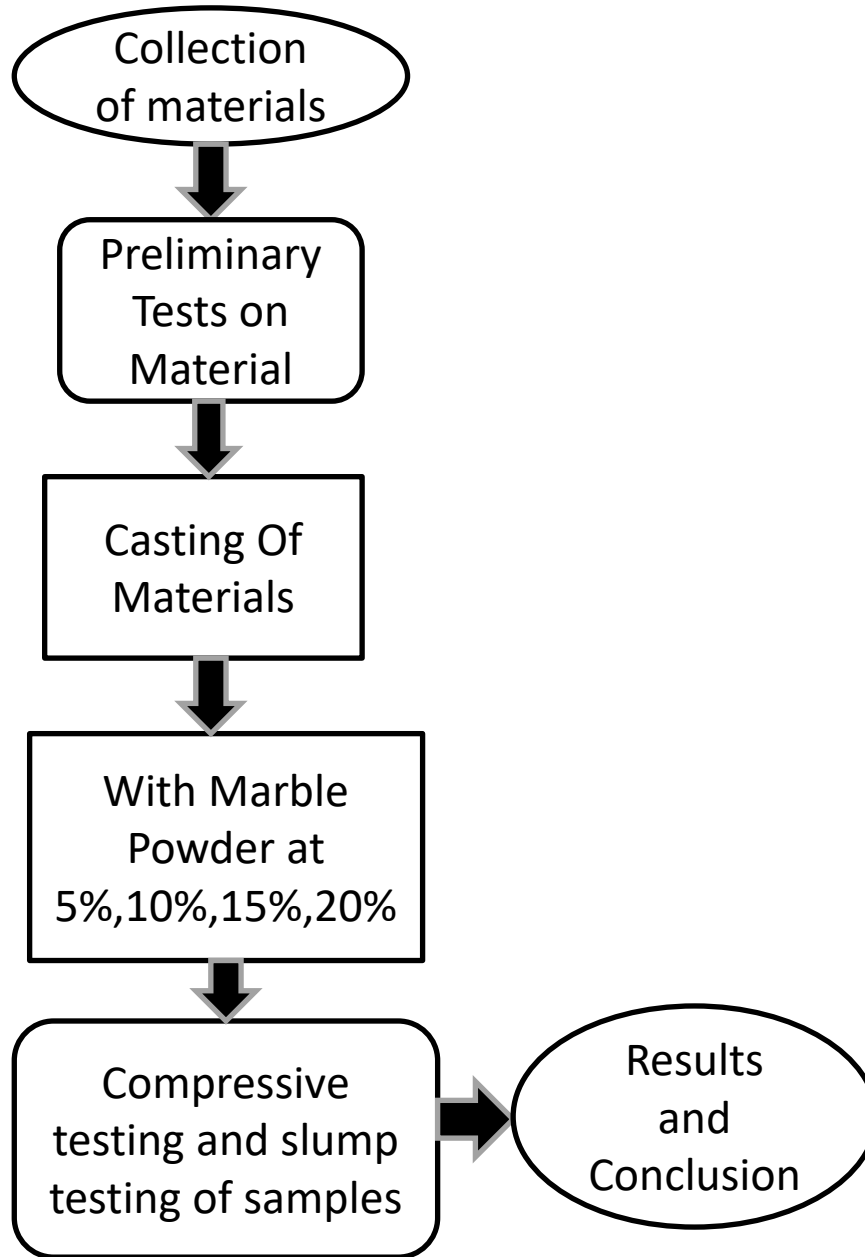


Details of mix proportion:- Grade of concrete is M25, the design is based on IS 10262-2009 and Water/cement ratio = 0.46.

Table: 1 Details of mix proportion

Serial No.	% of Replacement	Cement (Kg/m ³)	Marble Powder (Kg/m ³)	Fine Aggregate (Kg/m ³)	Coarse Aggregates (Kg/m ³)	Water (lit/m ³)
1.	0	400	0	644.58	1199	184
2.	5	380	20	644.58	1199	184
3.	10	360	40	644.58	1199	184
4.	15	340	60	644.58	1199	184
5.	20	320	80	644.58	1199	184

FLOW CHART OF EXPERIMENT



EXPERIMENTAL SETUP

Specimen Details :- Cube specimens of 150 mmx150mmx150mm for compressive strength of concrete using for specified test.

Casting and curing :- The moulds were tightly fitted and all the joints were sealed by plaster of Paris in order to prevent leakage of cement slurry through the joints. The inner side of the moulds was thoroughly oiled before going for concreting. The mix proportions done by hand mixing . The prepared concrete was placed in the moulds and is compacted. The same process is adopted for all specimens. After specimens were compacted the top surface is leveled with a trowel. The operation of curing is designed to overcome the problems of loss of hydration. The prepared specimens are cured in curing tank for a period of 7, 28 days.

Compressive strength test :- Compressive strength test is done as Per IS 5161959. The test is conducted on Compression testing machine of capacity 2000 KN as shown in Fig. 4.2 Mechanical behavior of concrete was studied for M25 grade of cubes were casted and cured for 7 and 28days. Compressive strength of concrete is tested on cube at different percentage of MDP content in concrete. The strength of concrete has been tested on cube at 7 days curing and 28 days.

Compressive strength = Maximum load at failure / Area of surface (N/mm²).

Workability :- It is observed that degree of workability is medium as per BIS (IS: 456-2000) for the normal concrete. It is also observed that, as the percentage of MDP increases from 0% to 20%, the mix becomes stiffer, and workability results in low slump value. Low slump value may have great impact on the workability of concrete.



SLUMP TESTING APPARATUS

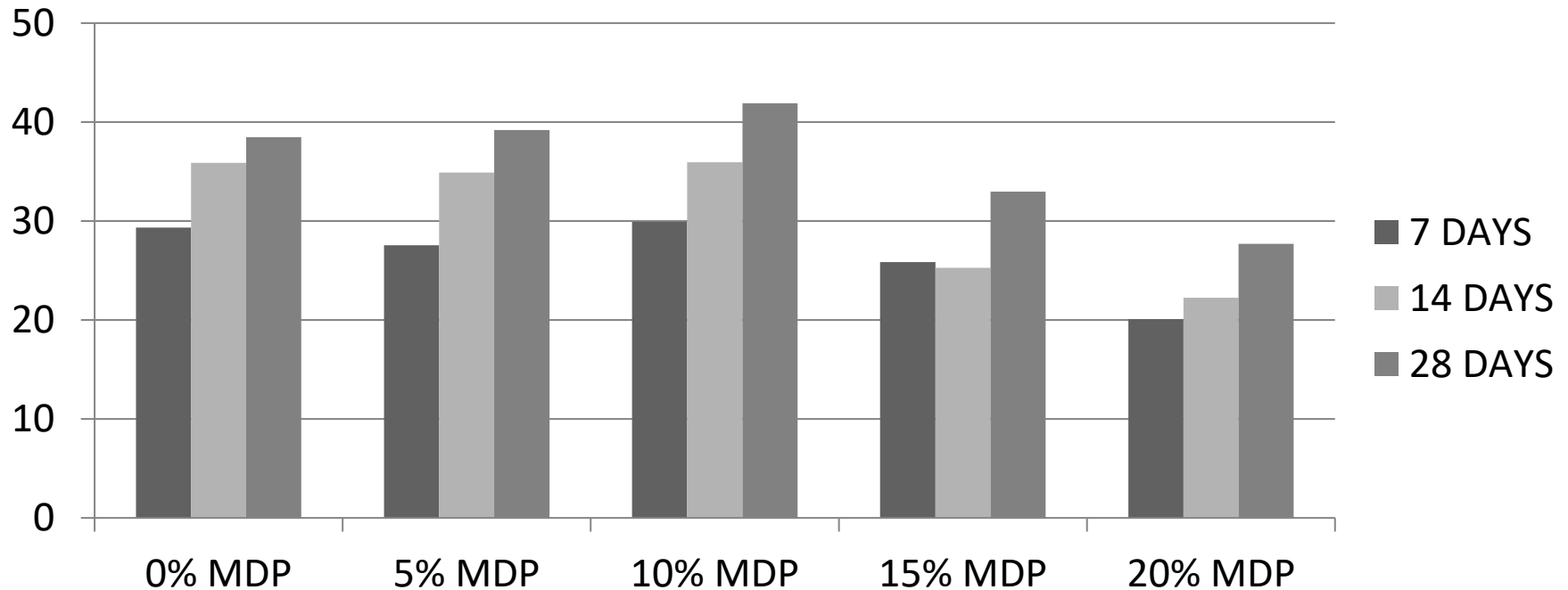


RESULTS

A. Compressive strength results and graphical representation are given below :-

Compressive Strength results of Marble powder

S.NO.	TYPE OF MIX	7 DAYS	14 DAYS	28 DAYS
1	0% MDP	29.33	35.87	38.47
2	5% MDP	27.55	34.90	39.2
3	10% MDP	29.93	35.95	41.9
4	15% MDP	25.865	25.285	32.97
5	20% MDP	20.1	22.265	27.71

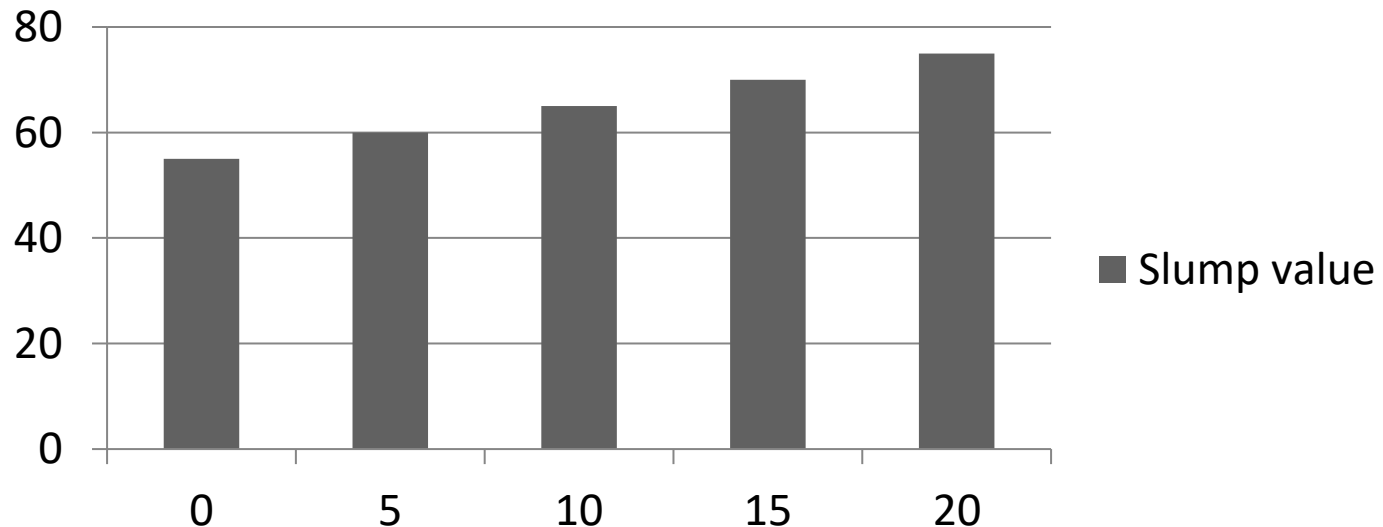


B Slump Test results are given below :-

S.No	Mix Id.	% replacement of cement with marble powder	Slump (mm)
1.	NM	0	55
2.	MP1	5	60
3.	MP2	10	65
4.	MP3	15	70
5.	MP4	20	75

Graphical Representation of Slump Test :- (X-axis= % replacement , Y-axis= Slump value in{mm}

SLUMP TEST



CONCLUSION

The compressive test , slump test of concrete cubes was tested. In this project the cubes and cylinders were casted by varying percentages of marble powder such as 0%, 5%, 10%, 15% and 20% replaced with cement. Based on the analysis of experimental results and discussion, the following conclusions can be drawn.

1. The Compressive strength of Concrete increases up to 10% replacement of cement by MDP and further increasing of percentage of MDP leads to decrease in compressive strength of concrete.
2. The workability increased with increase of marble powder.
3. Use of these waste material leads to sustainable development in construction industry.
4. To save the environment, MDP may be used as better partial substitute as a replacement of cement in concrete.
5. Addition of Marble dust increases the density of concrete thereby increasing the Self-weight.
6. Marble dust behaves similar to cement as it contains Silica (SiO_2) similar to cement.

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