Project Report on

Prevention of Drowning Incidents in Swimming Pool on Automated Vision Based Surveillance System

Submitted in partial fulfilment of the requirements

of the degree of

BACHELOR OF ENGINEERING

in

INFORMATION TECHNOLOGY

by

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CERTIFICATE

This is to certify that the project entitled **"Prevention of drowning incidents in Swimming pool on Automated Vision based Surveillance System"** is a bonafide work of **"Avinash Singh(203167),Ankit Tripathi(193109) and Rajan Vishwakarma(173128)"** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of "**Bachelor Of Engineering"** in **"Information Technology"**.

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

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Abstract

Nowadays swimming pools are everywhere, Like in homes, restaurant, clubs. There will be lifeguard at every pool and many swimmers in the swimming pool also, but after that also there are many number of drowning incidents. And the numbers are increasing day by day. To protect the people from drowning in swimming pool, we are using machine learning and mesh lifting system to prevent drowning incidents. The system will contain a mesh which will help the drowning person to lift up in the water, this mesh movement will be controlled by the servo motors which are connected to the Arduino Uno board, and there will be buzzer and led indication that will alert the people near swimming pool and. The drowning person is detected machine learning, using camera which is trained to detect these kind of situations, the camera is connected to the pc or laptop, this system is used to monitor the swimming pool, track swimmers in that, if any person is in drowning condition system will detect it and it will send command to Arduino Uno board to lift the mesh up. With the help of servo motors .The mesh will lift up along with the drowning person.

The organization of this report is as follows.

Chapter 1: Introduction

This chapter gives a brief introduction about Prevention of drowning incidents in swimming pool on automated vision based surveillance system Furthermore includes Motivation, Problem definition, Aim and Scope of the project.

Chapter 2: Literature survey

This Chapter divided in two sections; first one is literature review of the techniques which includes study of drowning Prevention as well as system contribution to project. Second section describes comparative Study of Automated vision based surveillance system

Chapter 3: System Architecture and Design

This chapter provides implementation details of the project in system design which gives information about the necessary things required for project implementation. It also provides information regarding the proposed system architecture to understand the project.

Chapter 4: System Design

This chapter presents different diagrams like Use-Case diagram, Data Flow diagram, Activity diagram, Sequence diagram, etc. to understand connectivity and flow of various activities.

Chapter 5: Results And Discussion

This chapter presents screenshots of system and discussion on working to understand various activities.

Chapter 6: Conclusion and Future scope

This chapter presents the lessons learned represented with the conclusion and the area where work can be further carried out in further represented with future scope.

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Acronyms

UML: UNIFIED MODELING LANGUAGE

DFD: DATA FLOW DIAGRAM

Chapter 1

Introduction

1.1 An overview

Now a days, Video surveillance can be used a tool for monitoring and security. Observing public and private sites has increasingly become a very sensitive issue. Video-based surveillance systems are designed and installed in places such as railways, airports and even dangerous environments. Image processing patterns recognition and machine learning based methods are efficient ways for real time intelligent monitoring of the objects or events of interest. Applying intelligence in video surveillance systems allows real-time monitoring of places, people and their activities. The tracking approach can change with varying targets and can change with varying targets and change from a single camera to multiple camera configurations. The tracking must be robust automatically detect drowning incidents. This surveillance information is very useful for later understanding events or as an incriminatory proof, many researchers study the possibility of exploiting these huge amounts of data and analyzing them in real time with the hope and preventing some of these emergencies or facilitate a faster or more efficient.

1.2 Motivation

Drowning is the 3rd reason for the highest unintentional deaths, and that's why it is necessary to create trustable security mechanisms. Currently, most of the swimming pool's security mechanisms include CCTV surveillance and lifeguards to help in drowning situations. But this method is not enough for huge swimming pools like in amusement parks.

Some of security systems are using AI for drowning detection using cameras situated underwater at a fixed location and also by using floating boards having a camera mounted on the bottom side so that underwater view can be captured.

1.3 Problem Definition

As per the WHO(World health Organization), drowning is the leading cause of unintentional deaths in the world, around 372,000 drowning deaths reported annually. Swimming pool Drowning Deaths and kids It's unbelievable statistic: According to CDC, drowning is the number one cause of unintentional deaths for children between the age 1 to 4.To overcome this problem the surveillance IoT model will helps to avoid maximum cases.

1.4 Aim

The project's main goal is to build a model that will prevent drowning incidents using automated vision technology: The main contribution of this project is to develop a system for monitoring swimming pool so that the swimmers can freely swim without the fear of drowning. To have an automated model that will function on its own, without the presence of a lifeguard. To build a system that will lift the mesh automatically to prevent the person from drowning.

1.5 Scope

The main scope of this project is to develop a system for monitoring swimming pool to prevent the on set of a drowning incident. The PC/Laptop as well as the Arduino Uno boards will be used in controlling the entire system. The camera will continuously monitor the swimming pool. The analyzed data will be sent to the PC/Laptop where a python Script is running. That mesh will help in the lift the swimmer upwards out of the pool. Meanwhile, a warning signal will alert the lifeguard.

Chapter 2

Literature Survey

2.1 Background

At present, swimming pools are built in hotels, sport clubs, schools and private residences. Although there have been various regulations put into place to reduce drowning accidents in some countries, communities still experience many drowning incidents. Accordingly, a real-time system that will track swimmers in a pool using machine learning techniques and prevents drowning accidents is proposed. The system consists of a PC/Laptop with the Windows operating system, and Anaconda, an Arduino Uno board, servo motors, an alarm system, and motor drivers. The proposed system is based on the Hough circle transform algorithm to position and rescue swimmers who are drowning. The device then sends an alarm to the lifeguards. To verify the performance of the proposed system, a prototype has been developed, implemented, and tested. The results from experiments indicate that the system has a unique capability to monitor and track swimmers, thereby enabling it to mitigate and curb the number of deaths by drowning.

[1]A Vision-Based Approach to Early Detection of Drowning Incidents in Swimming Pools.

Lei Fei, Wang Xueli, Chen Dongsheng, proposed a background subtraction method for drowning detection and swimmer identification using visual surveillance in their research paper. This method fails to reflect real background accurately thus restricting model accurate shape detection of moving objects. It also fails to reflect sudden background changes.

[2] A video-based Drowning Detection System.

Ajil Roy, Dr. K. Srinivasan, proposed drowning detection using RFID-based swimming goggles, however, this model also fails to overcome the limitation of accuracy since the water sensor is not placed very close to the mouth and nose. But this model successfully overcomes limitations of video surveillance-based drowning detection systems like the need for high power computing devices.

[3] A live Visual Surveillance System for Early Drowning Detection at Pool.

The paper by Hanbing Liu et al consists of a framework that takes advantage of dedicated cameras and DSP engines to build alerts based on swimmer motion analysis but this system lacks an autonomous rescue mechanism.

[4] Off-time Swimming Pool Surveillance Using Thermal Imaging System.

Aida Carballo-Fazanes et al have given a study on swimmer motion while encountering a risk in a swimming pool. The journal by Mr. Lin, CY., Wang, LY , in certain countries like South Africa, Guyana, Morocco, Houtamalla, and India, the death rate is heart-melting and makes anyone sad few countries such as Austria, Portugal, Austria, Netherlands, Denmark, Korea, etc. somehow managed to reduce deaths significantly. By integrating sensors with an embedded processor.

[5] Automatic Waist Airbag Drowning Prevention System Based on Motion Information Measured by Memos Accelerometer and Pressure.

A.Kulkarni developed another system based on an embedded algorithm for alerting in drowning situations. The method given in the reference is a wearable device with an airbag linked with a pressurized tank and airbag is blown based on the sensor.

2.2 Analysis

Table 2.2: Analysis Table

Paper Title [Reference]	Author	Advantages	Drawbacks
A Vision-Based Approach to Early Detection of Drowning Incidents in Swimming Pools	W. Lu, Y. Tan[1], Y. Peng[2].	Detect the drowning incidents	Accuracy is not that much
Deep residual learning for image recognition	He, K[1].; Zhang, X.[2]; Ren, S.; Sun[3], J.	It signals to the buzzer	Just make sound and no other action
Off-time swimming pool surveillance using thermal imaging system.	Wong, W.K[1].; Hui, J.H.; Loo[2], C.K.; Lim[3], W.S	It take action by lifting the mesh	No sound or alert
An Autonomous Wireless Device for Real-Time Monitoring of Water Needs. Sensors	Borrero[1], J.D.[2]; Zabalo[3],	It will detect heat emitted from the body	It can also detect heat from non living things
A Novel Camera-Based Drowning Detection Algorithm Chi Zhang	Xiaoguang Li[1], and Fei Lei[2]	ECG is detected	Particular area is not defined
Detection of swimmer using dense optical flow motion map and intensity information	K. L. Chan[1]	It will send notification to guide	Only notification and not the actual image

Chapter 3

System Architecture

3.1 Introduction

The PC/Laptop as well as the Arduino Uno boards will be used in controlling the entire system. Camera will continuously monitor the swimming pool. The capture 2D images will be processed by the PC/Laptop attached to the cameras. Based on these calculations, the occurrence of any abnormal events will be detected. If such events occur PC/Laptop will send an order to the lifting mesh. The lifting mesh will directly move to up. Meanwhile, a warning signal will alert the life guard of an imminent danger. The analyzed data will be sent to the PC/Laptop where a python script is running. The script will calculate swimmers' position and time under water. Based on these calculations, the occurrence of any abnormal events will be detected. If such events occur, PC/Laptop will send an order to the linear stage. Meanwhile, a warning signal will alert the lifeguard of an eminent danger.

3.2 Design

In designing, we implement a model for demonstrating the prevention of drowning using PC/Laptop and arduino that works and take actions by uplifting the mesh and siring the buzzer.

3.2.1. Requirement Analysis

For drowning detection System Using automated vision based surveillance system, the main requirement is images and videos dataset of analyzing the current situation, it contains the stored data.

Hardware Requirements:

- Motion detection sensor
- Camera sensor
- PC/Laptop
- Arduino Uno
- Servo motor
- Level Shifter
- Buzzer

Software Requirements:

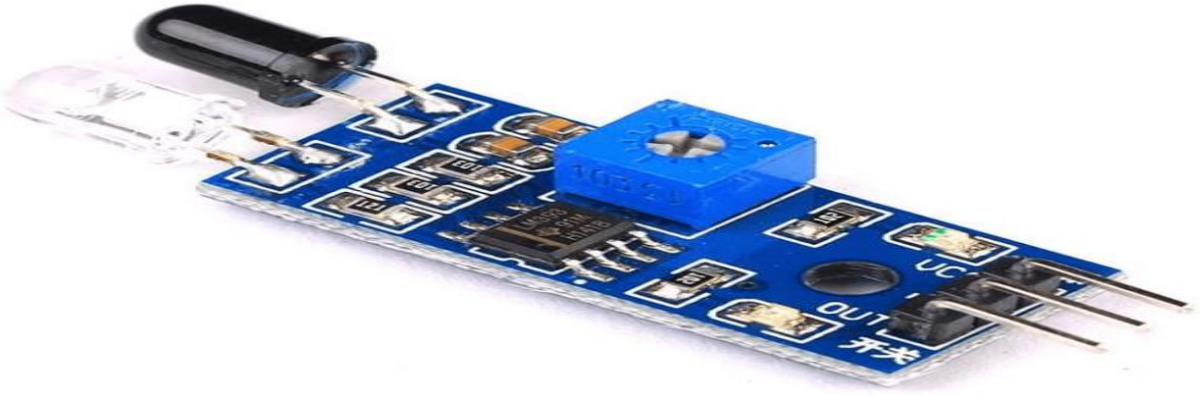
- Python 3.9 (Coding Language)
- Visual Studio Code
- Arduino Software (IDE)

List of Hardware Components:

Servo Motors:

A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

IR Sensors:

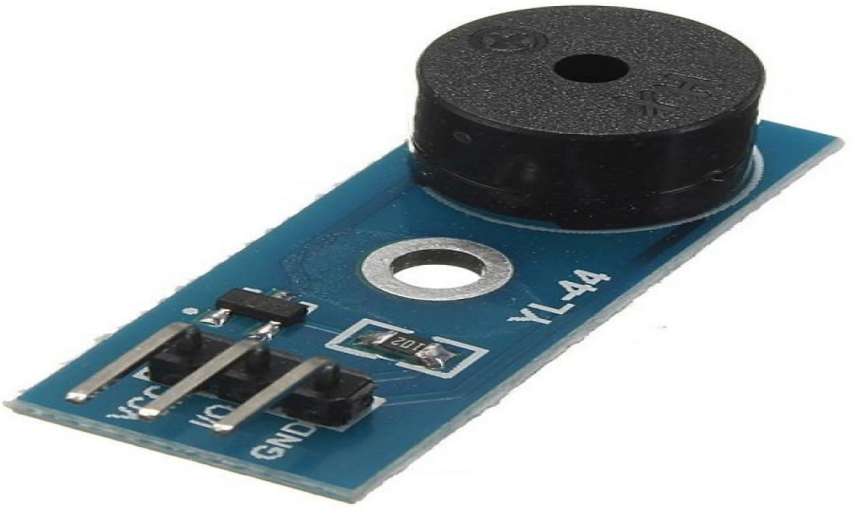


IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

Web Camera:

A webcam is a video camera which is designed to record or stream to a computer or computer network. They are primarily used in video telephony, live streaming and social media, and security. Webcams can be built-in computer hardware or peripheral devices, and are commonly connected to a device using USB or wireless protocols.

Buzzer:

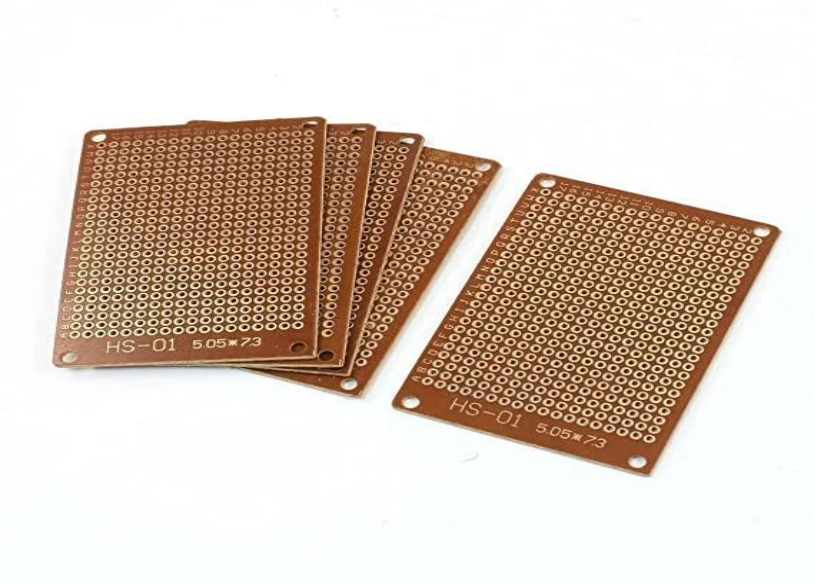


The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices. According to different designs and uses, the buzzer can emit various sounds such as music, siren, buzzer, alarm, and electric bell.

LED:

A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it. When current passes through an LED, the electrons recombine with holes emitting light in the process. LEDs allow the current to flow in the forward direction and blocks the current in the reverse direction.

Breadboard:



A thin plastic board used to hold electronic components (transistors, resistors, chips, etc.) that are wired together. Used to develop prototypes of electronic circuits, breadboards can be reused for future jobs. They can be used to create one-of-a-kind systems but rarely become commercial products.

3.2.2. System Architecture

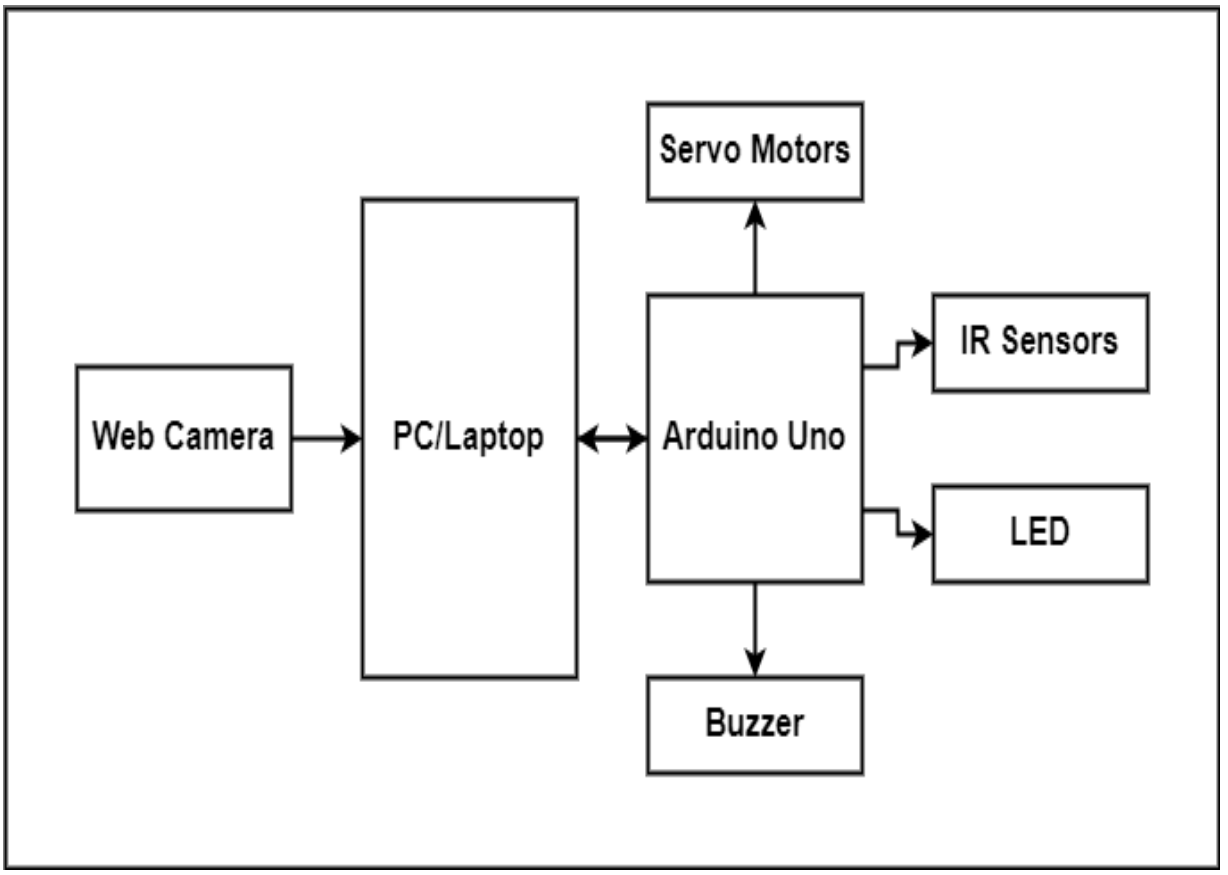


Fig 3.2.2: System Architecture

The PC/Laptop as well as the Arduino Uno boards will be used in controlling the entire system. Cameras will continuously monitor the swimming pool. The capture 2D images will be processed by the internal hardware attached to the cameras. The analyzed data will be sent to the PC/Laptop where a script is running. The script will calculate swimmers' positions, and time under water. Based on these calculations, the occurrence of any abnormal events will be detected. If such events occurs PC/Laptop will send an order to the lifting mesh. The lifting mesh will directly move to up. Meanwhile, a warning signal will alert the life guard of an imminent danger.

3.3 Proposed System

The proposed automated and intelligent system for monitoring swimming-pool safety based on the IoT and transfer learning is illustrated in Figure 3. The system utilizes a single image captured through two steps: (1) the motion sensor detects any number of persons entering the swimming pool and sends a signal to the camera, and (2) the camera that is installed overhead the swimming pool, as shown captures a single image. Then, PC/Laptop is connected to the camera and captures a single image.

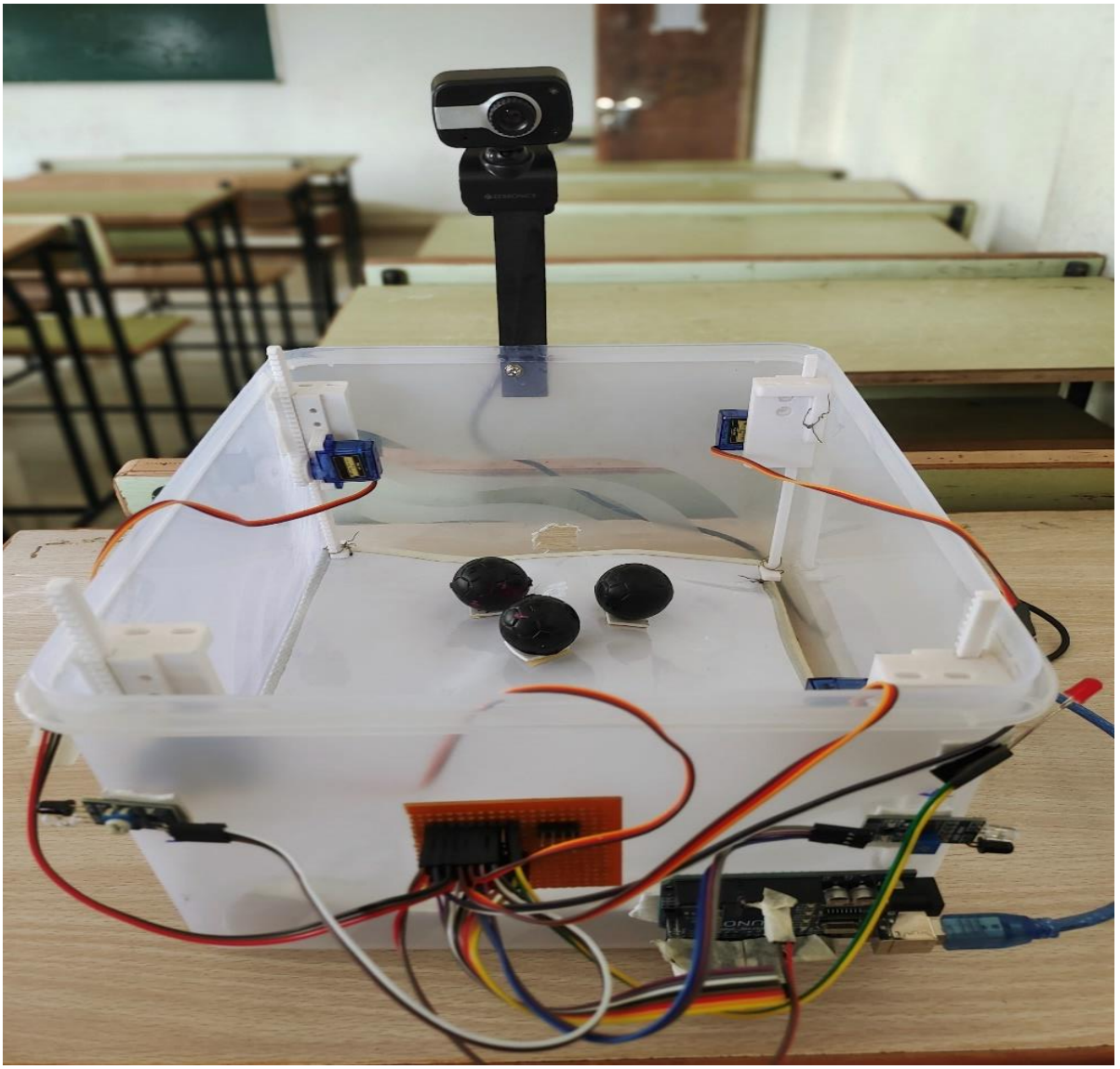


Fig 3.3: Proposed System

3.4 Algorithm

Hough Circle Transform Algorithm

The Circle Hough Transform (CHT) is a basic feature extraction technique used in digital image processing for detecting circles in imperfect images. A Hough circle transform is an image transform that allows for circular objects to be extracted from an image, even if the circle is incomplete. The transform is also selective for circles, and will generally ignore elongated ellipses. The transform effectively searches for objects with a high degree of radial symmetry, with each degree of symmetry receiving one “vote” in the search space. By searching a 3D Hough search space, the transform can measure the centroid and radius of each circular object in an image.

The basic algorithm that will be implemented for working of this proposed system is as follows:

Step1: Start

Step1: The Swimmer will enter the swimming pool.

Step2: Due to the dataset given to the PC/Laptop, The captured 2D images will be processed by the internal hardware attached to the cameras. It will analyze the pattern and movement of the swimmer.

Step3: After calculating the time under water , If it detects that the swimmer is drowning , it will give the command to the Arduino uno to take the necessary action.

Step4: The Arduino uno will take the necessary action by alerting the area with a buzzer and a red light.

Step5: After the buzzer and light , it will lift up the mesh ,to give an assistance to the swimmer so that the swimmer will be safe from drowning

Step 6: A message will be sent.

Step 7: Exit

Chapter 4

System Design

4.1 Introduction

System Design is the process of defining the architecture, components, modules, interfaces and data for a system to satisfy specified requirements. System design could be seen as the application of systems theory to product development. the proposed system consists of the following: Camera, PC/Laptop, IR Sensors, Arduino Uno, Servo Motors, LED Buzzer etc. The camera combines a camera and a microcontroller running an optimized color detection algorithm. It processed any input image in a resolution of 640 x 400 per frame and outputs an image with a resolution of 320 x 200 pixels. The camera requires 5v, and consumes 140 mA.

4.2 UML diagrams

We use these diagrams for describing our system in a static and dynamic way that is represents the modern approach to modeling and documenting software. It is based on dramatic representation of the software. UML diagrams is high level points arguably the most important aspects of any design system and it is rapidly evolving and responsive software.

4.2.1 Use case Diagram

This Use Case diagram gives an idea about the behavior of the system with respect to various actions performed by the proposed system. It includes the various actors and use cases involved in the system as well as the relationships between them. It is dynamic in nature.

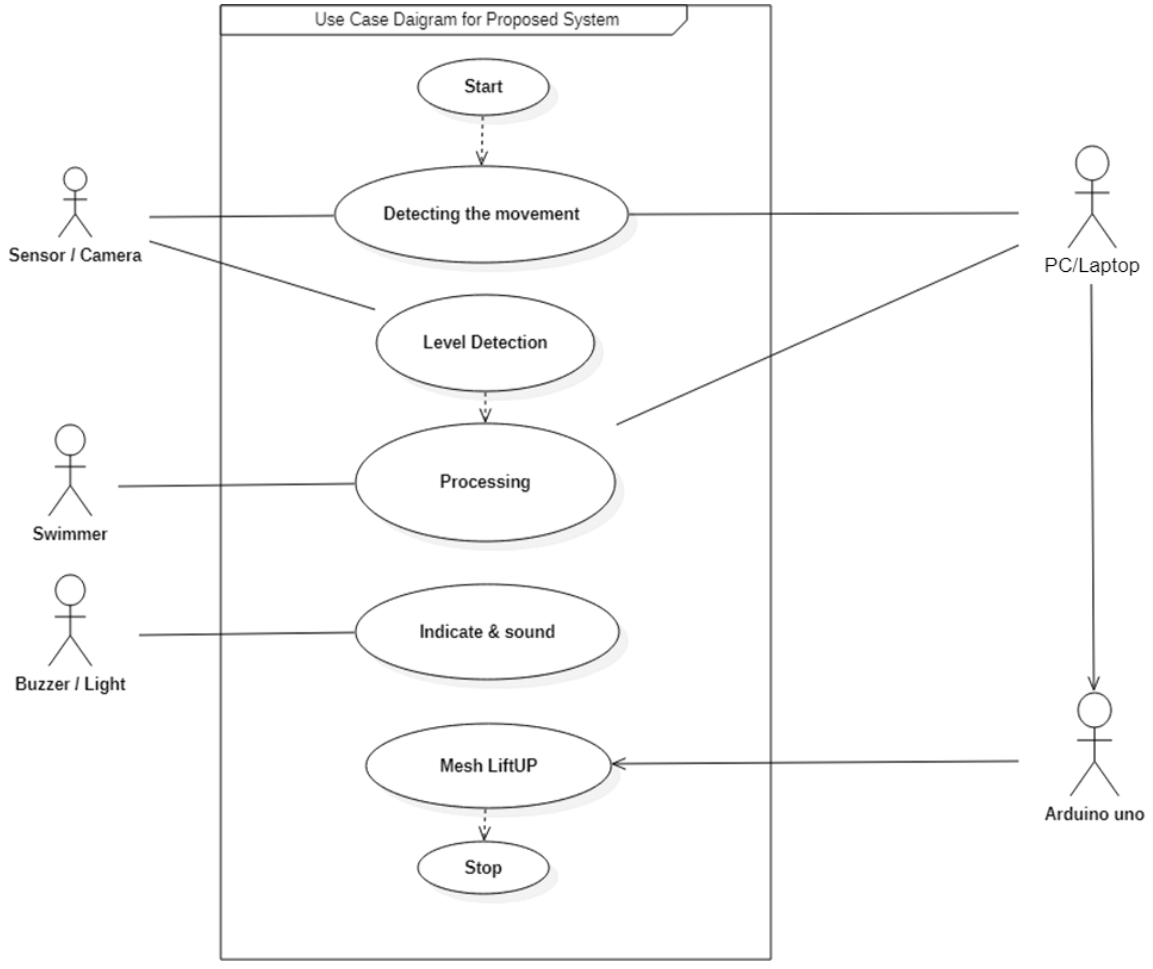


Fig 4.2.1: Use Case Diagram for Drowning Prevention System.

4.2.2 Class Diagram

A class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects. Describing functionality performed by the system. Construction of software application using object oriented languages.

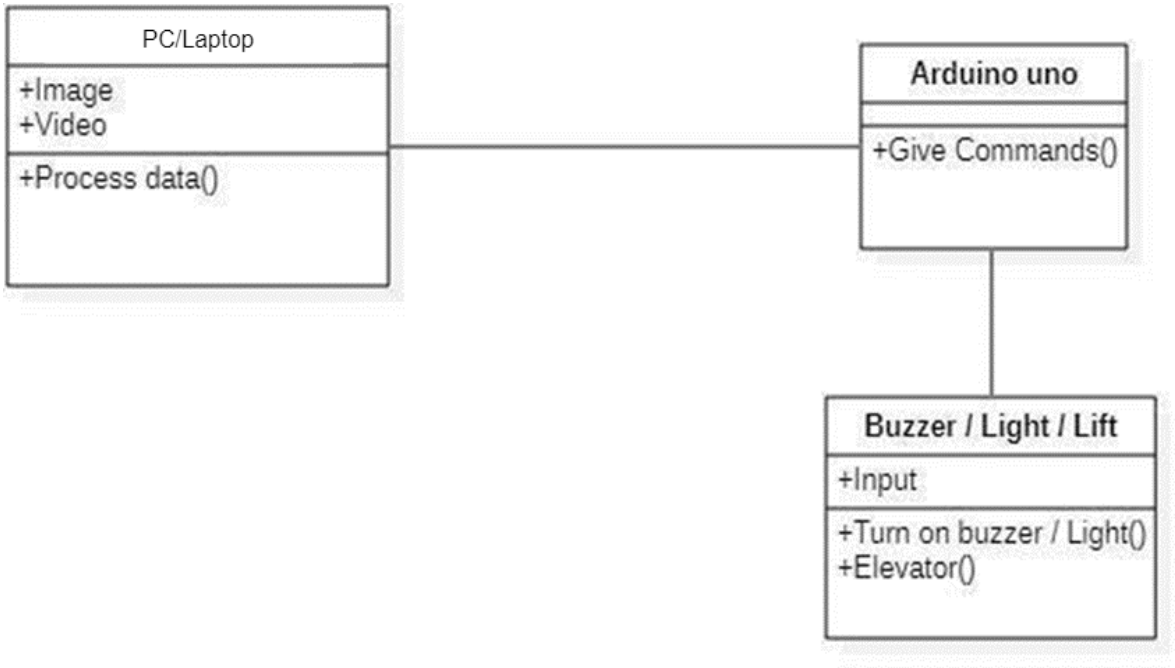


Fig 4.2.2: Class Diagram for Drowning Prevention System

4.2.3 Activity Diagram

The activity diagram is another important behavioral diagram in the UML diagram to describe dynamic aspects of the system. An activity diagram is essentially an advanced version of a flow chart that models the flow from one activity to another activity. It also describes the modelling business requirements, modelling workflow, investigation business requirements, high level understanding of the system's functionalities.

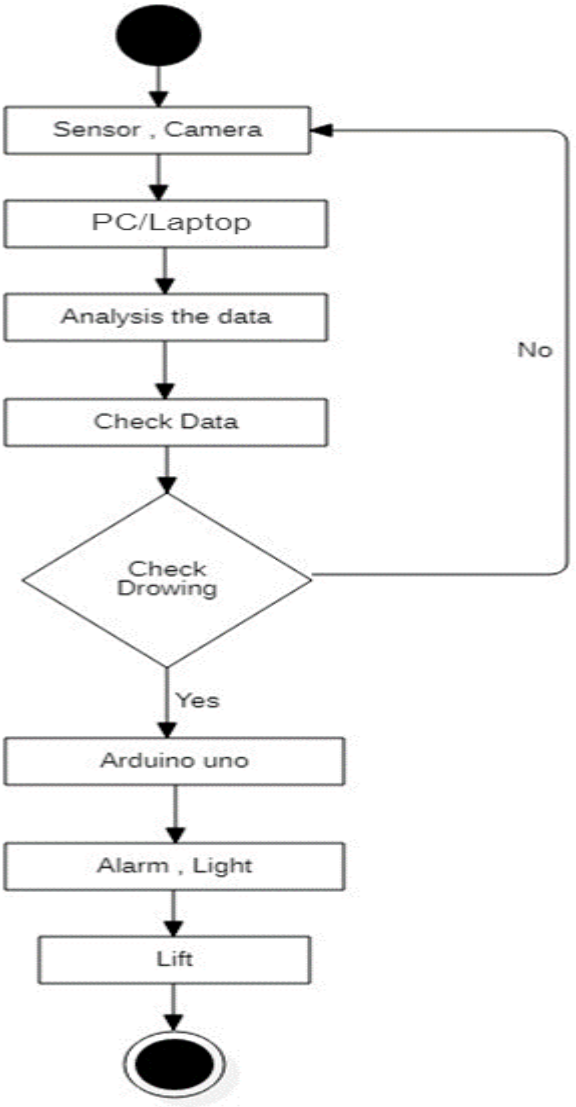


Fig 4.2.3: Activity Diagram for Drowning Prevention System

4.2.4 Component diagram

A component diagram, also known as a UML component diagram, describes the organization and wiring of the physical components in a system. Component diagrams are often drawn to help model implementation details and double-check that every aspect of the system's required functions is covered by planned development. In the first version of UML, components included in these diagrams were physical: documents, database table, files.

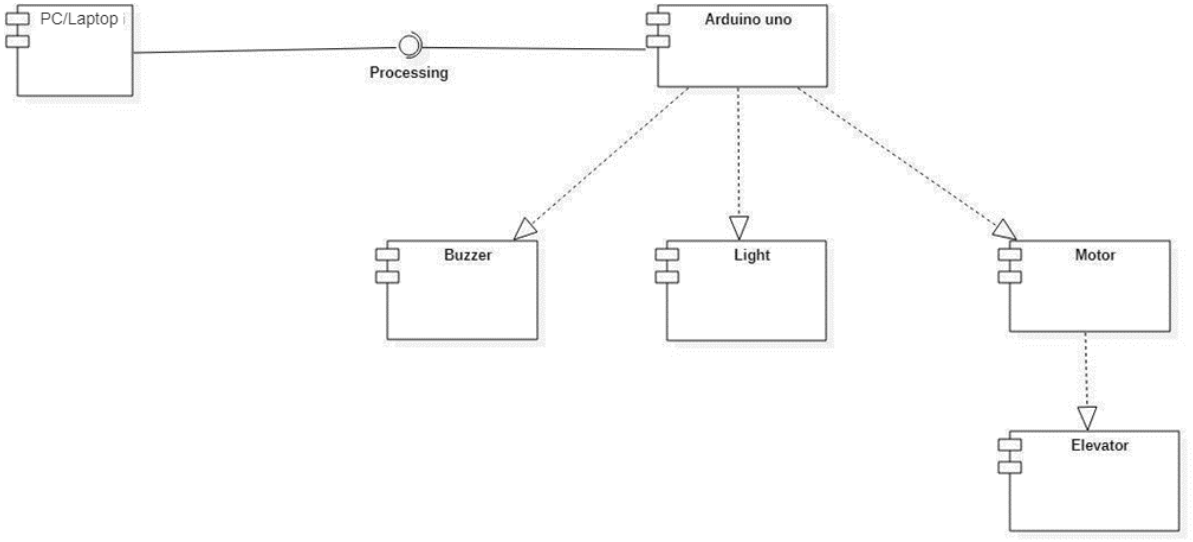


Fig 4.2.4: Component Diagram for Drowning Prevention System

4.2.5 Sequence Diagram

UML Sequence Diagrams are interaction diagrams that detail how operations are carried out. They capture the interaction between objects in the context of a collaboration. Sequence Diagrams are time focus and they show the order of the interaction visually by using the vertical axis of the diagram to represent time what messages are sent and when. They show end use cases, user and system interactions, and system to system are organized by objects and time, which are, respectively, aligned on the vertical and horizontal axes.

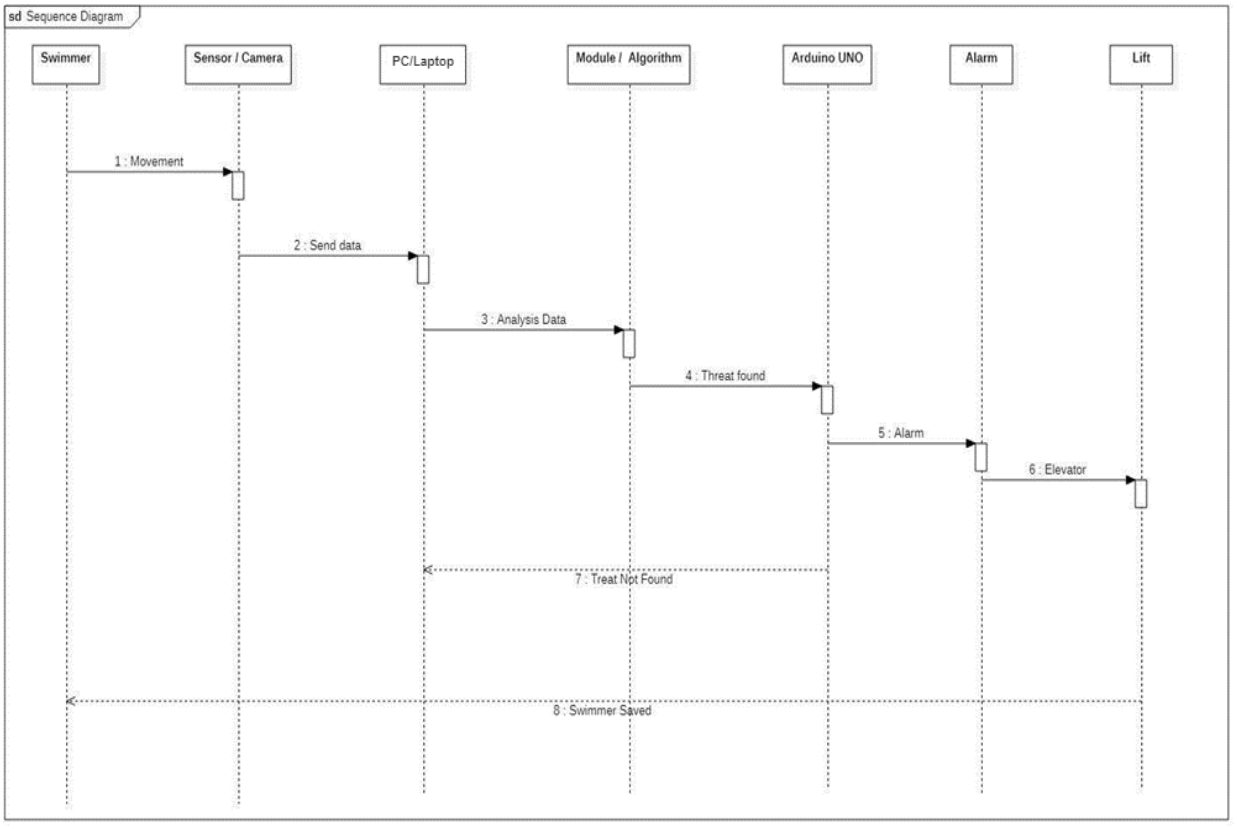


Fig 4.2.5: Sequence Diagram for Drowning Detection System

4.2.6 Gantt Chart

A Gantt chart, commonly used in project management, is one of the most popular and useful ways of showing activities (tasks or events) displayed against time. On the left of the chart is a list of the activities and along the top is a suitable time scale. Each activity is represented by a bar; the position and length of the bar reflects the start date, duration and end date of the activity.

Fig 4.2.6: Gantt Chart

4.2.7 WBS Chart

A work breakdown structure (WBS) is a visual, hierarchical and deliverable-oriented deconstruction of a project. It is a helpful diagram for project managers because it allows them to break down their project scope and visualize all the tasks required to complete their projects. Making a WBS is the first step in developing a project schedule. It defines all the work that needs to be completed (and in what order) to achieve the project goals and objectives. By visualizing your project in this manner, you can understand your project scope, and allocate resources for all your project tasks.

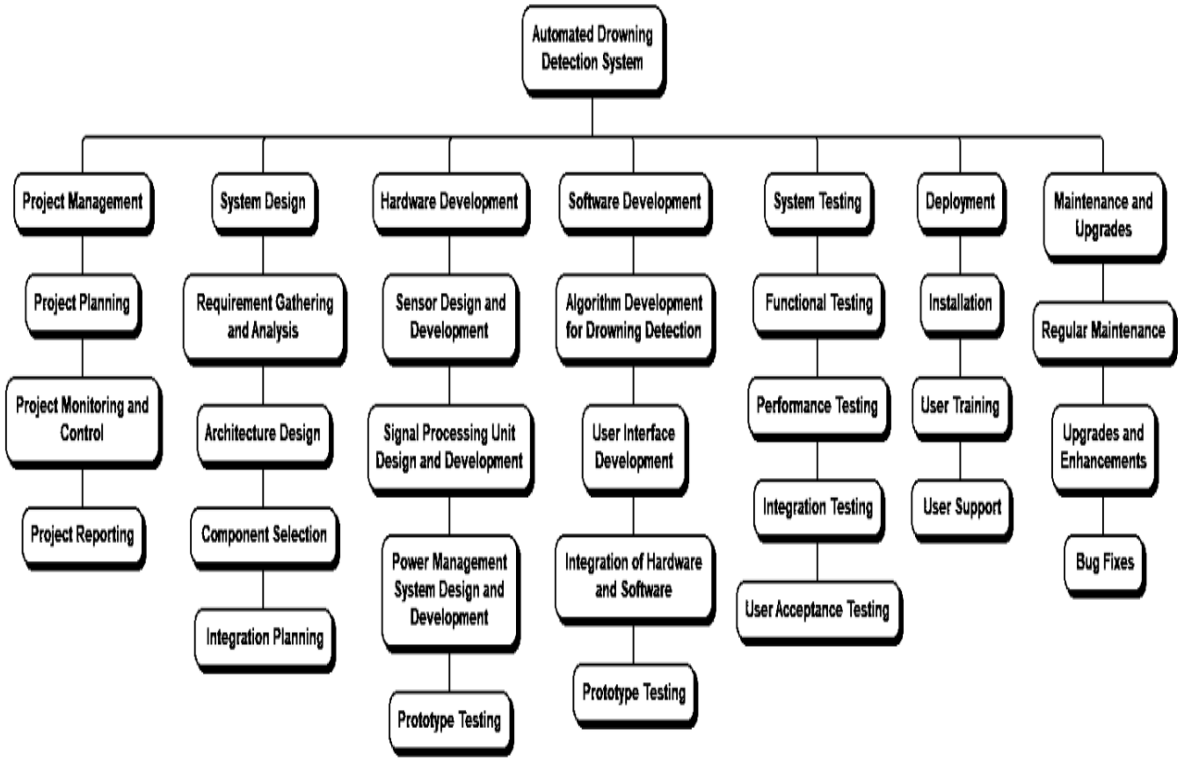


Fig 4.2.7:WBS Chart

4.3 Data Flow Diagram

A Drowning detection system data flow diagram is often used as an introductory step to create an overview of the drowning detection system. It consists of the overall application data flow and processes of the system. It contains all of the user flow and their entities such that sensor, camera, buzzer, Arduino.

4.3.1 Level 0 DFD

This is the level zero of detection system, where we have involved the high-level process of this system, it's a basic overview of the whole system.

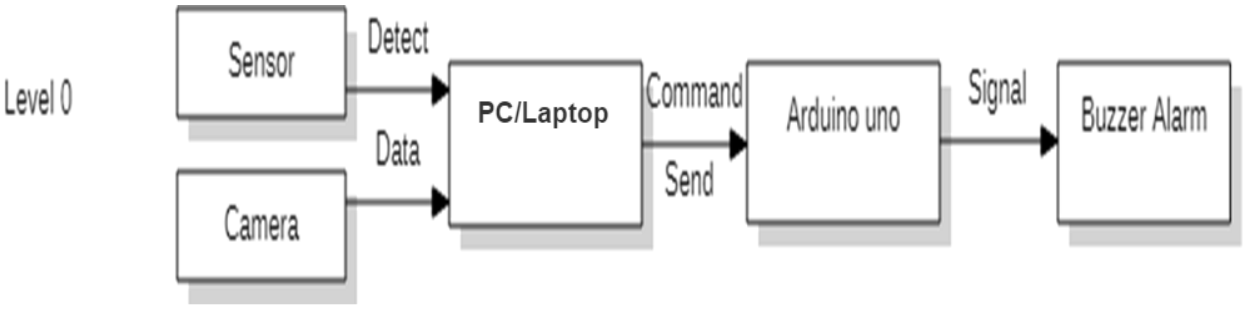


Fig 4.3.1: Level 0 DFD for Drowning Detection System

4.3.2 Level 1 DFD

Level one DFD of Drowning Prevention system shows how the system is divided into sub- systems (processes), each of which deals with one or more of the data flows to or from an external entity, which together provides all of the functionality of the DFD level 1 provides a more detailed breakout of piece of the Level 1 DFD.

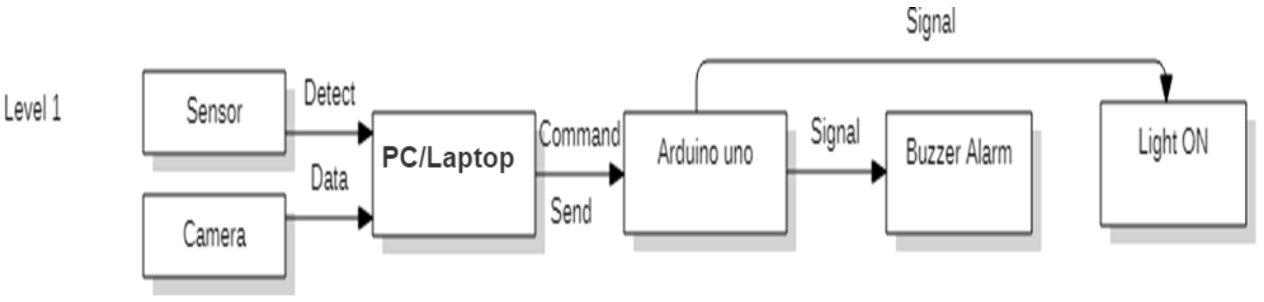


Fig 4.3.2: Level 1 DFD for Drowning Prevention System

4.3.3 Level 2 DFD

Level 2 DFD of Drowning Prevention System shows the last process of the system by uplifting the mesh as per the command of arduino.

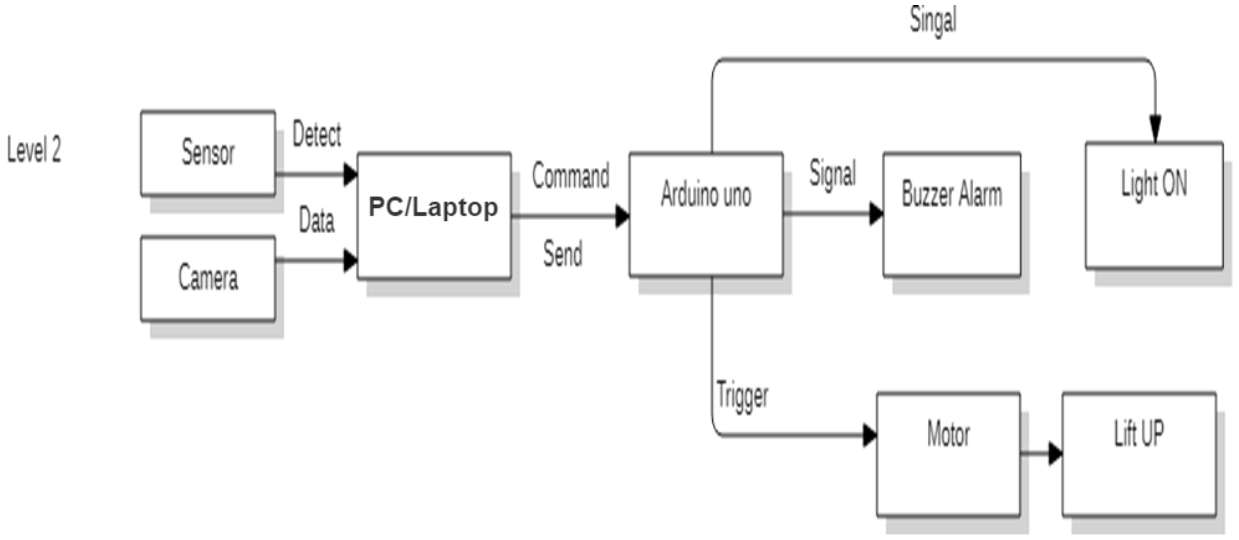


Fig 4.3.3: Level 2 DFD for Drowning Detection System

Chapter 5

Results and discussion

A prototype was created and tested at several occasions to check its endurance and responsiveness. The prototype worked exactly as described in UML diagrams. In a controlled environment, a prototype of the proposed product is built, tested for security and safety in a variety of lighting conditions, and calibrated for varying purity levels of water. The Fig is the framework used as an active elevator comprising all features and is tested by submerging in large water vessel. To reach the surface on time, the actual system must incorporate powerful elevator motors with tuned speeds. The system works well using the Hough Circle Detection method with an accuracy of 98% which is improved by taking consecutive frames value so as to avoid false triggers.

5.1 Accuracy in the form of Graph

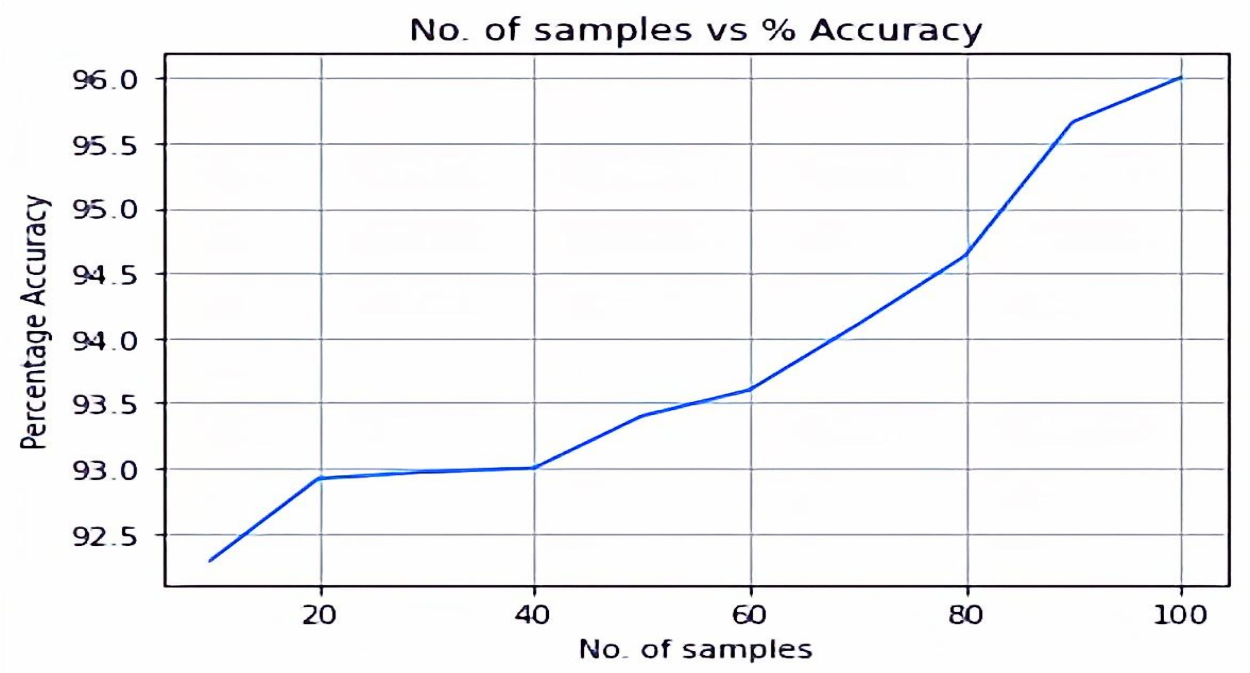


Fig 5.1:Accuracy Graph

No.of samples are the number of images captured from live camera video , Initially the no.of balls in 1 image is 3 balls.So , if the count of balls is 3 for every increasing image samples then the accuracy will be greater i.e,close to 98%.

5.2 Command for Activation

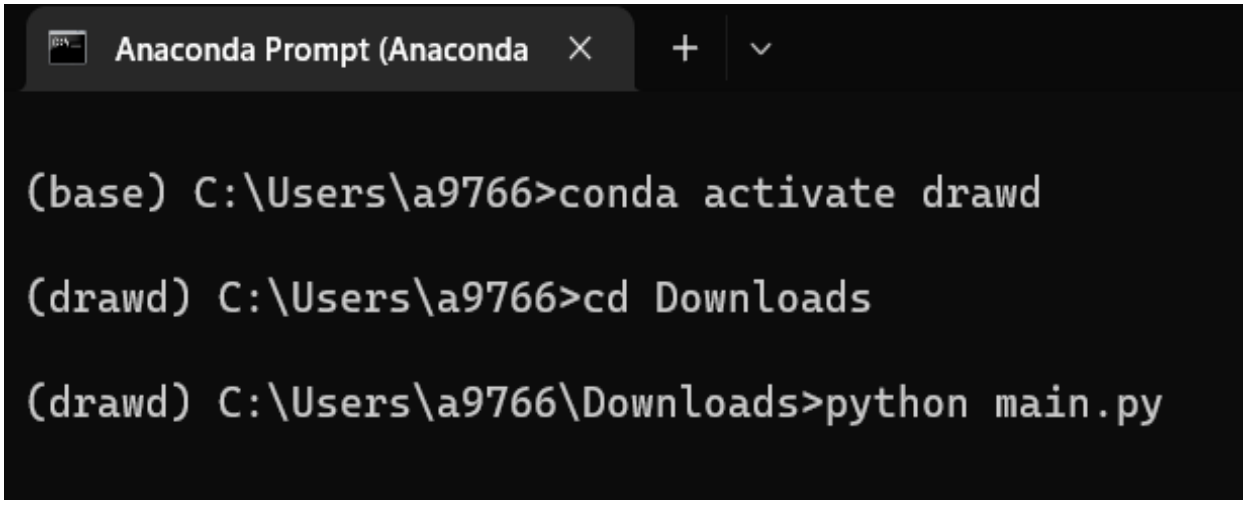


Fig 5.2: Command for Activation

To run the project,we need to open the terminal and activate the project name.After activating project name ,we need to give access to the path of python library in which the algorithm is stored. After providing the path , we need to run the main.py file from which the camera will start working and the process will go on.

5.3 Detecting the number of swimmers inside pool

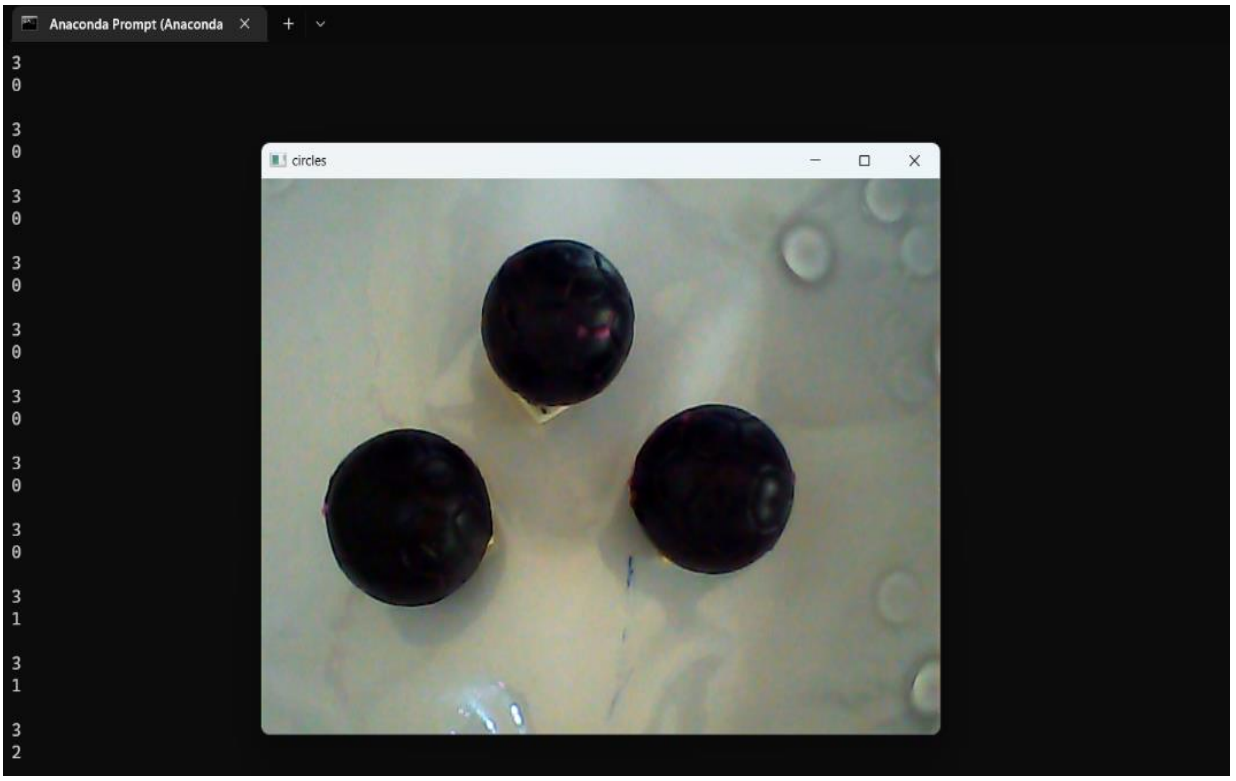


Fig 5.3: Detecting number of swimmers inside pool

The model will start working with the use of live camera as it detects the number of swimmer in the swimming pool with the help of hough transform algorithm and it will continue to do so until one of the swimmer is missing for a while,

5.4 Notification to guard

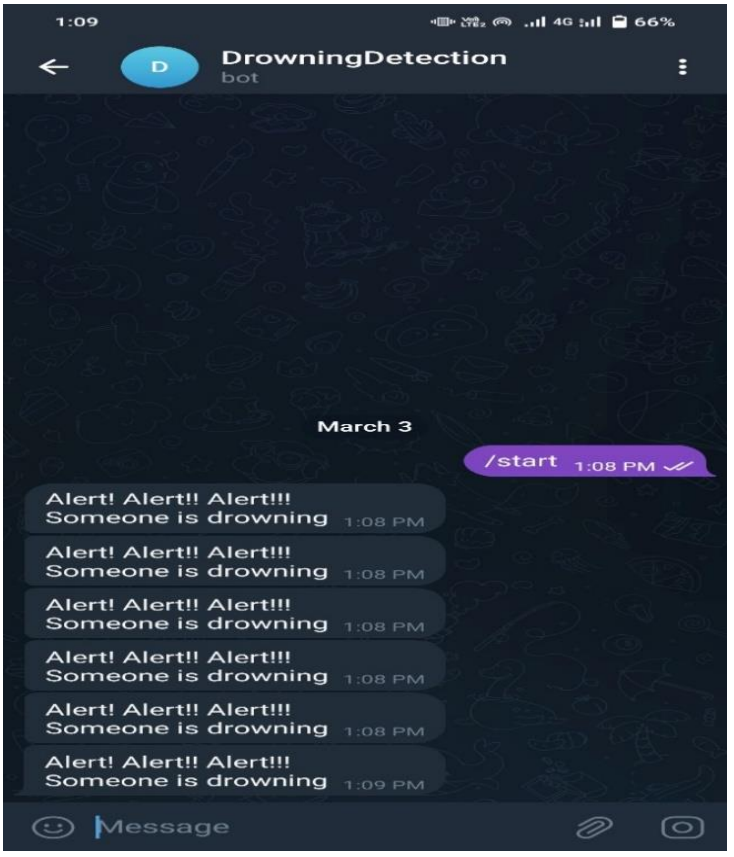


Fig 5.4: Notification to Guard

Within 10 seconds an alert notification will be send to the guard or the owner of the swimming pool so that they can be known about the incident within seconds and they can manually bring the mesh down.

5.5 Arduino Uno

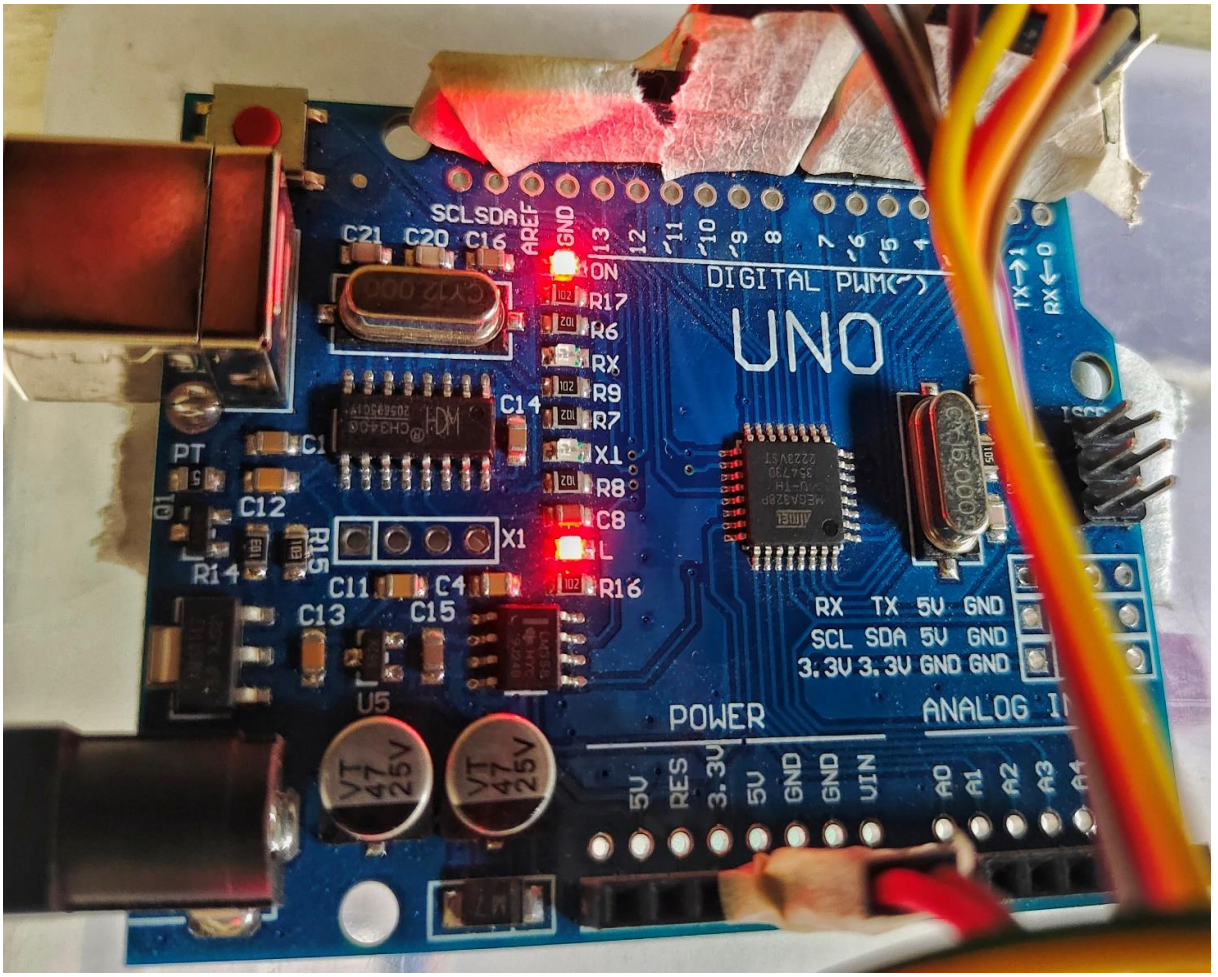


Fig 5.5: Arduino Uno

Arduino uno is used to instruct by lifting up the mesh , which are connected to servo motor.It will instruct the mesh , light and the buzzer to take the necessary action altogether after a certain break that is assigned in the code

Chapter 6

Conclusion and Future Scope

6.1 Conclusion

This paper proposes an efficient and reliable system that utilizes IoT technologies and transfer learning, to prevent the occurrence of these incidents. This project presents an automated vision-based surveillance system to detect drowning incidents in swimming pool. The swimmers in the pool are detected and tracked using the camera. The linear stage will uplifts the swimmer and Meanwhile, a warning message will signal the life guard of imminent danger.

6.2 Future Scope

In the future, a generative adversarial network will be applied to generate synthesis data, in order to increase the size of the training . In addition, more classes and libraries will be added to explore and to investigate the efficiency of the proposed system and also additional function of sending the live images of drowning just as a notification directly to the owner of the pool as currently only text messages is forwarded to the owner.

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Journal Paper:

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04/11/2022

Avinash Singh,
9657279308,
3F4 , Neelaxmi Apt , Anand Nagar ,
Near Platform no.1, Vasai (w)

Dear Avinash,

We are writing to express our interest in supporting Prevention of Drowning Incidents in Swimming pool on Automated Vision based Surveillance System and are glad to introduce Sharma Electricals, one of the best service-providing companies for home appliances like air conditioners, refrigerators, washers, etc.

Your project's specifics have been assessed, and we think they are in line with the goals and values of our business. As a result, we are eager to contribute money in the amount of Rs 10000 to help the project be implemented successfully.

As a sponsor, we'll collaborate closely with your team to make sure the project achieves its goals and yields the desired results. We will also fund marketing and promotion efforts to help spread the word about the initiative.

We are certain that our collaboration will be advantageous to both parties, and we eagerly await your response.

Sincerely,
Sanjay Sharma
Founder and CEO
Sharma Electricals