An Effective Real-Time Flood Disaster Management with Automated GSM Warning System

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical & Electronic Engineering

Department of Electrical and Electronic Engineering
Brac University
April 2022

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April 2022

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Approval

The Final Year Design Project (FYDP) titled "An Effective Real-Time Flood Disaster Management with Automated GSM Warning System" submitted by

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of Spring, 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical & Electronic Engineering on 28th April, 2022.

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Ethics Statement

We certify that this final year project on "An Effective Real-Time Flood Disaster Management with Automated GSM Warning System" satisfies graduation dissertation requirements and is entirely the product of our own work, free of any traces of plagiarism. We completed the whole project on our own, with the help of our supervisor and the EEE department, and some data was gathered from other sources that was correctly cited.

Abstract

Flood is one most devastating calamity of Bangladesh. A project is introduced that emphasizes management strategies throughout the crisis and issues alerts before and after a flood to reduce any concerns. To our study, flash flood is identified as a major concern of disaster. The flood warning system is triggered by two systems: sensors based and machine learning. Sensors with send signal to the main processing unit; Arduino. The Six distinct machine learning algorithms were developed in this study to estimate the river's water level on a daily basis using data that was gathered from 2017 to 2021 and utilized to train and test the proposed model. To determine the model's correctness, various design strategies were investigated. The method that produced the best prediction result had the lowest error rate. Machine leaning is taking place in a slave processing unit; Raspberry Pi. Both processing unit before and after flood can communicate via GSM module. Voice over is a new termed established in this project, where authority can directly connect and send announcement to the people of affected area.

Keywords: Flood warning; Flood prediction; Machine learning; GSM module; Voice over; Raspberry pi.

Dedication

To our parents, without their support and advice, we would not have been able to earn our bachelor's degree. This final year project is specially dedicated to the memories of Raisa Islam's parents, they had passed away due to the coronavirus pandemic. They would have been so proud to see us graduated.

Acknowledgement

We are pleased to convey our profound appreciation for Dr. A. S. Nazmul Huda, Assistant Professor in the Department of Electrical and Electronic Engineering at BRAC University, who supported us as supervisor and whose direction, inspection, brilliance and perfection were very essential to us during the entire process.

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List of Acronyms

ML	Machine Learning
XGBOOST	Extreme Gradient Boosting
GSM	Global System for Mobile communication

Chapter 1

Introduction

1.1 Introduction

Due to the geological structure, Bangladesh has always been prone to floods. It occurs due to the accumulation of the inflow of water from upstream catchments, water flashing from nearby hills and sometimes locally heavy rainfall. floods affect the lives of thousands of people in Bangladesh in a variety of ways, ranging from small irritation to serious disruption in terms of loss of life, property, and monetary loss, etc. Since no one can prevent floods from occurring, steps must be made to mitigate the consequences. As a result, it is required to construct an effective real-time flood disaster management system with an automated GSM warning system for the country's benefit. Our goal is for our Automated GSM Warning System to play a critical role in flood catastrophe management in Bangladesh, which is now under-emphasized.

1.1.1 Problem Statement

Floods have been Bangladesh's most serious disaster since the country's inception. The damage in terms of loss of life, property, and monetary loss due to disruption of economic activity is too well known. Furthermore, the geological structure, which is characterized by regular flooding and a large deltaic plain, increases the likelihood of storm development, which results in severe rainfall and, finally, flash floods. There are various sorts of floods, but their impacts are not the same. However, in Bangladesh, the Flash Flood has turned into a big calamity. Extreme volumes of rainfall in the piedmont in hilly places are the cause of flash floods [1]. It happens when heavy rainfall surpasses the ground's ability to absorb it; it can also happen quickly within 6 hours of a rain event and be caused by excessive localized rainfall or levee failures [2]. They can also happen when water fills normally dry creeks or streams, or when enough water accumulates to cause streams to overflow their banks, resulting in rapid water increases in a short period of time. Furthermore, flash floods

might occur before the rain ends. During strong rainstorms, the water level in small streams can swiftly rise, especially near river basin headwaters [3]. As a result, the country faces cumulative effects due to the accumulation of the inflow of water from upstream catchments, water flashing from nearby hills and sometimes locally heavy rainfall. Therefore, we are building a GSM warning system that is sustainable, efficient as well as automated to reduce the outbreak of diseases, destruction of human settlements, the loss of agricultural production and public infrastructure.

1.1.2 Background Study

Since no one can prevent floods from occurring, steps must be made to mitigate the consequences. Our goal is for our Automated GSM Warning System to play a critical role in flood catastrophe management in Bangladesh, which is now under-emphasized. Due to the buildup of water influx from upstream catchments, water flashing from surrounding hills, and occasionally locally significant rainfall, the country confronts cumulative consequences. Meanwhile, Bangladesh's annual floods cover roughly 26000 square kilometers, or 18 percent of the country, killing over 5000 people [4]. It also causes the destruction of almost 7 million dwellings [1]. In addition, a combination of excessive rains both inside and outside the country, as well as synchronization of major river peak flows, contributed to a lack of food, forced people to flee their homes, and resulted in tens of thousands of deaths [2]. Flooding also contaminated crops and animals, and filthy water led to a slew of catastrophic illnesses [3].

1.1.3 Literature Gap

We have reviewed a total of four papers. For 'GSM and web-based flood monitoring systems' when we looked over the document, we discovered that the system will send signals to a server [6], but that if the server's network connection is down, the operation will be delayed. It was also suggested that one can discover the exact location by utilizing Google Maps. We are aware that Google Maps does not always display location correctly, and that the system is based in a remote area. It's

important to note that rural residents may not have access to a phone that allows them to use any internet application. To resolve, we will use text messages to inform the people, as well as calls if there are any networking issues. We will also be using the sirens to alert the people immediately. Lastly, we will design a GSM warning system that will alert people via phone SMS, sirens, and calls, keeping in mind the limitations of GSM and web-based flood monitoring systems.

Secondly, for 'Flood Monitoring systems using IOT and Machine Learning', we found that in the machine learning approach it needs a lot of data to train the model properly [7]. If there is not enough data the model will be confused and the efficiency will be less. Moreover, the raspberry cam will face difficulty to take photographs of the water level at night. When the rasp cam fails to take proper photographs of the water level then the edge detection method will be invalid. To resolve this, we are going to use sensors to get the perfect water level of the rivers. The data will be collected automatically and saved in the machine learning model's database. Then the model will be trained automatically and will give updates to the system. In our approach, there will be no dilemma to collect the raw data whether it is daytime or night.

Furthermore, in the paper 'Flood disaster indicator of water level monitoring system', they have only used a process that sends SMS in three categories of danger level. Also, the power is not supplied using solar panels. In our project, we are using sirens as many people in our rural areas do not know how to read. Also, we will be using solar panels as a source of our power hence saving electricity.

Then, according to 'Image Segmentation Methods for Flood Monitoring System' they lacked a source of images to train their image processing model. So, they only used two images for their sample and carried out the evaluation [9]. As in real project implementation, we can not only rely on samples, rather we need more efficiency, no matter which technique we use. For one of our approaches, we used image processing with a region-growing technique. We used four sets of images and more than 20 sets after segmentation to train our model.

1.1.4 Relevance to current and future Industry

As a result, we've examined and analyzed a variety of methods and needs in light of the current situation. We also investigated and examined a number of strategies for delivering the right information and warning signal at the right moment, before settling on the best option for the project. Because limiting flood effects in disaster management is a top priority for the country, the initiative aims to reduce disease outbreaks, human settlement destruction, agricultural output losses, and public infrastructure damage. We discovered that flooding has a wide range of consequences [5]. It causes property damage and puts human and other animals' lives in jeopardy. Soil erosion and sediment deposition elsewhere, such as further downstream or along a coast, are caused by rapid water flow [5]. Fish spawning grounds and other animal habitats can be damaged or eliminated entirely. In areas without elevated roadways, prolonged high floods can cause traffic delays. Floods can disrupt drainage and economic land usage, for example interfering with farming. Bridge abutments, bank lines, sewage lines, and other structures in floodways can sustain structural damage [5]. Flooding causes annual financial losses of millions of dollars [3]. In many respects, floods have a direct impact on both the demand and supply sides of schooling. Floods, for example, cause lessons to be rescheduled, cause significant damage to school facilities and provide a range of challenges for teachers at work and at home. However, we discovered that some flood control measures have been used since ancient times [4]. Planting plants to retain excess water, terracing hillsides to delay downflow, and developing floodways such as man-made canals to divert floodwater are some of these strategies. Other methods include building levees, dikes, dams, reservoirs, or retention ponds to hold excess water during flooding [2]. These methods are ineffective in preventing flood damage. After doing some studies we found that, in our country, there is no such thing as a flood management system that could reduce the after-effects of floods [4]. In other words, flood disaster management should be something that would help the general people to be more conscious of the calamities. Hence in our project, we will be doing the voice-over, SOS and warning system to inform the people

before flood occurrence. To add, When the system is put together it will work to notify people using phone calls, if there is a network issue then a speaker siren will be used. To summarize, floods affect the lives of thousands of people in Bangladesh in a variety of ways, ranging from small irritation to serious disruption. As a result, it is required to construct an effective real-time flood disaster management system with an automated GSM warning system for the country's benefit.

1.2 Objectives, Requirements, Specification and constant

1.2.1. Objectives

The main goal of the planned project is to create a system to detect floods using sensors of various types. Moreover, it will be designed to save the lives of numerous people. All of the features will make these methods sustainable options to be considered to improve the flood control which in return will be able to save peoples value things. The proposed project has mainly one objective, which notably is sending alarm to people ahead of time. Also, the project uses different type of sensors and make use of soil moisture to detect it.

The implementation of this project will achieve the following objectives:

1. To rescue lives as much as possible by taking cautions in real-time
2. To determine incoming danger zone so the impact can be reduced
3. To minimize havoc in affected areas by alerting ahead of time
4. To minimize the effect of losing livestock therefore people will not lose their way of living
5. To communicate with people who are stuck in the affected area so that they can be guided

1.2.2 Functional and Nonfunctional Requirements

There are essentially two parts functional and non-functional requirements when it comes to the requirement phase. For the functional requirement phase, we have researched and analyzed it further and found out some crucial parts.

Functional Requirements:

1. We will be analyzing the situation by monitoring water level.
2. Water level detector works within the specific time provided.
3. Master Arduino has to be able to find out the perfect soil moisture value.
4. Generate power using solar panels.
5. When the system is put together it will work to notify people using phone calls, if there is a network issue then a speaker siren will be used.

Non-Functional Requirement:

1. The materials used are very easy to replace and repair.
2. The system performance needs to be real-time based, and the accuracy is needed to be perfect as it plays one of the most important roles.
3. The cost of the system cannot be too high, as it will create less interest for the mass installation.

1.2.2 Specifications

For the research and analysis phase, we have considered some specific constrains and requirements and based on that, we have done some research on where we are going to implement our project. And we have narrowed down to Lama a river situated in outskirts of Chittagong as it is more prone to flash floods. Moreover, we will be focusing in flash floods that is a flood caused by heavy rainfall; the flooding that begins within 6 hours, and often within 3 hours, of the heavy rainfall. From which millions of people lose their lives and houses. Also, we decided who are basically our target consumers, how much power to be consumed on the whole system, how many solar PV panel we are going to use and etc.

Table 1: System, Subsystem specification and components

Correlating among system	**Subsystem**	**Components**	**Description of the components**	**Specifications of components**
Collect Real time sensor data	Subsystem 1	Solar Panel	Generate electricity by using sunlight	• 12-volt 5-watt solar panel • High efficiency A grade solar cells small in size • Can be applied to varies DC equipment
		Rechargeable Battery	Power storage	• 12V 7,5AH Rechargeable Battery with 6.35mm Terminal • Float or. Cells Per Unit: 6 • Voltage Per Unit: 12 • Capacity: 7.5Ah @ 10hr-rate
		Charge controller	Power distribution	• 1-hour 135V ± 1V 10A-45A • Series Regulator Common Negative 25V Per 36cell • 122V ±1 V Single Array
Send text and Voice over		Arduino (Uno)	Send commands to take action	○ Microcontroller: ATmega328 ○ Operating Voltage: 5V ○ Input Voltage(recommended): 7-12V ○ Input Voltage (limits): 6-20V ○ Digital I/O Pins: 14 (of which 6 provide PWM output) ○ Analog Input Pins: 6 ○ DC Current per I/O Pin: 40 mADC ○ Current for 3.3V Pin: 50 mA ○ Flash Memory: 32 KB ○ SRAM: 2 KB ○ EEPROM: 1 KB ○ Clock Speed: 16MHz

		GSM module	Send text and communicate through Voice over	○ Power Input: 3.4V to 5V ○ T Link- Download: 85.6kbps ○ Upload: 42.8kbps
		Electric Pole	Hold equipments and solar panel	○ 12 feet height ○ material: Steel / wood
Emergency Lighting		Lamp/Light	Ensure light during night time of flooding	• Type: LED fog lamp • Ni-Cd battery • Self 3hours backup
		Siren / Speaker	Generate sound warning	○ DC 12V ○ Sound: 120dB
		Sensors	To collect real time flood data	Sonar Sensor HC-SR04 • Power: 5V DC • Current: 15 mA (Working) • Frequency: 40 kHz • Max Range: 4 meters • Min Range: 2 cm • Angle: 15º • Input Signal: 10uS TTL pulse • Output Signal: TTL pulse
				Water Level Sensor Module • Voltage: DC 3 to 5V • Current: less than 20mA • Sensor: Analog Type • Detection Area: 40 mm x 16 mm • Humidity: non-condensing10% to 90%
				Rain Sensor • Anti-conductivity and oxidation for long time use • Sensitivity: adjusted by potentiometer • Required voltage: 5V • Easy installation: bolt holes

				• LM393 comparator by wide voltage • Output comparator: waveform above 15mA
Image processing	Subsystem 2	RGB Camera	Capture flood images	• Dynamic range: 67 dB @ 8x gain • Color picture • SLR lens frame equivalent: 35 mm • S/N ratio: 36 dB • Sensitivity: 680 mV/lux-sec
Send text and Voice over Emergency Lighting		Nvidia Jetson	Detect flood form the captured images	• CPU: Quad-core ARM A57 @ 1.43 GHz • Memory: 4 GB 64-bit LPDDR4 25.6 GB/s • GPU: Maxwell 128 core • Storage: micro-SD
Machine learning Send text and Voice over Emergency Lighting	Subsystem 3	Raspberry pi	Predict flooding	• Pi 2 model B • CPU: ARM Cortex 900 MHz quad core • SD ram: 1gb • Compatibility: Raspberry Pi1A /B • OS: Linux, ARM GNU • USB ports: 4 • Ethernet port: 1 • Micro-SD slot • 3.5 mm jack port

1.2.3 Technical and Non-technical consideration and constraint in design process

In this project we merged our two multiple design approach to one; real time sensor and machine learning. We used different variable and multiple sensors. During the process it can be confusing detecting the proper algorithm, proper driver, and proper library for the project. To implement this project, we needed to learn about the machine learning process. It is a method of data analysis that automates analytical model building. Furthermore, it is a new technology for many people and it is

highly recommended for the project. As a result, it was a little bit difficult to learn everything about machine learning and implement; but we overcome and considered both technical and non-technical issues.

Table 2: Technical and Non-technical consideration

Consideration		
Technical	Independent power source	As during flood power shortage from electrical grid is a common fenomena. To keep that in mind, having an independent power generation source is vital.
	Implement sensors	Sensor have to be protected and calibrated when implemented in the real scenario.
	Identify machine learning model	Selecting the best and effective machine learning model to make the almost perfect prediction of flood.
Non-technical	Determine location	Around 18% of the total around of Bangladesh is being

		flooded every year. So, determining a specific location for accuracy for our project is a must.
	Collect data	Collecting authentic data for proper machine leaning for a specific location of flood for at least 5 years.
	Familiar locality with voice-over/siren	When warning is taking place, people at that area should know when will the siren go on and as well as voice-over.

Constraints:

There might be circumstances that will not go according to the plan that we have discussed and demonstrated so far. However, the cost has to be kept at a minimum keeping the system in its best quality to work so that in can be implemented for mass installation. And people will need to have faith in the system and follow instructions once the warning of the flood is given. Moreover, we must also do our best to market the system ensuring people have confidence in our technology.

Therefore, the key points are:

- Determining specific location: one of the major constraints is that we will not be able to carry out the project throughout Bangladesh. Instead, it will be performed in specific small areas that are vulnerable to flooding. Therefore, determining the location for installing the system needs to be decided carefully so that we can save the area from disaster.

- Communicating with native people: as it might be a rural area the communication has to be in the native language of the particular area so that they can get the message clearly.

- Not enough documented previous data for all location: when we worked on the alternative design approach we faced few difficulties as there was not enough data for machine learning though we implemented having more data gives accurate results. And for image processing it was very hard to get the suitable images as we needed the particular areas and due to the pandemic, it was not possible to go to the particular area and set up for obtaining images then during night the system will not work. Also, the cost is very high if we consider this solution.

Thus, focusing on a specific locality to implement the project in the first phase, and collecting parameter data is key to a successful program.

1.2.4 Applicable compliance, standards, and codes

PV Panels

- The photovoltaic module should have a peak power output of at least 250Wp
- IEC 61730 for safety equipment. (International Electro-technical Commission)

- IEC 61646: Thin Film Silicon Terrestrial PV Modules Design Qualification and Type Approval
- IEC 61701 Ed 2.0: Salt mist corrosion testing of PV Modules
- International Electro Technical Committee (IEC) 61215:2005: Crystalline Silicon Terrestrial PV Modules Design Qualification and Type Approval
- Each module must have permanent labeling indicating at a minimum: Manufacturer, Model Number, Serial Number, Peak Watt Rating, Voltage and Current at peak power, Open Circuit Voltage, Short Circuit Current and Cell Efficiency of each module.

Charge Controller

- The controller may/may not have MPPT technology
- The controller needs to have short circuit and overload protection
- The controller must have minimum efficiency of 90%
- The controller must be tested and certified against efficiency fromIDCOL accredited testing center i.e. (BUET).

Rechargeable battery - Batteries in general, taken from Electropaedia.

Standard Number	**Title**
IEC 60050	International electro technical vocabulary. Chapter 486: Secondary cellsand batteries.
IEC60086-1, BS387	Primary Batteries - General

IEC 60086-2, BS	Batteries - General
ANSI C18.1M	Portable Primary Cells and Batteries with Aqueous Electrolyte - Generaland Specifications
ANSI C18.2M	Portable Rechargeable Cells and Batteries - General and Specifications
ANSI C18.3M	Portable Lithium Primary Cells and Batteries - General and Specifications
UL 2054	Safety of Commercial and Household Battery Packs - Testing
IEEE 1625	Standard for Rechargeable Batteries for Mobile Computers
USNEC Article 480	Storage Batteries
ISO 9000	A series of quality management systems standards created by the ISO. They are not specific to products or services, but apply to the processes that create them.
ISO 9001: 2000	Model for quality assurance in design, development, production, installation and servicing.
ISO 14000	A series of environmental management systems standards created by the ISO.

ISO/IEC/EN 17025	General Requirements for the Competence of Calibration and Testing Laboratories
IEEE 802.21	GSM standard
IEEE 1625	Rechargeable battery standard
IEEE 1562:2007	Solar panel standard
IEEE 2400:2016	Wind turbine / metrology standard
IEEE 833:1988	Protection from water hazards

Standards on overall project [IEEE]

1. The total affected environment exists in quite a damp, wet environment and therefore the products need that type of protection. Many components might need watertight or rain tight enclosures. The need for keeping the equipment dry and away from corrosion is a must. The equipment must also be of correct specification for the need

2. Every equipment must have short circuit protection and overcurrent protection.

3. The equipment needs to have ambient temperature compensation i.e. they are to be operating at the perfect voltages they are supposed to be operating in. Too much temperature might cause harmful effects on the equipment

4. There are cases of lightning problems in the rural areas of Bangladesh. The maintaining of power arrestors need to be present as the PV panels are kept mostly on the rooftops and destruction of PV panels might occur.

5. All of the equipment should be necessarily grounded to prevent injury to people and damage to equipment.

1.3 Systematic Overview/summary of the proposed project

The project's main goal is to create a system that gives out alert before and after a flood is occurring saving lives and livestock. The project uses real time sensors along with machine learning to give out text alerts and sirens. Also focusing on management course of action through the project during the flood crisis.

1.4 Conclusion

We were very hopeful about this standalone project implementation in practical; saving lives and controlling damage from the most common natural disaster of Bangladesh. And we successfully implement the project. We make sure to fulfill the primary criteria of complex engineering and acquiring project management skills through implementation is our academic purpose. After extensive literature review, we can state that the project ensured a low-cost future certified flood disaster management tool supporting industrial standards and codes by taking into consideration of our objectives, requirements, specifications and constants.

Chapter 2

Project Design Approach

2.1 Introduction

Flood disaster management with warning project has various objectives to overcome. Have to identify system level changes keeping the outcome same. In our design approach power source and management tasks are fixed then system levels changes are made. Investigate the approaches through intensive simulation and figuring out the best one for hardware implementation is the aim.

2.2 Identify multiple design approach

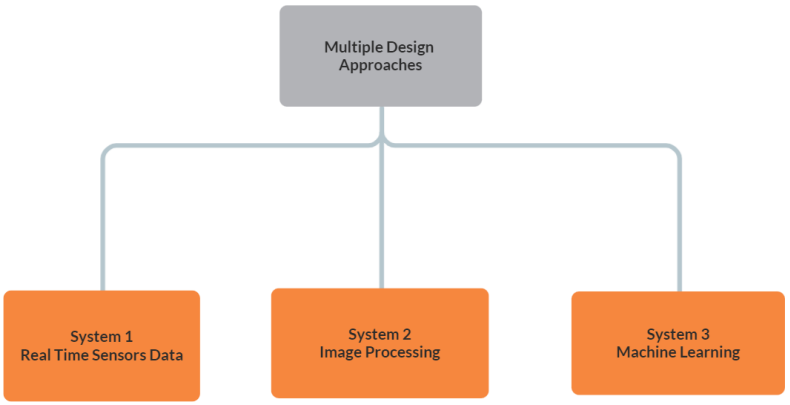

Figure 1: Selecting multiple design approaches

System 1

Real Time Sensors Data:

In this system, data from the sensors will be directly used by the processing unit to determine the flood response. And such that the management (SOS, Voice Over, Warning) process will be placed accordingly. As this system do not need previous data, so it can be calibrated instantly at any location. We will be needing a power source to make the project running. Keeping two sensors

simultaneously to ensure backup, if any one sensor fail another will be working and feed parameters to the machine.

System 2

Image Processing:

Keeping the flood management features from system 1. We made the change in the processing unit. For this system, image processing will be placed in Nvidia Jetson. Instead of sensors, camera will be the input medium. After images or videos are being processed, Jetson will be able to determine the water level or else flood and send response to the Arduino to ensure further tasks.

System 3

Machine Learning:

From previous collected data, two parameters or variables will be defined; time and water level. With these two known variables, machine learning will learn and predict the unknown water level. If the water level is more than danger level, flood warning will be triggered and management will be placed.

2.3 Describe multiple design approach

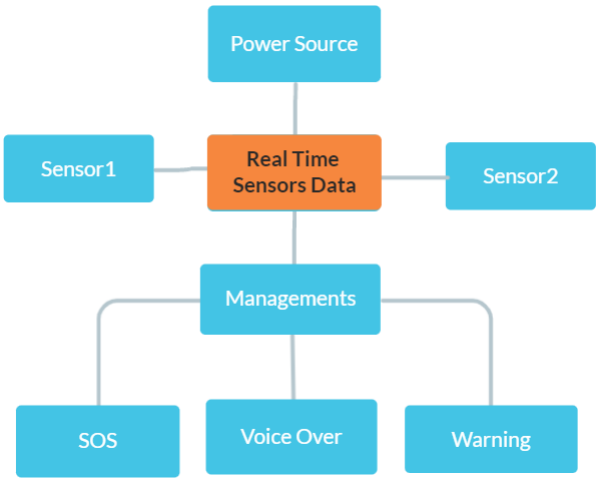

Figure 2: Design 1 block diagram

Design 1

Objectives:

- To read sensor data continuously
- To ensure renewable power source
- To send warning text
- To enable lighting protocol
- To communicate through voice over

Requirements:

- Multiple sensors need to send information to Arduino
- Solar panel will generate power

- Battery will store the power from solar panel
- GSM module will send text and ensure voice over
- During night time, lighting will be enabled when flood is occurring
- Siren or speaker will announce to the affected area people

Methodology:

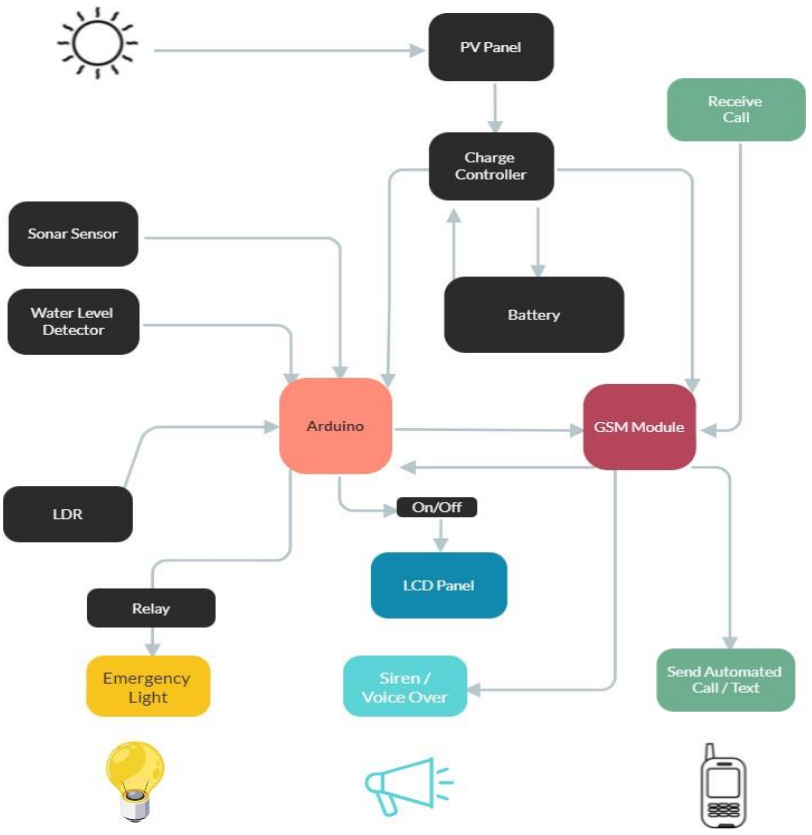

Figure 3: Design 1 system block diagram

Arduino will be the processing unit and make the decision required as per need. GSM module will carry the warning via text or call. This module also able to add the voice over solution. After going the simulation testing, sonar sensor and water level sensor will be the most appropriate decision for design 1. For power source, solar panel will be placed and through charge controller battery will

store the power. From power storage, all the components will receive required voltage for 24x7. Emergency lamp with the help of light emitting register, will be turned on during the night time only and when flood is occurring. For this, a relay will be used as the switch.

Constrains:

- Sensor failing to get data, system will not work
- System calibration after every installment

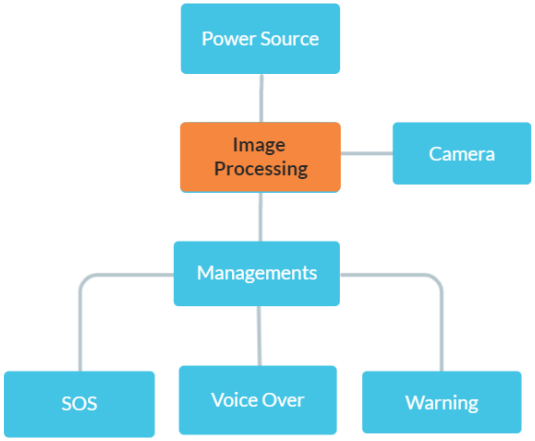

Figure 4: Design 2 block diagram

Design 2

Objectives:

- To take image and predict flooding
- To have an image processing prediction model
- To ensure renewable power source

- To send warning text
- To enable lighting protocol
- To communicate through voice over

Requirements:

- A camera needs to take images
- Nvidia Jetson will process the images with prediction model
- If flood is detected, Arduino will receive signal
- Solar panel will generate power
- Battery will store the power from solar panel
- GSM module will send text and ensure voice over
- During night time, lighting will be enabled when flood is occurring
- Siren or speaker will announce to the affected area people

Methodology:

For image processing simulation, MATLAB will be trained, with previous images and videos of flood. Before image segmentation RGB color need to be defined. Then in image segmentation process, region growing will be used. From that machine will learn a threshold value. With that Th value Jetson later on able to determine water level or else flood.

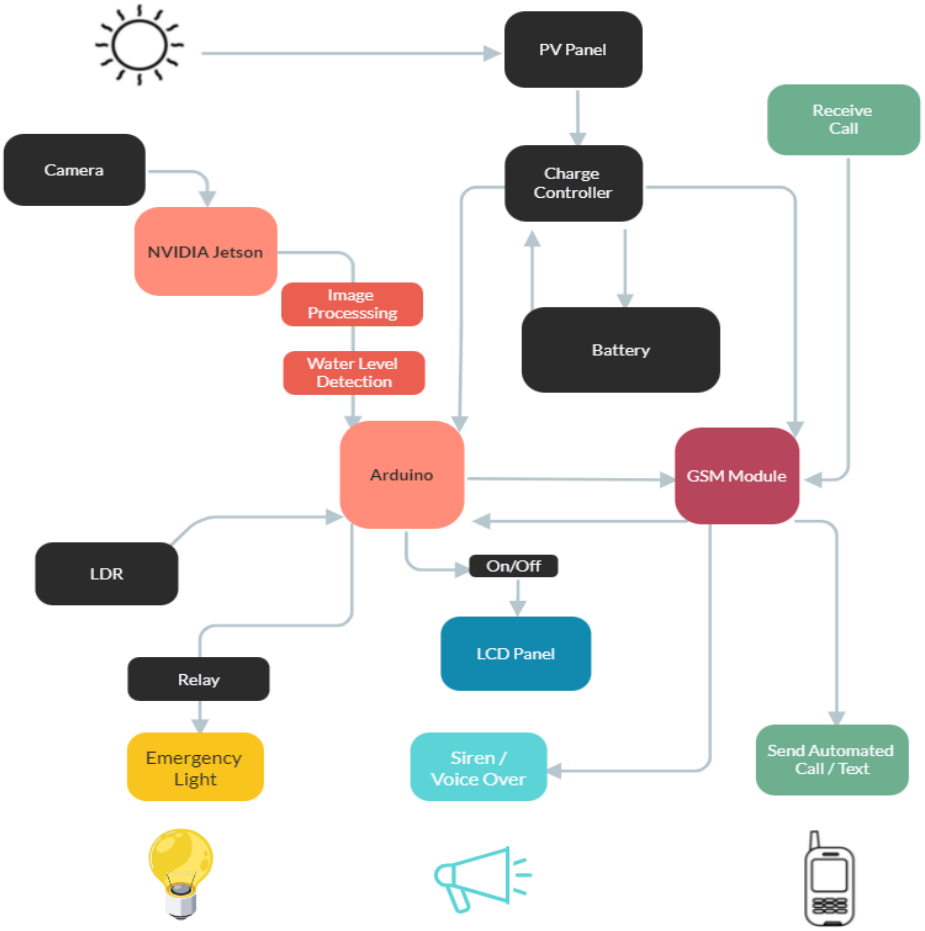

Figure 5: Design 2 system block diagram

Constrains:

- Lack of flood images to train the model
- During night time this system will not work

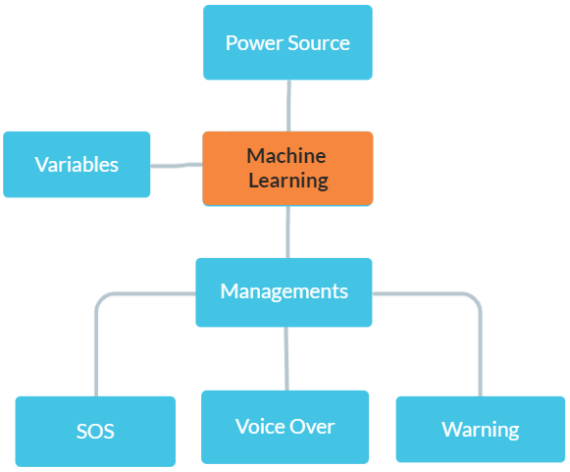

Figure 6: Design 3 block diagram

Design 3

Objectives:

- To have most efficient machine learning model
- To have rainfall data and time as parameters
- To ensure renewable power source
- To send warning text
- To enable lighting protocol
- To communicate through voice over

Requirements:

- Raspberry Pi will process and predict flood
- Rain sensor will collect rainfall data
- Parameters data will be saved to further improvement of efficiency

- Solar panel will generate power
- Battery will store the power from solar panel
- GSM module will send text and ensure voice over
- During night time, lighting will be enabled when flood is occurring
- Siren or speaker will announce to the affected area people

Methodology:

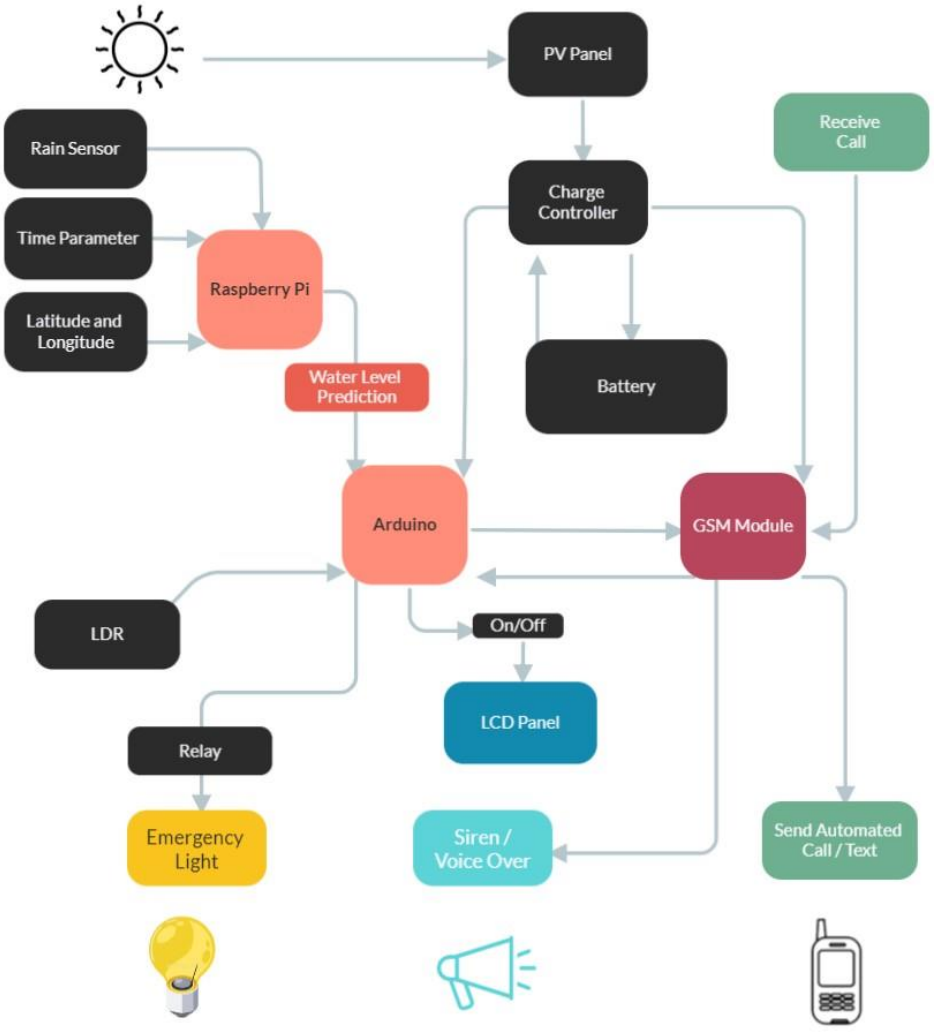

Figure 7: Design 3 system block diagram

For this system we need Raspberry Pi for our processing unit. Python will use eXtreme Gradient Boosting (**XGBoost**) algorithm to predict the water level. With millions of data, ML will improve and should able to give 99 percent prediction accuracy almost all the time with very minimum error rate.

From the prediction we will face four outcomes.

Case 01 - True Positive:

Flood is occurring in actual | Prediction stated flood will occur

Case 02 - False Positive:

Flood is not occurring in actual | Prediction stated flood will occur

Case 03 - False Negative:

Flood is not occurring in actual | Prediction stated flood will not occur

Case 04 - True Negative:

Flood is occurring in actual | Prediction stated flood will not occur

System 1 Design + System 3 Design

For figuring out optimal solution, we merged System 1: Real Time Sensors Data with System 3: Machine Learning together. We did analyze of this design in depth to see it fall under complex engineering and effective in terms of cost to benefit.

Methodology:

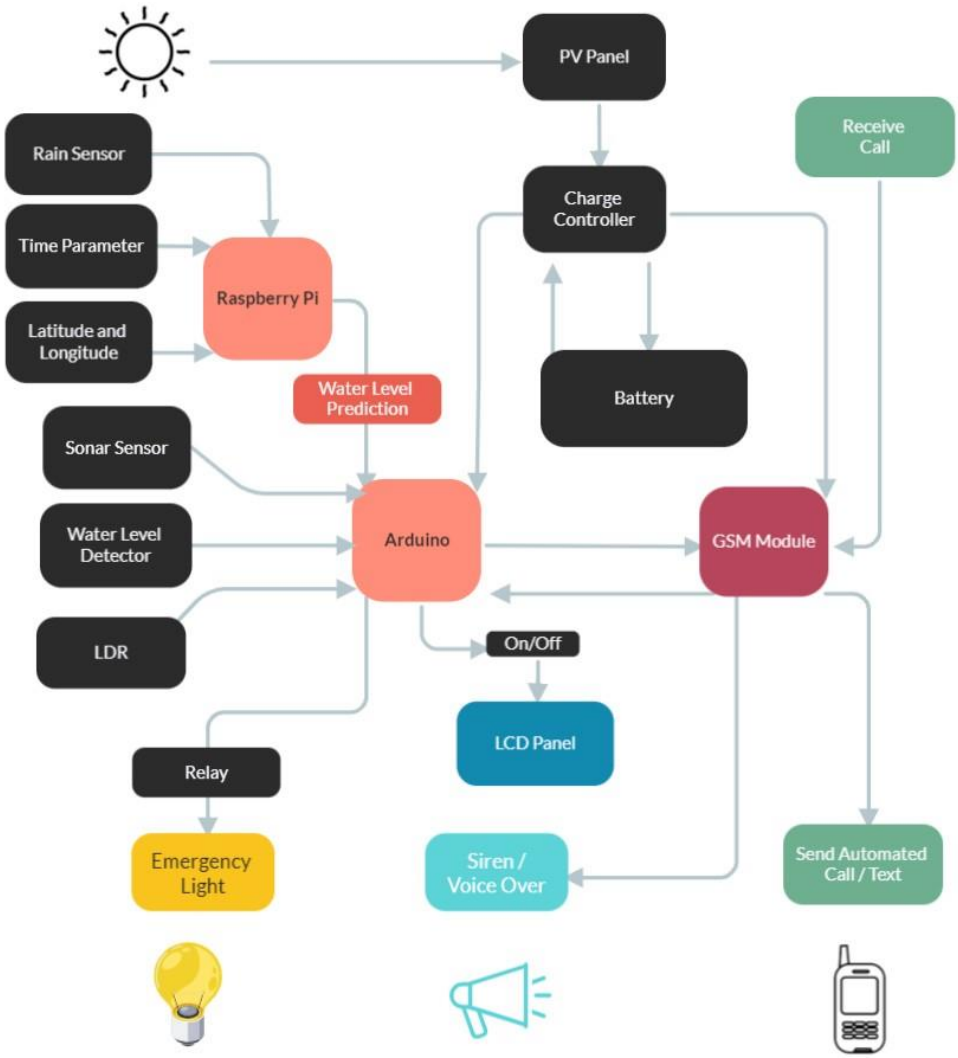

Figure 8: Design 1 + Design 3 merged system block diagram

In this design both Arduino and Raspberry Pi will act as processing unit Arduino will make the decision for real time sensors data and Raspberry Pi will predict the flood. In terms of two processing unit Raspberry Pi will act as a slave to Arduino.

2.4 Analysis of multiple design approach

System 1 Analysis:

Real Time Sensors Data:

- Efficiency: 100 percent effective at any environment and location
- Component Level Cost: 9,165 taka
- Usability: Practical approach for the problem with added new feature for flood management; reliable system.
- Manufacturability: All the components are available in the market
- Impact: Along with other impacts, system will also ensure secure of public data.
- Sustainability: System will be able to tackle harsh environment of disaster
- Maintainability: As a standalone project, will not be needing any update once at the beginning of implementation is calibrated.

System 2 Analysis:

Image processing:

- Efficiency: 70 percent effective at any environment and location. Due to lack of enough flood images for any specific location.
- Component Level Cost: 32,338 taka
- Usability: Although we mange to get 100 percent efficiency with images at day time, the system will break during the night time.
- Manufacturability: All the components are available in the market. But due to covid, Jetson price increased as lack of production.

- Impact: System will not ensure secure of public data as it will capture images frequently without everyone's concern.
- Sustainability: System might be able to tackle harsh environment of disaster but camera may get hamper or start taking blurry images after heavy rainfall or storm.
- Maintainability: After every month, system needs to be updated with more image data to increase efficiency. Also have to check camera is functioning properly.

System 3 Analysis:

Machine Learning:

- Efficiency: After providing a month of data, system is almost 99.6 percent effective at certain environment and location. But this is not enough as it may cause false positive or false negative cases warning.
- Component Level Cost: 24,325 taka
- Usability: Time consuming approach for the problem. Lack of enough documented data. So, the machine needs to learn from his own data to increase the accuracy level.
- Manufacturability: All the components are available in the market
- Impact: Along with other impacts, system will also ensure secure of public data, as it only rely on time and water level parameters.
- Sustainability: System will be able to tackle harsh environment of disaster
- Maintainability: After every six months model needs to be updated.

2.5 Conclusion

All the three identified approaches meet our required objectives and changes in the system are valid. For these three system and design approach coding language, software and all need to be

changed as well as component level changes. In terms of preliminary analysis some system seems better than another, further decision will be made after simulation analysis and verification.

Chapter 3

Use of Modern Engineering and IT Tool

3.1 Introduction

As we decided to work on three multiple approach; and find out the best solution in terms of efficiency and other factors. We need to do simulations and gets results of those multiple design approaches. For simulation and later hardware implementation there are tons of software and tools available, have to select the most appropriate one considering every factor of the project and convenience for a fast troubleshoot.

3.2 Select appropriate engineering and IT tools

For System 1: Proteus

After starting the simulation process realized the components we are planning to use is not available in the software. We later on find those libraries, updated the software as per need and then did our simulation.

For System 2: MATLAB

There is a build in option of image processing in this software. We trained the model then tested how well the model is working in terms of water level or else flood is detected. And surprisingly with limited resources the simulation was giving us quite accurate output.

For System 3: Visual code

Using two variables of the data we received from BWDB, python language with 70% data trained the eXtreme Gradient Boosting (XGBoost) algorithm. Then with 30% unknown data was predicted by the algorithm with an excellent accuracy level.

After going through all the simulation, efficiency of each approach was measured in percentage. Along with other factors, then we are able to decide the optimal solution. Hence these Modern IT Tools are helping to decide whether to go on an engineering approach with data accuracy and efficiency rather than assumption before implementing the project in hardware level.

3.3 Use of modern engineering and IT tools

Table 3: Software and Hardware tools identified

Name	**Tool type**	**Description**	**Task**	**Process**
Proteus	Software	For circuit simulation test and verification of coding	Verify wire connection and code authenticity	Using build in library or updating the library of components
				Connecting wires as per design
				Upload code to Arduino and Modules
				Run simulation
MATLAB	Software	For image processing model	Train and test image processing model	Write code
				Read mean value of green, red, blue color from that specific color picture
				Train model with set of pictures after segmentation
				Image classification
				Test model with new picture

Visual Code	Software	For machine learning model	Show prediction, accuracy and error rate.	Data collection
				Data preparation in excel
				Selecting a model
				Train the model
				Parameter Tuning
				Prediction
				Also show accuracy and error rate
Arduino Uno	Hardware	For processing received data and sending commands	Continuously running code in loop and send commands	Write code in Arduino IDE in PC
				Upload the code in Arduino via usb
				Make necessary wire connection with components
Raspberry Pi	Hardware	For running machine learning model	Using two parameters to increase efficiency and send command to Arduino	Write python code
				Upload the trained model in micro-SD
				Insert the micro-SD in Raspberry pi
				Make necessary wire connection with components
GSM Module	Hardware	For sending text and voice over	Always connected to network, follow commands of Arduino	Insert SIM card
				Wait for some time for making the connection with network
				After connection is established LED will blink
				Make necessary wire connection with Arduino
	Hardware			Connect battery with the controller

Charge Controller		For distribution of power as required	Save power in battery and use that power to active every component	Connect solar panel with the controller
				Connect load with the controller
				Confirm power ON of the controller
Sensor Module	Hardware	For collecting data	Rain sensor, Sonar sensor, Water level sensor; collected data send to Arduino or Raspberry Pi	Rain sensor send data rainfall data to Raspberry pi
				Sonar sensor send water level distance data to Arduino
				Water level sensor send water danger level data to Arduino

3.4 Conclusion

Most of the modern engineering tools and software were already familiar to us. Although some of them were completely new, we had to learn how to use those tools from the scratch for better understanding whether it is right for us or there are other alternative. After doing various trial and error we finalized the tools and software. And make use of those in our project in the best way possible.

Chapter 4

Optimization of Multiple Design and Finding the Optimal Solution

4.1 Introduction

Identified multiple design approaches simulated and verified in this chapter. Later from those system, best one or in our case best two are considered as optimal approach. For simulation we used the identified modern engineering software. Simulation helped us to prepare code which will later be used in optimal hardware implementation.

4.2 Optimization of multiple design approach

System 1: Proteus

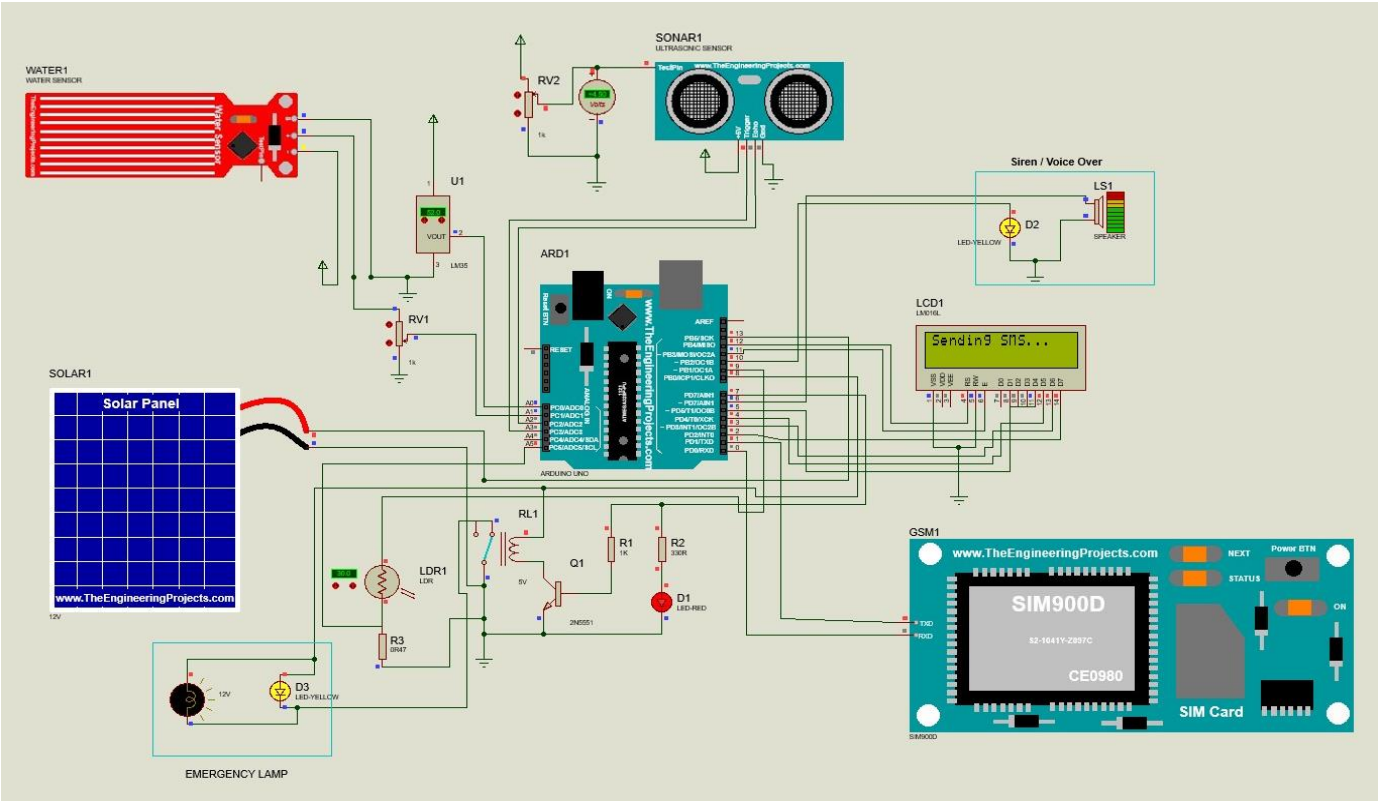

Figure 9: Proteus simulation for real time sensors data

Real Time Sensors Data Design 1:

After starting the simulation process realized the components we are planning to use is not available in the software. We later on find those libraries, updated the software as per need and then did our simulation.

System 2: MATLAB

There is a build in option of image processing in this software. We trained the model then tested how well the model is working in terms of water level or else flood is detected. And surprisingly with limited resources the simulation was giving us quite accurate output.

Image Processing Design 2:

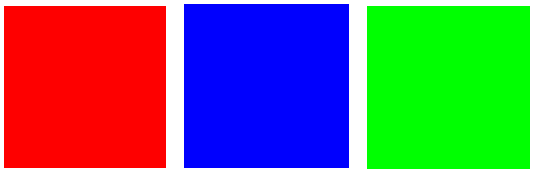

Figure 10: Base images for getting mean value of red, blue, green color

From fig-11 this four set of images, fig-12 almost 20 images is segmented into smaller parts, where flood is occurring in the pixels. With this segmentation, model is trained and region growing technique is used to detect flood using images from camera.

Figure 11: Four set of images to train the model for flood detection

Figure 12: Some samples of flood image segmentation to train the model

Figure 13: Testing MATLAB simulation for image processing

From the testing we can see that the model is able to detect flood and region growing technique is working. Red color is the detection level.

Although, we can see that not all the flood water can be detected with this model. So, to increase efficiency we need more set of flood images to train the model.

System 3: Visual code

Using various variables of the data we received from BWDB, python language with 70% data trained on different algorithms. Then with 30% unknown data was predicted by the algorithm with an excellent low error rate means a better accuracy level.

Machine Learning Design 3:

Data collection:

We collected the data of water level, rainfall, time, latitude-longitude etc for Lama. Data was for 5 years 2017 to 2021. And the data was collected from Bangladesh Water Developing Board (BWDB) coming the authenticity of the data.

Data Type: Water Level			**Frequency Name:3 Hourly**		**Duration: 2017 to 2021**	
SL	DISTRICT	UPAZILA	RIVER	DATE/TIME	WATER LEVEL(m)	Rainfall(mm)
1	Bandarban	Lama	Matamuhuri	1 January, 2017 06:00:am	6.22	0
2	Bandarban	Lama	Matamuhuri	1 January, 2017 09:00:am	6.22	0
3	Bandarban	Lama	Matamuhuri	1 January, 2017 12:00:pm	6.22	0
4	Bandarban	Lama	Matamuhuri	1 January, 2017 03:00:pm	6.22	0
5	Bandarban	Lama	Matamuhuri	1 January, 2017 06:00:pm	6.22	0
6	Bandarban	Lama	Matamuhuri	2 January, 2017 06:00:am	6.22	0
7	Bandarban	Lama	Matamuhuri	2 January, 2017 09:00:am	6.22	0
8	Bandarban	Lama	Matamuhuri	2 January, 2017 12:00:pm	6.22	0
9	Bandarban	Lama	Matamuhuri	2 January, 2017 03:00:pm	6.22	0
10	Bandarban	Lama	Matamuhuri	2 January, 2017 06:00:pm	6.22	0

Figure 14: Sample of collected data for Machine Learning

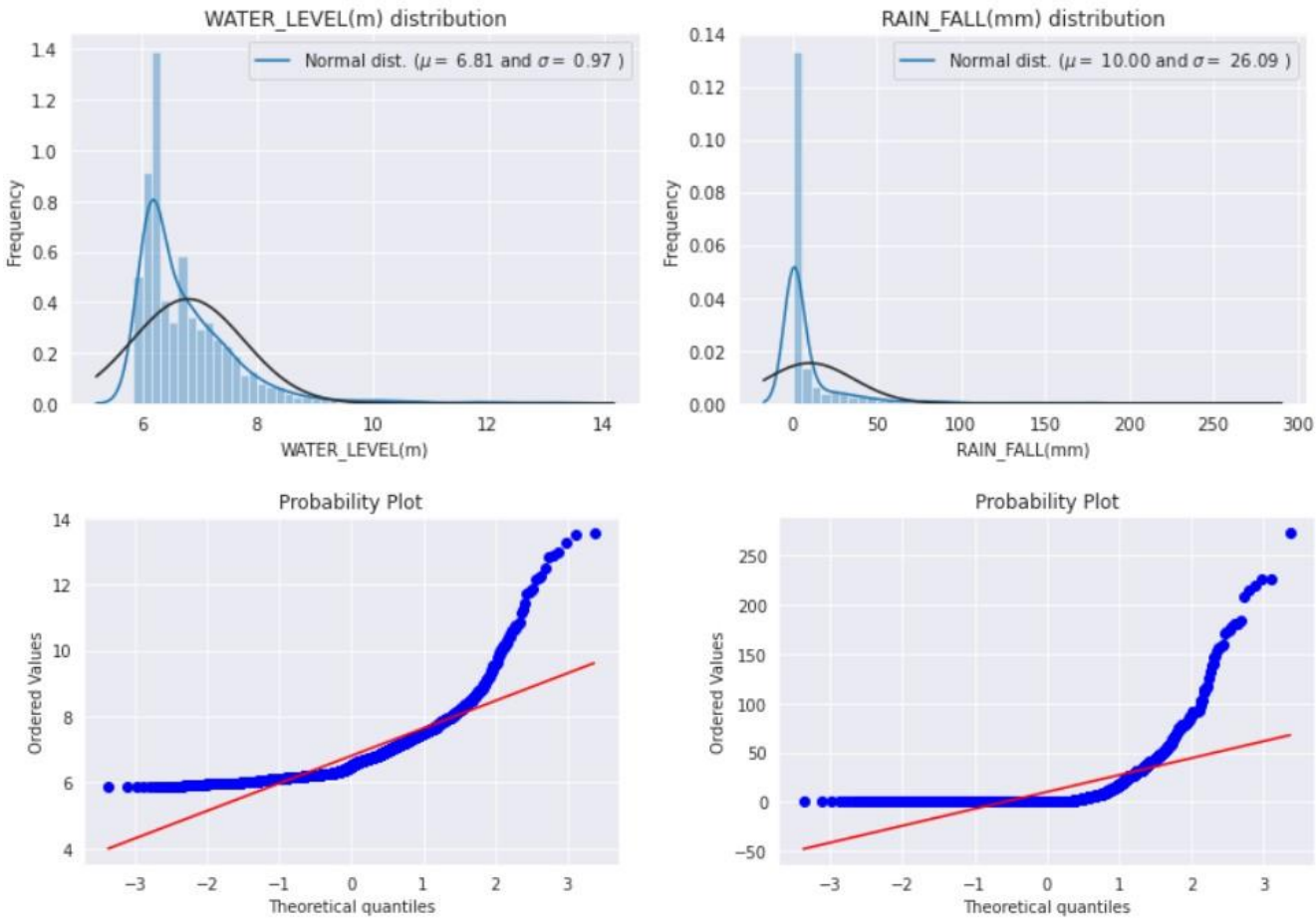

Figure 15: Data analysis prior to algorithm approach

Prior to approach machine learning with our data set, from the above graph of distribution plot we can state that:

1. Flood occurs after heavy rainfall.

2. Time of flood plays a role; time as in during which time of the year flood occurs

From the Q–Q (quantile-quantile) probability plot, with the intersection of ordered values and theoretical quantities, we can confirm that Machine Learning approach will work with our data set.

Applying algorithms:

Which algorithm will work best for us, to figure it out we have to apply various types of algorithm. Then compare their score, like error rate. The model with the lowest error rate will be giving best prediction result.

Model we used are:

1. Support Vector Regression (SVR): A supervised learning algorithm that is used to predict discrete values.
2. Adaptive Boosting (AdaBoost): It boosts the performance of any machine learning algorithm.
3. K-Nearest Neighbors(K-NN): Finding the distances between a query and all the examples in the data, selecting the specified number examples closest to the query, then votes for the most frequent label.
4. Ridge regression: A regularization technique, which is used to reduce the complexity of the model.
5. Least absolute shrinkage and selection operator (Lasso): a regression analysis method that performs both variable selection and regularization in order to enhance.
6. eXtreme Gradient Boosting (XGBoost): Gradient boosting is a supervised learning algorithm, which attempts to accurately predict a target variable by combining the estimates of a set of simpler, weaker models.

As we approached with linear regression could not apply ROC_AUC as it can measure classification or binary classifier. As an alternative we approached with Mean Absolute Error (MAE) score. When the model will show less error rate meaning better accuracy rate.

Table 4: Results of different machine learning models

ML Models	SVR	AdaBoost	KNN	Ridge	Lasso	XGBoost
MAE **Error Rate**	0.56	0.46	0.42	0.60	0.86	0.41

From the table we can see that, XGBoost performed better than the other models. From our understating, XGBoost works better with AdaBoost. We can utilize the AdaBoost model for low noise data when the precision of the result is not critical. Whereas XGBoost has system optimizations, it performs better than Adaboost for complicated and high dimension data.

XGBoost make use of tree pruning and handles missing values. It minimizes the regularized object function. The derivative loss functions the model

$$L(yi, pi) = [-yi\ Log\ (pi) + (1 - y)\log(1 - pi)]$$

Regularization of the equation is $\sum_k \Omega(f_k)$, making the final equation of XGBoost,

$$\mathcal{L}\ (\Phi) = \sum_i L(yi, pi) + \sum_k \Omega(f_k)$$

Figure 16: Graphs of Different Machine Learning Models

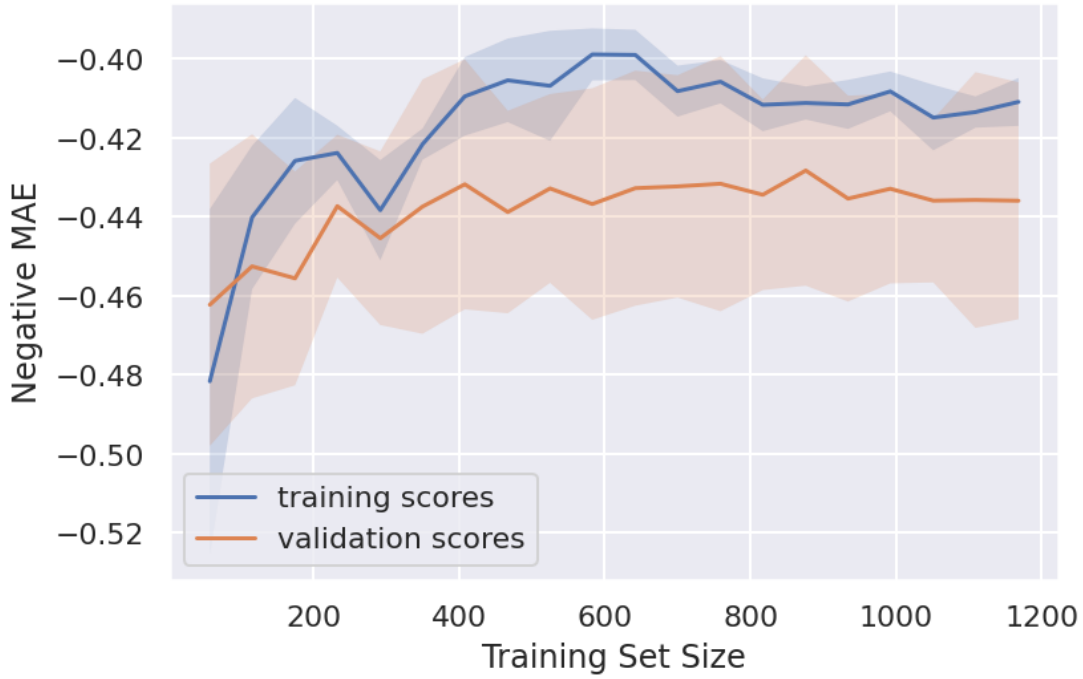

Figure 17: XGBoost Model Performance

4.3 Identify optimal design approach

Optimal Solution:

After comparing all the analysis of the three system through various simulation and other stated above factors, we choose **System 1: Real Time Sensors Data** and **System 3: Machine Learning** and merge two system as the optimal solution to flash flood.

Table 5: Comparison of systems with optimal solution

Analysis	System 1	System 2	System 3	Optimal Solution
Efficiency	100%	70%	99.6%	100%
Component Level Cost	9,165 taka	32,338 taka	24,325 taka	27,164 taka
Usability	Reliable system	During night time, not effective system	Needs to increase accuracy level	Most reliable and authentic system
Manufacturability	Components are available	Components are available	Components are available	Components are available
Impact	Along other impacts, secure privacy	Not ensure privacy	Secure privacy	Secure privacy
Sustainability	Tackle harsh environment	Might tackle harsh environment	Tackle harsh environment	Tackle harsh environment

Maintainability	No need of regular maintenance after installment	Model needs to be updated after every month	Model needs to be updated after six months	Model will update itself, no need of regular maintenance

4.4 Performance evaluation of developed solution

Table 6: Functional verification comparison of three system after going through simulation

System	Flood Detection	Flood Prediction	Works during night time	Send SMS and Voice over	Emergency Lighting	Renewable power source
System 1 Real Time Sensors Data	✓		✓	✓	✓	✓
System 2 Image Processing	✓			✓		✓
System 3 Machine Learning		✓	✓	✓	✓	✓

Test Case 1:

When flood occurs, general affected people cannot get warned or have moral support. Flood management do not only mean to rescue, but also getting proper mental support, so that they can fight with the disaster.

Voice over is an innovative approach to communicate with the affected mass within a very short time. When we are considering LAMA, Chittagong for project implementation, we are also considering destitute people who does not own a mobile phone to get notified. For them a voice over feature is the only solution.

Test Case 2:

During disaster electricity will not be available. And there will be places near river, where we need to install the project for a tentative early warning of the upcoming flood. In those places people do not live, so there will be no chance of having electricity there.

Standalone solar powered project is a necessity. And making sure the battery life to last more than expected. So, need to have a battery saver option which will make sure to keep the device turned off during a specific time of the year.

4.5 Conclusion

Before hardware implementation cost benefit analysis and testing, everything is placed in simulation. Then after verification we decided the optimal solution for our system, then we proceed to buy the components. We merged two system together and made our optimal design for flood disaster management.

Chapter 5

Completion of Final Design and Validation

5.1 Introduction

After every analysis and choosing the optimal solution, we finally approached to hardware implementation. During testing we had to troubleshoot some issues, those issues are also identified in project engineering management chapter. We overcome those issues and successfully completed the final design which fulfil all the assigned objectives.

5.2 Completion of final design

We successfully completed the hardware implementation of the project in industrial grade. Meaning we can implement this project in real scenario.

Safety box ensured the durability and waterproofing was also taken into consideration for the components outside the box. For Machine Learning Raspberry Pi was into double layer protection, as it is costly component.

For demonstration, we used a part of water bottle where when the water level increased, sensors detect the changes and triggered the processing unit to take action regarding our objectives.

In the future to troubleshoot the project a LCD panel is also included. By reading the status we can easily figure out the problem whether it is calibration issue or a component is damaged.

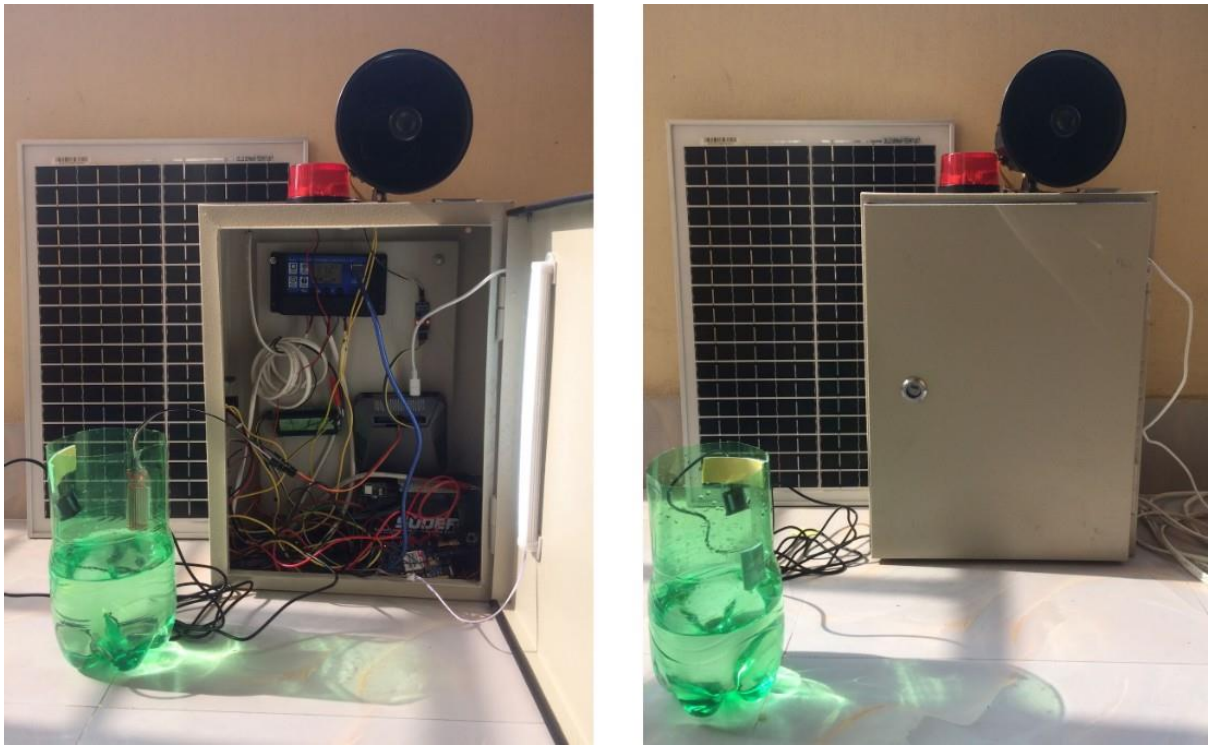

Figure 18: Complete project inside the safety box

5.3 Evaluate the solution to meet desired need

As the project will be independent from the grid line, solar panel is used to generate, battery to store and charge controller to distribute the power to all the components.

Figure 19: Power generation, storage and distribution

The LCD is showing water level and status of the management. The panel can be easily turned off by a dip switch, to save power of the battery.

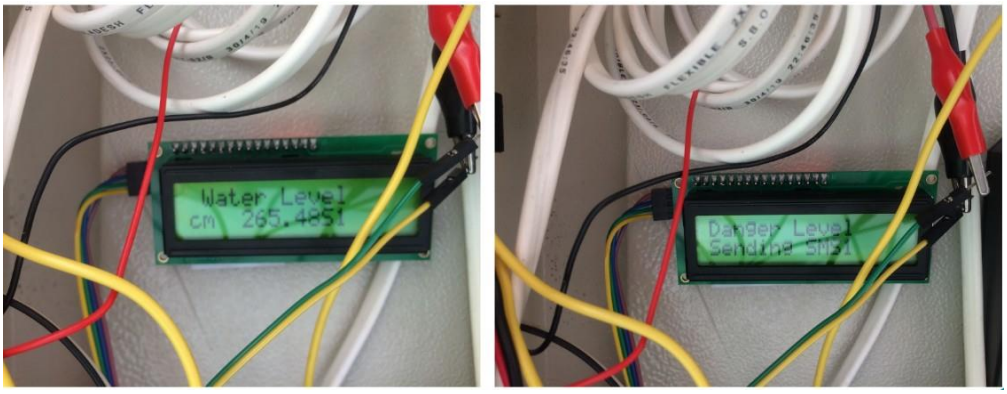

Figure 20: LCD panel verifying the system running properly

Table 7: Functional verification of the hardware solution meeting desired need

System: Optimal Solution	Flood Detection	Flood Prediction	Works during night time	Send SMS and Voice over	Emergency Lighting	Renewable power source
Hardware implementation	✓	✓	✓	✓	✓	✓

From the table we can state that the hardware implementation of the project is fulfilling all our objective. On the other hand at the receiver end a designated number will receive text and able to make voice over through the project.

Figure 21: Warning text to a defined number

Only a defined number can make the voice over, making sure there will be no accidental call received in the device.

5.4 Conclusion

Flood occurring places will be hostile for the project. As the project will be placed in an open, under the sky ground we needed to take safety of the components very seriously while building the project. Then successfully building the project we fulfilled our obligation in academics term and the country's benefit in the near future.

Chapter 6

Impact Analysis and Project Sustainability

6.1 Introduction

Floods have the power to cause massive community disruption, displacement, economic loss, property destruction, deaths, injury, as well as profound emotional distress and agony. Flood Disaster Management Strategies for our project is a collection of processes and actions aimed at lessening the overall effects of flooding on society.

6.2 Assess the impact of solution

People's awareness and Safety Impact:

Because the project we're working on is based on cutting-edge technology, it's understandable that the general public will be skeptical of anything they don't comprehend. As a result, increasing public awareness through various sorts of marketing might help them comprehend the advantages of using the system. While conducting campaigns, we must ensure that they receive accurate project information for their own benefit. Also, our flood crisis management system's most evident benefit, and indeed its sole goal, is to reduce flood damage. This will aid in the rescue of lives, livelihoods, and property in the case of catastrophic flooding. Since we will ensure people's safety and electrocution is the number two cause of death during a flood. The reason is, water has the ability to conduct electricity. Because the technique will be communicated via text messages, individuals will be alerted early and avoid coming into touch with water.

Social Impact:

The term "social impact" refers to a major, beneficial change that tackles a critical social issue. A purposeful collection of activities with an aim that matches this description produces a social effect. It primarily addresses social acceptance, equity, and the influence of any new breakthrough technologies that may improve living quality. The influence on this issue is detailed further down:

Policies and incentives from the government:

Because this project is essentially a new management system, it is understandable that many may be skeptical of its results. Bangladesh is also highly considered as a "Role Model" for disaster and climate risk management on a global scale. Institutional structures and policy frameworks are in place to guide national efforts to meet key disaster management goals.

As a result, in order to create confidence, a government incentive would be necessary in terms of trust concerns and market support. This will provide people a better understanding of the system by allowing them to learn more about it in a more concise manner.

Security and the use of human as resource:

The fundamental goals of any program are to prepare all types of people for leadership and management roles in security and emergency management, as well as to discover best practices for community planning, security, and disaster prevention and mitigation.

Hence because this is the current technology, it is likely that many individuals will be needed to help create the disaster management system. So, if we emphasize the relevance of our initiative to people like volunteers and students, they will be able to provide a thorough

understanding of the project to the wider public. The human will be able to play a role as a resource in cultivating flood awareness by adopting this step.

Health and prevention of breakthrough diseases:

Drowning, injuries, cold, and animal bites are among the direct health effects of floods. The evacuation of patients, the loss of health staff, and the loss of health infrastructure, including crucial drugs and supplies, all pose health hazards. Flooding has the potential to negatively impact people's mental health and well-being. The majority of people can manage the scenario, but a small number of people may suffer mental health issues. Separation from family and friends, disturbance to family life and daily routine, loss of pets and things, and moving to temporary housing can all have an impact on children's mental health. The flood disaster management system has the potential to significantly lower the death toll of thousands of people. Field personnel, particularly health workers, teachers or trained volunteers can provide psychological first aid.

Environmental Impact:

Environmental authorities play a crucial role not just in raising awareness of the environmental consequences of structural defenses, but also in lobbying for environmentally sustainable solutions when suitable.

6.3 Evaluate the sustainability

- Recycling of batteries

Batteries that have been improperly disposed of contribute to water and air pollution. Batteries that have been depleted are thrown away and wind up in landfills, where they degrade and leak. Thousands of aquatic plants and animals live in our ecosystems, which are jeopardized by battery chemicals. This implies we could be eating hazardous metals, and if the human body absorbs nickel and cadmium from leaking batteries, it will serve as a cancer-causing agent, as well as cause serious medical problems. As a result, it's critical that we properly dispose of the batteries, and our project is also more environmentally friendly because we're employing rechargeable batteries. One of the major advantages of using rechargeable batteries is that they are more environmentally friendly as a result of their ability to recharge, fewer resources are consumed throughout the production process.

- Proper use of sound system

Since we are employing sirens to inform people, there are some issues about sound. Sound pollution difficulties may arise as a result of loud sound systems. Sound pollution, for example, is said to induce mental and physical sickness in humans. High blood pressure, headaches, indigestion, ulcers, and sleep disturbances are all possible side effects. We are deploying sirens to warn people about the impending flood in our project. There will be no problems caused by excessive sound pollution since we will use it very successfully to maintain the normal sound levels, which are 0-20 dB for a normal sound level and 21-40 dB for a moderate sound level.

- Solar Panel Accessibility

Typically, distributed solar panels are installed on the roofs of homes or businesses. One of the applications that have acquired a lot of traction in recent years is this one. It is becoming more accessible as solar panel costs fall and more people become aware of the financial and environmental benefits of solar energy. These solar power systems create enough electricity to cover the property owner's needs while also sending any surplus to the grid. A solar battery can be connected to your solar power system to allow you to use solar electricity after the sun has set, charge an electric vehicle overnight, or offer backup power in an emergency. So, it will be effective to use solar panel in our warning system.

6.4 Conclusion

Flood disasters have always wreaked havoc on societies, destroying livelihoods and investments with enormous monetary worth and significance for development. Our automated GSM warning system, on the other hand, will increase residents' awareness and preparedness for flood events, reducing the negative effects of these disasters on people, as well as the importance of monitoring, evaluation, and mainstreaming flood disaster management into national development planning.

Chapter 7

Engineering Project Management

7.1 Introduction

For a successful project a logbook and proper plan are integral parts. This gives us a proper idea about the pace of our work and maintaining a proper schedule to fulfill all the tasks. We have strictly maintained a proper project plan and tried our level best to maintain it throughout the whole time.

7.2 Define, plan and manage engineering project

Table 8: Plan of overcoming challenges

Plan	Challenges	Accomplish
Building the team	Having an active team with skills and almost same mindset	Finding students from different majors and batchmates or already familiar personality
Find out a complex engineering project and innovative	Almost all the projects are built around the world	After doing the weekly offered classes and ATC help, later during 400D we figure out what were the gap in the existing systems
Full filling the COs of the course	Full filling all the COs were very difficult	Proper discussion with teammates and ATC consultations, guidance

Literature review	Finding out all the existing system and the gap those system	After going through various conference papers and journals, figured out which are and which are not already existing and how it can be done through our project
Multiple design approach	Figuring out different systemic approaches to meet our desired outcome	ATC members and Faculty members helped us to identify three systematic approaches to fulfill our objectives of the project
Software simulation	Not every component is available in Proteus	Had to add different libraries to run the simulation
Availability of the components	For hardware execution, every component must need to be available in the market	After going though all the online shop, if a component is unavailable there, then we went to the market in person and able to find everything
Cost minimizing	As the project need to be mass installation, cost barrier was always an issue	After the successful simulation we finalized the components. Even when we merged two multiple approach, still the cost was lower than the third one

Machine learning	Collecting authentic data	ATC Chair helped us to collect confidential authentic data from BWDB
Algorithm development	Choosing a near to perfect ML model and narrow error rate	Testing data with different models and comparing them with each other
Hardware implementation	Calibration of all the sensors and alignment of all the code together	After setting up with the required connection, calibration of the sensors took place. As well as changes in the code if required
Sustainable	Durable and eco-friendly in harsh real-life disaster scenarios	Protective metal case and water proofing all the components also solar powered to sustain resource-efficient

7.3 Evaluate project progress

Table 9: Project Timeline

Task Name	Start	End	Duration (days)
Concept Note	04-07-21	12-08-21	39
Project Proposal	14-08-21	10-09-21	27
Research	10-10-21	25-11-21	46
Multiple Design	19-10-21	30-11-21	42
Algorithm Development	12-11-21	14-12-21	32
Programing	17-11-21	20-12-21	33
Circuit Simulation	15-11-21	25-12-21	40
Design Report	10-12-21	07-01-22	28
Component Test	05-02-22	10-03-22	33
Prototype Design and Troubleshoot	17-02-22	26-03-22	37
Practical Implementation	11-03-22	26-04-22	46
Project Final Report	24-03-22	06-05-22	43

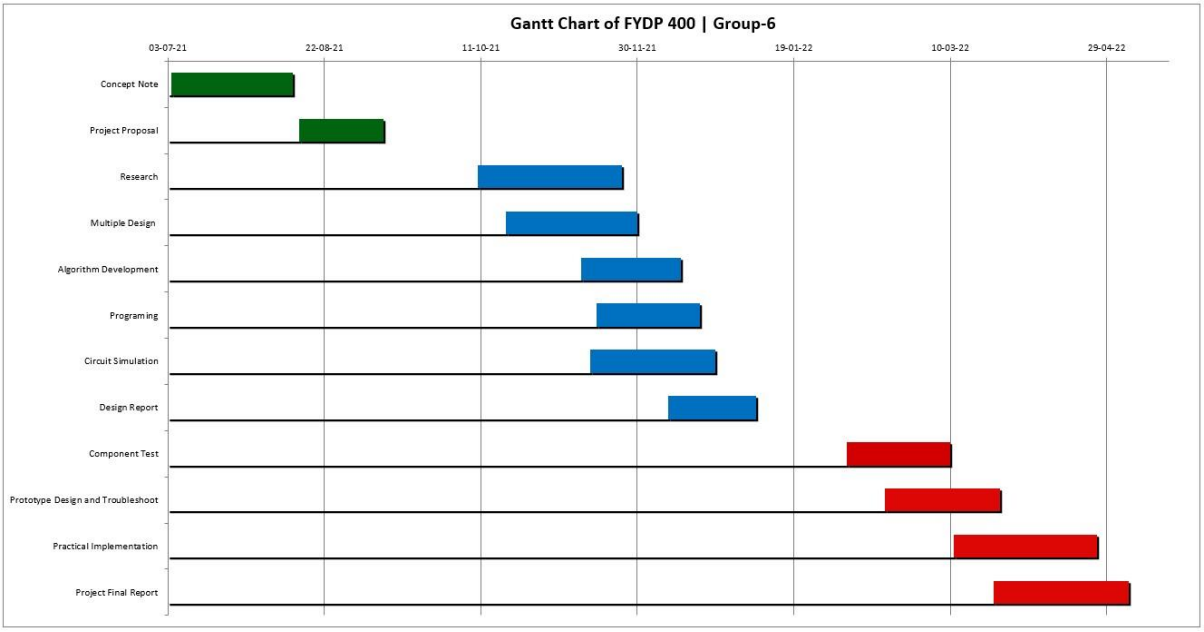

Figure 22: Gantt chart of the project

We have to change from previous project plan and update for 400D and further for 400C. 400P did not focus on multiple design approach. In new timeline is showing the added new tasks. We shifted the component testing to 400C. We also updated time duration as per need. Which showcase we allocated more time on research, multiple design and practical implementation. As it helped us to do circuit simulation with programming in a very short period of time. Some tasks overlapped with other tasks, reason we did various assigned problem solving simultaneously. From the gantt chart we can say that, we end our project by the fourth month of this year; consuming exactly one year to developed the full-fledged FYDP project.

7.4 Conclusion

It took three semesters to finally complete our project. We had to work really hard to maintain the proper plan and give updates to our ATC members. They were really helpful and supportive. We continuously kept updating our plans and finding ways to make the project better.

Chapter 8

Economical Analysis

8.1 Introduction

Flood is one of the major disaster in Bangladesh. Therefore, to keep us safe from the hazardous circumstance we have to build our project in mass installation. When we are building the device we have to consider, how much economical it is in terms of the availability for the government stakeholders or population of that area.

8.2 Economic analysis

Table 10: Components list and budget

Components	**Price**	**Quantity**	**Store Link**
Arduino Uno R3 Original with Cable	780 taka	1	https://bdspeedytech.com/
12volt Solar panel	845 taka	1	https://www.eeeshopbd.com/
Solar Charge Controller	550 taka	1	https://bdspeedytech.com/
12V Rechargeable Battery	1000 taka	1	https://store.roboticsbd.com/
Sonar Sensor (HC-SR04)	850 taka	1	https://bdspeedytech.com/
Rain Sensor	140 taka	1	https://leetechbd.com/

Raspberry Pi + Aluminum case + Memory card	17999 taka	1	https://www.electronics.com.bd/
LCD Display (16x2)	220 taka	1	https://www.eeeshopbd.com/
Emergency Lamp	350 taka	1	https://www.eeeshopbd.com/
Siren / Speaker	980 taka	1	https://www.daraz.com.bd/
GSM Module	2950 taka	1	https://bdspeedytech.com/
Water Level Sensor Module	500 taka	1	https://bdspeedytech.com/
Sub Total	**27,164 taka**		Note: *wooden electric pole and safety box cost for implementation
Implementation Cost	**1,800 taka**		
Miscellaneous Cost	**700 taka**		
Total Budget	**29,664 taka**		

We updated the component list as per our optimal solution requirement. Total components cost is 27,169 taka and we kept 2500 taka in budget for the implementation and miscellaneous

purpose. So that we can safely state that our project at the end will not cost more than 30,000 taka.

8.3 Cost benefit analysis

In this project for algorithm training purpose the raspberry pi will store the data in memory chip. So, here we are not using any cloud drive. Therefore, the costing of our cloud drive will be zeroed out. However, due to the unavoidable circumstance in China the budget of Raspberry Pi rose for which it made the budget a bit higher than we intended too. But, we believe it will be drop soon after the situation normalizes. As a result, we have tried our best to keep the device budget friendly and low maintenance so that we can go for mass installation. Moreover, as we are using solar panels to generate our own power, we are minimizing the cost of electricity also saving it.

Package: One-time purchase

Project Maintenance Cost: As per defected item (very low)

Awareness Training: After installation a free training to local people

8.4 Evaluate economic and financial aspects

As a developing country, flood is a burden in economic growth of Bangladesh. Based on various reports and recent flood statistic in Bangladesh, we can see that almost 2,000 crore taka of loss take place every year [11]. Along with deaths of people, this loss can not be measured in any term.

Table 11: Flood in Bangladesh causes loss per year (approx.)

Crops damaged	Tk1,323 crore
Affected lives	3.1 crore people
Deaths	144 people
Home destroyed	600,000
Livestock mortality	1,321 cattle and 466 farms
In total estimated loss	Tk2,000 crore / USD 2 billion

Comparing with the losses, with only 30,000 taka, we will be able to cover a large area of an union parishad, where chairman will directly monitor and take necessary steps with the help of our device. The chairman can contact with district deputy commissioner if requires to provide help to the affected people and warn them beforehand to move to safe places or even assist them when to cultivate which crops and if there is any probability of happening flood.

8.5 Conclusion

In conclusion, the cost of the project is bare minimum compared to the loss flood disaster make every year in our country. In addition, awareness training will be provided to the local people to get familiar with the warning system. As the device is almost a modular system, if a component is broken or damaged, it can be easily replaceable, so the maintenance cost after installation will be always very low.

Chapter 9

Ethics and Professional Responsibilities

9.1 Introduction

Engineers are required to uphold the highest levels of honesty and integrity as members of their profession. Engineering has a direct and significant influence on everyone's quality of life. As a result, engineers' services must be based on honesty, impartiality, justice, and equity, as well as a commitment to the public's health, safety, and welfare. Engineers must adhere to a professional code of conduct that compels them to follow the highest ethical standards.

9.2 Identify ethical issues and professional responsibility

Ethical issues

During the implementation of any project there arise some ethical issues. In our case, we have planned to implement this project in an open area where we will have to take permission from the chairman and government officials. We have already discussed our project with one of the government officials who is a senior officer of BWDB. After the discussions, he agreed to provide us with the required data like the water level of the rivers, rainfall and the danger level of some specific rivers. As almost every year thousands of people get affected by floods, this project will boost the safety management of the rural people. Moreover, in this project, we are not going to use any equipment which can hamper the privacy of the people or that specific area. Hopefully, we will get the support of the rural people as this project is for their safety. Besides, we have planned to explain the project to the rural people before implementing it in their area.

On the other hand, as this project is for the betterment of flood management and it will be able to save lives as well valuable things by giving them real time updates, if we can make people understand the whole issue and the benefits, the rural people will be interested to implement it in their area. We are really optimistic about this project.

Side by side, being an innovative technology that we intend to develop, maintenance of responsibilities professionally will play a great role in catching the eyes of the general people as well as the investors and the stakeholders.

- Relationship management:

  It is very necessary to maintain a good relationship between clients and stakeholders. In any case, the investors stop investing for any professional issue, there will be a critical situation to continue the mechanism of this project efficiently. As we are the suppliers we need to ensure the relationship among the suppliers, clients and investors remain well and smooth.

- Improvement:

  It is certain that after a period of time we will have to develop our project and make it more efficient. As of right now this project is under development, we will ensure to develop and find out it is lacking with the flow of time. Later on, we will work on developing the project and make it more advanced.

- Meeting the deadline:

  It is obvious that we have to complete the project before supplying it to the investor. It should be properly checked before the deadline. Handing over any project before the

deadline creates a better impression and builds a healthy relationship with the clients and stakeholders.

Professional Responsibility

Nowadays technologies are getting more advanced. With the increasing number of latest technologies vulnerabilities and risks are rising. Different electronic devices and newly improved versions of them have some ethical issues. Various kinds of faulty components are being sold in the market. However, we are confident that, it will not be a problem in our case as we will test the components and sensors properly before implementing them in our project.

The whole project that we are trying to build and implement is basically a two-focused project that is the project is both product-focused and process-focused. Product-focused in that we are building a scale model to act as a proof of concept and to assess design parameters and outputs.

- Checking validation of equipments:

  Now if we talk about the risks while building the project for the actual river, field, getting proper equipment for the project might create issues for implementing the project. We know that solar panels and GSM Modules are the two most important parts for building this project. Other than this, these parts almost carry most of the expense of the overall project. So, maintaining the safety and security of these parts is also very important. Other than this, if we talk about the other parts that are microcontrollers, sensors these are also very important. So, we need to ensure the proper safety and efficiency of these instruments.

- Upholding Trusts and Beliefs of a Consumer:

  Next thing is about managing the risks and upholding the trust of the consumers. As solar panels are very expensive in real field-type projects, it is necessary to maintain proper observation and monitoring for the solar panels. It is natural that, out of human interaction and instincts, people might have intended to damage the properties especially the solar panels or to break the other parts also which will affect us in covering more cost for the project. For these reasons, the consumers might show less interest in investing in this project to implement. So, for safety measures, we can either place the solar panels in the rooftops or nearby house regions or we will put them on the electric poles.

- Ensuring the proper quality of each and every equipment:

  In this project, each and every equipment is very important to get an efficient result. If and component stops working it may ruin the whole project. we will make sure that each and every equipment we are going to use is completely fine and try to check the efficiency before implementing them in our project.

Contingency Plan

As the project that we intend to build is an open field project, it is obvious that all the equipment is pretty much exposed to an open environment. For this reason, due to many unwanted and undesired situations, this might happen that the project that was supplied to the stakeholders failed to operate the way it was supposed to. Now, if this kind of problem happens then it is obvious that the investors/stakeholders might lose their interest in our project. So, in order to get rid of that issues, we the suppliers have some contingency plan to backup these risks and to maintain a healthy relationship with the stakeholders.

- Ensuring the safety of microcontrollers, sensors:

  Microcontrollers and sensors are a very sensitive part of this project. As these will be in an open field project we will make ensure that these elements are inside the safety boxes. So that, nobody or nothing can damage these elements.

- Protecting elements from Lightning thunder:

  Since there may be heavy rainfall during the flood or storm can take place. At that time, it is obvious that there will be thunder lighting. This Thunder lightning can hamper our elements. So, to protect them from this thunder lightning we are going to use a Lightning arrester.

- Backup Power Source:

  During the flood due to heavy rainfall or any other reason if our battery gets damaged, we need to have a backup power source so that the project can work properly. For that reason, we are going to use a Backup power source like the direct-coupled system to give the backup at least during daylight.

9.3 Apply ethical issues and professional responsibility

We have already discussed our project with one of the government officials of BWDB. After the discussions, with procedures they provided us the required data like the water level of the rivers, rainfall and the danger level of some specific rivers. As almost every year thousands of people get affected by floods, this project will boost the safety management of the rural people. Moreover, in this project, we are not going to use any equipment which can hamper the privacy

of the people or that specific area. Hopefully, we will get the support of the rural people as this project is for their safety. Besides, we have planned to explain the project to the rural people before implementing it in their area.

On the other hand, as this project is for the betterment of flood management and it will be able to save lives as well as valuable things by giving them real-time updates, if we can make people understand the whole issue and the benefits, the rural people will be interested to implement it in their area. We are really optimistic about this project.

Table 12: Professionally responsible person assigned as per ethical issues and risk associated

Risk Event	**Type of Risk**	**Likelihood**	**Impact**	**Contingency Plan**	**Person to Response**
Lack of Validation of equipment	Equipment could stop working in the middle of the project	High	High	We will check each and every equipment and their efficiency before using in the project	Omar, Salmani, Raisa, Afrida
Risk of Solar panels	People can break the solar panels or those could be broken	High	High	Putting the solar panels above electric poles or the	Omar, Salmani

				nearby rooftops	
Displacement of Microcontrollers	Microcontrollers may be hampered during the flood and storm	Low	High	By putting these elements inside safety boxes these elements can be protected	Omar
Displacement of sensors	During flood sensors can be displaced or may be hampered	Low	High	Using the safety boxes for sensors	Omar, Salmani
Lightning Thunder	At the time of Storm there can be thunder which may damage the equipments	Medium-High	High	Use of Lightning arrester	Raisa, Afrida
Damage of the battery	Due to heavy rainfall or any external reason can be damaged	Medium	High	We will arrange direct-coupled system to	Omar, Salmani

				give the power backup	

9.4 Conclusion

We have tried our best to maintain all the ethical considerations. Being an innovative technology that we intend to develop, maintenance of responsibilities professionally will play a great role in catching the eyes of the general people as well as the investors and the stakeholders.

Chapter 10

Conclusion and Future Work

10.1 Project summary/Conclusion

As stated, the major goal of this project is to design a real time flood disaster management system with sensors and machine learning that is highly efficient and can specifically assist individuals in flood- affected areas. To accomplish this, we first choose a location for the implementation. Then we came up with three different implementation designs, but owing to some constrain which cannot be overcome, we decided to merge two system. We a developed a controller algorithm and code for that system that will be able to point water level data and also predict through sensors and deliver warning signals to individuals via text or sirens. That is why, in the design report, we have attempted to focus on the project's incremental development in order to make it more efficient and to arrive at a conclusion with the most optimized solution capable of delivering the outputs. And in the final report we focused on the hardware implementation and how the project meets all our objectives. In fact, we can state that completion this project in mass production will be making a significant impact on our country's recovery from the oncoming flood crisis and innovating new flood management technique.

10.2 Future work

For further improvement in the future, we can extend the project and connect it with the database, and also develop an app for connectivity. If possible, we will now reach out for government funding or investor to build the project in mass production. We will be focusing on publishing a paper of flood management and machine learning on perspective of

Bangladesh, so that people all over the world will able to take this innovative management approach in their design as well.

Chapter 11

Identification of Complex Engineering Problems and Activities

11.1: Identify the attribute of complex engineering problem (EP)

Table 13: Attributes of complex engineering problem

	Attributes	**Put tick (√) as appropriate**
P1	Depth of knowledge required	√
P2	Range of conflicting requirements	
P3	Depth of analysis required	√
P4	Familiarity of issues	√
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	√
P7	Interdependence	√

11.2: Provide reasoning how the project address selected attribute (EP)

Depth of knowledge required:

We have studied and researched various papers. We also have read almost 20 conference papers and journals throughout the semesters and have chosen four for literature review. Those are GSM and web-based flood monitoring system, Flood Monitoring system using IoT, Machine Learning and Flood disaster indicator of water level monitoring system and Image Segmentation Methods for Flood Monitoring System. We also gone through study materials for python coding and machine learning. By doing this, we also obtained sufficient system

knowledge, and ultimately, we gathered extensive theoretical knowledge of the tools required to construct the design.

Range of conflicting requirements:

We did not find any confliction with our requirement and everything is matching with the simulation and hardware implementation. Although when we started for extensive hardware implementation confliction happen with the previous budget. So, we had to update to new budget margin.

Depth of analysis required:

From there multiple approach, we simulated all there and get the results. From the results we come up with the best approach with optimal solution to the problem we are solving. We are very much aware of the false warning, and made sure the project will work at superlative state without any problem.

Familiarity of issues:

For this project we are going to implement it for flood control to save peoples live so we have to go outside to gather information about the area, how the flood starts and to explain the project to the people where it will be implemented. Although, we have knowledge about the project on engineering level but still we have to consider the real field scenarios and exceptions while implementing the project in the open field.

Extent of applicable codes:

We are following the codes and standards from IEEE, IEC and ISO. Making sure that as the project will be in a disaster-prone area, the project is always reaching the safety and longevity. Also making sure the quality standard at the best with the limited resources and budget for mass installation.

Extent of stakeholder involvement and needs:

As we are implementing this project for especially the rural people. Every year many people lose their crops, cattle, valuable things due to floods. So as this project will be working for the betterment of the rural people, our stakeholders can be our government, then again, we have various NGO's like BRAC, ASA etc. We have researched enough and gone through a lot of papers to ensure the efficiency of this project. Working with this project we have applied complex engineering methods to detect the stakeholders and their proper needs. Moreover, as our approach is really innovative there is a high chance that we will have more stakeholders in near future.

Interdependence:

Interdependence means dependent on one another. In this project, so many things are dependent on one another. Each of the elements is necessary. There are dependencies among those elements. During this project, we have learned the depth of the very elements how they are been used. Moreover, we have seen how these elements can be used in the most efficient way and how the elements are dependent on each other. However, as this is a complex engineering

project we have learned about the dependency and depth of use of many elements and their work process.

11.3 Identify the attribute of complex engineering activities (EA)

Table 14: Attributes of complex engineering activities

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	√
A2	Level of interaction	√
A3	Innovation	
A4	Consequences for society and the environment	√
A5	Familiarity	√

11.4 Provide reasoning how the project address selected attribute (EA)

Range of resource:

The range of resource is planned according to ours projects system. All the equipment has been listed and the funds are allocated precisely. Therefore, the whole system has been analyzed and they go impeccably with our requirements.

Level of interaction:

We have talked with the rural people about how the flood actually happens, what are the difficulties they face. Then we have come up with the idea of implementing this project. Later on, we have met with a Government Official to discuss our project. Then we collected our

necessary data from him, and Bangladesh Water Developing Board. Side by side, we had our team meeting almost every week. In the sessions, we usually had the brainstorm session and used it to plan the development of our project. We had to discuss with our faculty members and had taken their suggestions and worked on their feedbacks. Hence this is a complex engineering project we left no stone unturned to interact with the people we may need. Lately, we had a plan to pay a visit to the specific location which is Lama, so that we can interact with the native people there.

Innovation:

We have a feature in flood management which is completely an innovative idea. After going through lots of papers and journals, this feature was never implemented before. Warning system through text or call is already exiting concept. But warning and reaching out to affected people through voice over is never done before. So, by our project we will be able to give a complete package of flood management possible through till date modern technology.

Consequences for society and the environment:

In our report, we conducted an essential study and analysis on the implications for society and the environment, keeping everyone's well-being in mind. Introduction to the flood disaster management system, which is an excellent technique to ensure that the environment is not contaminated. Our project is also a way to introduce technology to the general public and provide them with the necessary knowledge about the system so that they can be inspired to protect themselves during floods and contribute to the society and country for a better future in order to reduce disease outbreaks, human settlement destruction, agricultural production loss, and public infrastructure loss.

Familiarity:

Flood being the most common natural disaster in Bangladesh and many more countries around the world, project based on flood was always there. And for implementation components; Arduino, sensors, modules are familiar to all and available. This project can be implemented by any technical person, although for software coding expert is needed.

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Log-Book

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
July-4	Omar, Salmani, Raisa, Afrida	Introductory Meeting with ATC	Omar, Salmani, Raisa, Afrida	Briefly described about the project.
July-8	Omar, Salmani, Raisa, Afrida	Team Meeting about the selection of the topic of our project. We had brain storming session and selected few topics to work on.	Omar, Salmani, Raisa, Afrida	
July 11	Omar, Salmani, Raisa, Afrida	Team meeting about selection of the topic of our project. We had brain storming session and selected few topics to work on.	Omar, Salmani, Raisa, Afrida	
July12-July 14	Omar, Salmani, Raisa, Afrida	Several team meetings occurred among our team members. We went through some research papers to narrow down	Omar, Salmani, Raisa, Afrida	

		our topic to work on and made draft concept note		
July 15	Omar, Salmani, Raisa, Afrida	we had Meeting with our ATC members and submitted the draft concept note	Omar, Salmani, Raisa, Afrida	ATC members suggested us to find a specific area where we want to implement our project and slight changes in our draft note
July 18	Omar, Salmani, Raisa, Afrida	Team meeting about selecting the specific area and work distribution following our act's suggestion to edit the concept note, Team meeting on the progress of our individual works	Omar, Salmani, Raisa, Afrida	
August 12	Omar, Salmani, Raisa, Afrida	Submitted final concept note. We had meeting with our ATC members	Omar, Salmani, Raisa, Afrida	They said that it was okay and suggested to prepare Draft proposal

August 26	Omar, Salmani, Raisa, Afrida	Meeting with ATC about draft proposal	Omar, Salmani, Raisa, Afrida	They gave us a brief about the proposal
August 28	Omar, Salmani, Raisa, Afrida	we had a team meeting and we distributed our work and started working.	Omar, Salmani, Raisa, Afrida	
September 2	Omar, Salmani, Raisa, Afrida	We submitted the final proposal	All of the members	ATC members suggested for little changes
September 16	Omar, Salmani, Raisa, Afrida	submitted Project proposal	Omar, Salmani, Raisa, Afrida	
7-Nov-21	Omar, Salmani, Raisa, Afrida	ATC members discussed about preliminary design of multiple engineering solution	Omar, Salmani, Raisa, Afrida	ATC members suggested us to start working on the various design
14-Nov-21	Omar, Salmani, Raisa, Afrida	We had a meeting with our ATC members about Tool selection to design and analyze solution	Omar, Salmani, Raisa, Afrida	ATC members said to start working on our design approaches

18-Nov-21	Omar, Salmani, Raisa, Afrida	We had team meeting among ourselves and distributed works	Omar, Salmani, Raisa, Afrida	
21-Nov-21	Omar, Salmani, Raisa, Afrida	We showed our progress in designing then ATC members discussed Performance analysis and best	Omar, Salmani, Raisa, Afrida	ATC members suggested us to work on our lacking of designs
22-Nov-21	Omar, Salmani, Raisa, Afrida	We went through several research papers to finalize our approaches	Omar, Salmani, Raisa, Afrida	
24-Nov-21	Omar, Salmani, Raisa, Afrida	We started working on our different design approaches and simulations	Omar, Salmani, Raisa, Afrida	
28-Nov-21	Omar, Salmani, Raisa, Afrida	Presented our simulations to our ATC members.	Omar, Salmani, Raisa, Afrida	ACT members gave their feedback and suggested to overcome and develop our lacking
30-Nov-21	Omar, Salmani	We meet Tasfin sir in person on the campus and discussed about our	Omar, Salmani	Tasfin sir guided us on Machine learning and parameters. Later

		design approaches on Machine learning		helped us to redefine the model
2-Dec-21	Omar, Salmani, Raisa, Afrida	We had meeting among ourselves how to overcome and develop the lacking of the approaches	Omar, Salmani, Raisa, Afrida	
5-Dec-21	Omar, Salmani, Raisa, Afrida	ATC members gave us a brief about ethical issues and responsibilities	Omar, Salmani, Raisa, Afrida	ATC members advised to work on possible ethical issues
8-Dec-21	Omar, Salmani, Raisa, Afrida	Found out the data's we needed for machine learning and plotted them in spreadsheet	Omar, Salmani, Raisa, Afrida	
10-Dec-21	Omar, Salmani, Raisa, Afrida	prepared all the design approaches and overcome the lacking our ATC members showed	Omar, Salmani, Raisa, Afrida	
11-Dec-21	Omar, Salmani, Raisa, Afrida	Had meeting with Mohaimenul sir and discussed about design approaches	Omar, Salmani, Raisa, Afrida	Mohaimenul sir discussed about the system and design

12-Dec-21	Omar	Had in person meeting with Mohaimenul sir and discussed about design approaches	Omar	Mohaimenul sir explained it further by drawing flowchart
12-Dec-21	Omar, Salmani, Raisa, Afrida	ATC members had a meeting with us and we reviewed the progress of our works	Omar, Salmani, Raisa, Afrida	ATC members appreciated our work and suggested few changes on our report
14-Dec-21	Omar, Salmani, Raisa, Afrida	We had team meeting and worked on our final report for the semester	Omar, Salmani, Raisa, Afrida	
19-Dec-21	Omar, Salmani, Raisa, Afrida	We prepared our draft project report	Omar, Salmani, Raisa, Afrida	ATC members discussed about the lacking of our writings and advised to add few things
18-Dec-21	Omar, Salmani, Raisa, Afrida	Meeting about our progress on report and practiced for the final presentation	Omar, Salmani, Raisa, Afrida	
26-Dec-21	Omar, Salmani, Raisa, Afrida	We prepared simulation and presentation	Omar, Salmani, Raisa, Afrida	ATC members gave a brief about final report

				and about the final presentation
2-Jan-22	Omar, Salmani, Raisa, Afrida	We worked on image processing	Omar, Salmani, Raisa, Afrida	ATC members gave a brief about final presentation
5-Jan-22	Omar, Salmani, Raisa, Afrida	We had several meetings on writing follow up	Omar, Salmani, Raisa, Afrida	
7-Jan-22	Omar, Salmani, Raisa, Afrida	We submitted the project design report.	Omar, Salmani, Raisa, Afrida	
15-Jan-22	Omar, Salmani, Raisa, Afrida	We meet honorable Nazmul Huda sir in campus and had feedback about our project design report	Omar, Salmani, Raisa, Afrida	Honorable Nazmul sir reviewed our paper in details and give instructions to follow up for our revised report
2-Feb-22	Omar, Salmani, Raisa, Afrida	FYDP C introductory class	Omar, Salmani, Raisa, Afrida	Welcomed and talked about probable presentation dates
8-Feb-22	Omar, Salmani, Raisa, Afrida	Updated Preliminary design of selected approach	Omar	

15-Feb-22	Omar, Salmani, Raisa, Afrida	Tool Selection to design and analyze solution	Omar, Salmani, Raisa, Afrida	ATC members guided us to focus on hardware implementation
22-Feb-22	Omar, Salmani, Raisa, Afrida	Perform analysis and optimal solution	Omar, Salmani	Nahid sir provided and discussed on machine learning study materials
1-Mar-22	Omar, Salmani, Raisa, Afrida	Validating solution with the cases	Omar, Salmani, Raisa, Afrida	Nahid sir noted our progress
8-Mar-22	Omar, Salmani, Raisa, Afrida	Physical meeting with ATC panel	Omar, Salmani, Raisa, Afrida	ATC members give feedback on our hardware testing
15-Mar-22	Omar, Salmani, Raisa, Afrida	Discussion about Machine learning approaches	Omar, Salmani, Raisa, Afrida	ATC members discussed about different machine learning models
22-Mar-22	Omar, Salmani, Raisa, Afrida	Validation of machine learning	Omar, Salmani, Raisa, Afrida	ATC members suggested us to collect authentic data set
23-Mar-22	Omar, Salmani, Raisa, Afrida	Validating the hardware solution with test cases	Omar, Salmani	

24-Mar-22	Omar, Salmani, Raisa, Afrida	Started searching for hardware tools	Omar, Salmani, Raisa, Afrida	
25-Mar-22	Omar, Salmani, Raisa, Afrida	Getting few tools from online shops	Omar, Salmani, Raisa, Afrida	
26-Mar-22	Omar, Salmani, Raisa	Meeting with ATC Chair about more effective approach of machine learning	Omar, Salmani, Raisa	Honorable Nazmul sir provided application with his signature to approach BWDB
27-Mar-22	Omar, Salmani	Found the tools from physical shop	Omar, Salmani	
29-Mar-22	Omar, Salmani, Raisa, Afrida	Meeting about the hardware implementation	Omar, Salmani, Raisa, Afrida	After reviewing ATC members guided us to focus on machine learning
3-Apr-22	Omar, Salmani, Raisa, Afrida	Done with the hardware testing and getting started with the machine learning	Omar, Salmani, Raisa, Afrida	

5-Apr-22	Omar, Salmani, Raisa, Afrida	Started writing the report distributing the works	Omar, Salmani, Raisa, Afrida	Honorable Nazmul sir further helped us to get data from BWDB
12-Apr-22	Omar, Salmani, Raisa	Discussion about the machine learning models with ATC	Omar, Salmani, Raisa	ATC members appreciated the authenticity of the data for ML
19-Apr-22	Omar	Discussion about alignment of all code together	Omar	Antara miss guided how to write code and combine them as per need
24-Apr-22	Omar, Salmani, Raisa, Afrida	Done with the whole project both hardware implementation and machine learning approach	Omar, Salmani, Raisa, Afrida	
28-Apr-22	Omar, Salmani, Raisa, Afrida	Final year design project final show case	Omar, Salmani, Raisa, Afrida	Nahid sir reviewed and appreciated our hardware implementation

Appendix A.

Arduino Code:

```
#include <SoftwareSerial.h>

#define TRIGPIN 11

#define ECHOPIN 10

#define SIRENPIN 3

#define EMLIGHTPIN 4

#define ldrPin 3



#include <Wire.h>

#include <LiquidCrystal_I2C.h>



LiquidCrystal_I2C lcd(0x27, 16, 2);



//Creating software serial object to communicate with SIM900

//SIM900 Tx & Rx is connected to pin 7,pin8

SoftwareSerial mySerial(7, 8);
```

```
// Floats to calculate distance
float duration, distance;

void setup() {

// Setting up serial monitor
SIM900power();
Serial.begin(9600);

mySerial.begin(9600);

// Setting pinmodes for sensor connections

pinMode(ECHOPIN, INPUT);
pinMode(TRIGPIN, OUTPUT);
pinMode(SIRENPIN, OUTPUT);
```

```
pinMode(EMLIGHTPIN, OUTPUT);

pinMode(ldrPin, INPUT);


lcd.init();

lcd.backlight();

}


void loop() {


lcd.setCursor(0,0);

lcd.print(" Water Level");

lcd.setCursor(0,1);

lcd.print("cm ");

lcd.print(distance);


// Setting the trigger pin LOW for 2uS

digitalWrite(TRIGPIN, LOW);
```

```
delay(200);


// Setingt the trigger pin HIGH for 20us to send pulse

digitalWrite(TRIGPIN, HIGH);

delay(2000);


// Returning the trigger pin to LOW

digitalWrite(TRIGPIN, LOW);


// Measuring the width of the incoming pulse


duration = pulseIn(ECHOPIN, HIGH);


// Determining distance from duration

// Use 343 metres per second as speed of sound

// Divide by 1000 as we want millimeters
```

```
distance = (duration / 2) * 0.343;


// Printing result to serial monitor
Serial.print("distance: ");
Serial.print(distance);
Serial.println(" cm");


if (distance < 230)


{
lcd.setCursor(0,0);
lcd.print("Danger Level");
lcd.setCursor(0,1);
lcd.print("Sending SMS");


digitalWrite(SIRENPIN, HIGH);
digitalWrite(EMLIGHTPIN, HIGH);
```

```
Serial.println("Initializing...");
delay(1000);


mySerial.println("AT"); //Handshaking with SIM900
updateSerial();


mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
updateSerial();
mySerial.println("AT+CMGS=\"+8801521[redacted]\"");//Sending sms to this number
updateSerial();
mySerial.print("Flood is occurring in lama at Danger level of 12.5"); //text content
updateSerial();
mySerial.println("ATA=\"+8801521[redacted]\"");//Recieve call from this number and make voice over
```

```
updateSerial();

mySerial.write(26);


delay(30000);

}


if (distance < 350)


{

lcd.setCursor(0,0);

lcd.print("Danger Level");

lcd.setCursor(0,1);

lcd.print("Sending SMS");


digitalWrite(SIRENPIN, HIGH);

digitalWrite(EMLIGHTPIN, HIGH);
```

```
Serial.println("Initializing...");

delay(1000);


mySerial.println("AT"); //Handshaking with SIM900

updateSerial();


mySerial.println("AT+CMGF=1"); // Configuring TEXT mode

updateSerial();

mySerial.println("AT+CMGS=\"+8801521[redacted]\"");//Sending sms to
this number

updateSerial();

mySerial.print("Flood might occur in lama"); //text content

updateSerial();

mySerial.println("ATA=\"+8801521[redacted]\"");//Recieve call from this
number and make voice over

updateSerial();

mySerial.write(26);
```

```
delay(30000);
}

else

{
digitalWrite(SIRENPIN, LOW);
digitalWrite(EMLIGHTPIN, LOW);

Serial.print("Flood not occuring");
}

}
void updateSerial()
{
delay(500);
```

```
while (Serial.available())
{
mySerial.write(Serial.read());//Forwarding what Serial received to
Software Serial Port
}

while(mySerial.available())
{
Serial.write(mySerial.read());//Forwarding what Software Serial received
to Serial Port
}
}

void SIM900power()
{
pinMode(9, OUTPUT);
digitalWrite(9,LOW);
```

```
delay(1000);

digitalWrite(9,HIGH);

delay(2000);

digitalWrite(9,LOW);

delay(3000);

}
```

Python code: (partial)

```
In [ ]:

X = df['RAIN_FALL(mm)'].values.reshape(-1,1) # input feature

y = df['WATER_LEVEL(m)'].values.reshape(-1,1) # target feature


In [ ]:

X_train, X_test, y_train, y_test = train_test_split(

X,y, test_size=0.2, random_state=17, shuffle=True

)
```

In [ ]:

```
pt = PowerTransformer(method='box-cox')

X_train_transformed = pt.fit_transform(X_train+0.000001)

X_test_transformed = pt.transform(X_test+0.000001)
```

In [ ]:

```
pt.lambdas_
```

Out[ ]: array([-0.10662485])

In [ ]:

```
y_train_transformed = pt.fit_transform(y_train+0.000001)

y_test_transformed = pt.transform(y_test+0.000001)

y_train_transformed = y_train_transformed.ravel()

y_test_transformed = y_test_transformed.ravel()
```

Out[ ]: array([-5.34754941])