SMART FLOOD DETECTION, ALARM, AND MONITORING SYSTEM USING IMAGE PROCESSING

A Project Study Presented to the Faculty of

Electronics Engineering Department

College of Engineering

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In Partial Fulfilment of the Course Requirements for the Degree of

Bachelor of Science in Electronics Engineering

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Abstract

In the Philippines, one of the common aftermaths of a natural phenomenon is flood. It is usually caused by heavy rains and high tides. This natural calamity cannot be avoided but the good thing is, we can practice ourselves to be prepared for it. After conducting an analysis regarding the needs of people residing in rural areas, it was then decided to develop a project that can help lessen the difficulty they are experiencing when they evacuate. The system's structure consists of three devices namely: rain gauge, flow meter device, and the camera. The system uses image processing as its flood detection method. It also uses several sensors for different purposes to make it more reliable to the users. Multiple Linear Regression was applied in this study for its ability to predict the level of flood by depending on the amount of rain gathered in a certain time. The total number of samples is based on the historical data of the municipality to ensure that the resulting output is accurate. The device calibration is partnered with the government agency that specializes with forecasting and this study has provided notification system based on the mobile application. To measure the reliability of the system, the flood level taken from the automated system using image processing and conventional method were compared. The actual flood level and predicted level were also compared. The results showed that there is a low percentage error of 2.17% and a 91.8% flood prediction accuracy implying a high reliability of the system.

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Chapter 1

THE PROBLEM AND ITS BACKGROUND

The introduction, background of study, problem statement, objectives, significance of study, and the scope and limitations of the study are presented in this chapter.

1.1 Introduction

The Philippines is located near the equator and is surrounded by different bodies of water. It is near the Pacific Ocean where the water is warm. This results to the formation of typhoons where it often hits the Philippines due to the nature of the earth's westward-blowing wind.

Floods are usually the aftermath of a calamitous typhoon and the consequences are based on the location, volume, intensity, and timespan of rainfall. Other factors may involve the tide times. Some of the common flood level monitoring are based on the marking on utility posts, river basins, and allocating Closed Circuit TV (CCTV) to monitor rivers and dams. In 2009, Tropical Storm *Ondoy* affected the 184 municipalities and has a record of a thousand casualties, and the 2013 Super Typhoon *Yolanda* affected almost the whole Southeast Asia region, particularly in Visayas region, that has a total death toll of over 10,000.

The efficiency of manual monitoring is doubtable since it cannot transfer the gathered data immediately. Inaccuracy of data can also be a problem since manual monitoring is prone to human errors. This may also result to lack of awareness in the community. The application of image processing can be used to lessen the casualties during these natural phenomena. It can be coordinated to an early warning system that will predict the flood level in a certain hour that considers the factors that contributes to flood. This study aims to provide flood monitoring with early warning system that will benefit the community using the Precipitation Sensor that can measure the amount of rainfall from the first drop.

1.2 Background of the Study

Out of 18 Major River Basins in Metro Manila, there are 10 that has a functional Flood Forecasting and Warning System for Dam Operation as of early 2019. In order to cope with flood risks, the Philippine Department of Science and Technology (DOST) developed project NOAH or the National Operational Assessment of Hazards. It utilizes the latest and most advanced technology like 3D terrain mapping through Light Detection and Ranging (LIDAR), attachment of automated rain gauges, and water level monitoring stations to provide warning to agencies and communities 6 hours prior to impending flood. Another method of flood monitoring currently exists in Marikina River, where they use ultrasonic sensors to measure the rate of change of water level and determine flood waters accurately in real time.

These technologies are not remotely available in rural areas, such as the town of Calumpit and Hagonoy in Bulacan.

The local government of Calumpit, Bulacan is having trouble with the evacuation of residents due to the large amount of people who need their help. They use flood markers painted along concrete posts and walls as flood level indicator. In the presence of flood, the process of evacuation and delivery of relief goods becomes delayed due to uneven road surfaces, strong water current, and high-water level; aggravated by the daily occurrence of high tide and release of waters from 3 major dams; namely Angat, Bustos, and Ipo dam. Their only means of dispersing relevant information regarding dam releases and flood warnings is to manually relay news with a rescue boat and a megaphone. Therefore, communities are unaware of the current situation of the nearby dams, resulting in extensive property destruction and even human life. This establishes the need for an early flood warning system that could detect and monitor current flood status and immediately inform nearby residents. Hence, , this paper introduces a project designed to support flood-affected communities in the province of Bulacan, especially in the Barangay Frances district in Calumpit, by providing real-time water level detection through a wireless sensor network and early warning system over website and/or calls that alert concerned authorities and affected individuals for an impending flood, to speed up the evacuation process, and improve emergency measures.

1.3 Statement of the Problem

The purpose of this study is to innovate the conventional way of flood detection alarm and monitoring to help the area prepare early and prevent casualties faster by developing an image recognition system that analyzes the depth of the flood relative to the flood markings. This study seeks to solve the following problems: how would the researchers develop a system that automatically recognizes and determines the depth of a flood using Python and a surveillance camera; how the system will be more precise compared to manual observation; how the system will operate faster than the conventional method; and how would the mobile application benefit the residents of the area.

1.4 Proposed Solution

1.4.1 Objectives

This study aims to establish a flood monitoring device and an early warning system for residences vulnerable to flooding. It is directed to:

1. Design a flood monitoring system using Rain Gauge, Float Switch, Flow Rate Meter Sensor and Arduino microcontroller utilizing solar panel as the system's main source of power.
2. Develop an image recognition system composing of a Raspberry Pi and a camera that will identify the flood water level and activate a 3-stage alarm level siren using Python.
3. Create an android application with the use of Internet module for water-level monitoring of the areas within the barangay. Flood prediction is also a feature of the application using three parameters: flow rate, water level and precipitation rate.
4. Test the efficiency, functionality, reliability of the flood detection, alarm, and monitoring system.

1.5 Significance of the Study

This study would be beneficial to rural areas and other flood prone areas to monitor, detect, and give them early warning of an impending flood. The study will provide the history of flood incidents as the system will process, analyze, and store data automatically on a database which they can access online.

This study will also help the residents of the area to monitor the flood and rain status via mobile application which will provide the residents early knowledge of an impending flood and help them prepare for evacuation in the worst-case scenario. The precipitation sensor will be used to measure the intensity of the rain and is also used as a triggering device for the surveillance camera to take images of the flood situation then send it to the system. The system will then process and analyze the images to determine the exact depth of the flood and will then activate the alarm siren based on the flood level's corresponding warning and send out alerts. This will help local authorities to monitor the flood situation without having the need to go outside to see the flood marker, therefore, reducing the possible risks of going outside amidst an ongoing flood.

Also, it will help lessen the delay of delivery of relief goods by informing the people delivering the goods prior knowledge whether the roads are still passable or not in order for them to plan another way for the goods to be delivered on time.

1.6 Scope and Delimitation

The study covers the design of a device which is capable of detecting, monitoring, and alarming regarding the flood level in the barangay and a rain gauge and precipitation sensor that contacts the authorities in case of an emergency. The study also covers flood level prediction 3 hours early. Flood level or water level is identified through observations of the residents and Local Government Authorities. They place indicators or markings on the streets or CCTVs that help them to identify the level of the water in their area.

There are three steps that must happen in order to trigger the detection, alarm system, and monitoring system. First, the precipitation sensor detects rainfall, a rise of flow rate reading, and a trigger from the float switch. Second, the camera automatically captures images of the flood. Third, the images will undergo image processing and analyse the depth of the flood. When these three conditions are met, the system will allow residents & LGUs to monitor the status of the flood in real time and alarm them earlier during storms or typhoons with the use of an internet modem. The device will have a solar panel as its main power source and a lead acid battery as its backup power source.

The study does not cover geographical mapping and prediction of the duration of the flood in an affected area.

1.7 Operational Definition of Terms

The following are the technical words used in this study's discussion. For easy comprehension of its information, definitions were given.

1. Arduino

Arduino is an open-source business, project, and user group for hardware and software that develops and produces single-board microcontrollers and microcontroller kits to create digital devices and interactive objects that can physically and digitally feel and control.

2. Image Processing

In order to get an improved image, or to extract some useful information from it, image processing is a technique for conducting some operations on an image.

3. Internet of Things (IoT)

The word IoT includes everything that is connected to the internet, but it is increasingly used to describe objects which are "talk" to each other.

4. Pocket WiFi

Pocket WiFi is a portable wireless modem that could be connected to any device that is Wi-Fi enabled.

5. Float Sensor

A float sensor is a system which is used inside a tank to detect the level of liquid.

6. Python

Python is a popular high-level, general-purpose programming language that is usually used in web development that is responsible for the improvement of today's technology.

7. Rain Gauge

A rain gauge is a useful weather tool that indicates that amount of rainfall that has fallen.

8. Raspberry Pi

Raspberry Pi is the go-to microcomputer to begin in the world of programming and electronics for all ages and abilities.

9. Water Sensor

A water sensor is a device used for different purposes in the detection of water levels.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

The related literature and studies used in the implementation of this study are presented in this chapter. The proponents included discussion on the facts and values to which the current study is related. They also included already performed studies that connect, have some influence or resemblance to the current proposed research.

2.1 Conceptual Literature

2.1.1 Flood

Floods are a very common disaster and it happens to both undeveloped and highly developed countries. It has a great potential to damage infrastructures, economies, and human health. Since climate change is becoming a norm, occurrence of distorted precipitation patterns with the aid of increasing sea levels are becoming the main cause of floods. The Southeast Asia region has been said to be prone to natural disasters especially floods. One can never ensure safety even after the event of a flood because its aftermaths still has the potential to post a threat to human health.

2.1.2 Flood Detection

The purpose of flood detection is to identify and measure the level of flood that pose potential threat after it occurs.

2.1.2.1 Tidal Force

Changes in the gravitational pull of the Sun, Moon and Earth are recognized to be tidal forces. Such forces cause the seas to move regularly, creating a temporary shift in water levels that varies depending on the area.

2.1.2.1.1 High Tide

A tide when, at a certain moment and location, it is at its highest peak. When the Moon and Sun are specifically aligned with respect to Earth, the highest tides occur. High tides alone do not cause flooding, but when combined with heavy rain or storm, it can have a significant effect on the increase in the water level that causes flooding.

2.1.2.2 Storm

A storm is any disturbed state of an environment usually marked by wind and rain here in the Philippines. Storms are the main cause of dangerous flooding in the country.

2.1.2.3 Flow Rate

It is the quantity of fluid that passes through a pipe or any channel within a given or standard period. It is known as the volume of liquid which passes per unit time usually represented by the symbol Q in physics and engineering. Its unit is m^3/s. It is calculated by the formula $= \frac{V}{t}$, where V is the volume and t is the time. Flow rate can be a parameter for predicting the rate of rise of water.

2.1.2.4 Rain Fall Intensity

It is the measure of the amount of rain that falls at a certain time. The intensity of rain can be measured in two ways; (1) to collect rain water through a rain gauge and measure the height after every given period of time; and (2) with the use of the absorption of mm wave and microwave signals due to rain by establishing a small link on the ground and measure absorption of signal in decibels and computer's error free measurements.

2.1.3 Real-Time Monitoring

The purpose of real-time monitoring is to send data to the cloud that allows users to monitor any updates the flood detection, alarm, and monitoring system will detect. In real time, it will enable the officials or residents of the area to respond to an impending flood right away.

2.1.4 Internet of Things (IoT)

The Internet of Things (IoT) is a network of devices containing software, actuators, and Internet access, such as sensors, modules, and mobile phones. It enables physical devices to wirelessly transmit data to each other, promoting a new form of industry communication. The main objective of IoT is to provide convenience to people by lessening their manual duties (Sachchidanand Singh, 2015). IoT has lots of application and a statistical ranking shown in Figure 2.1.

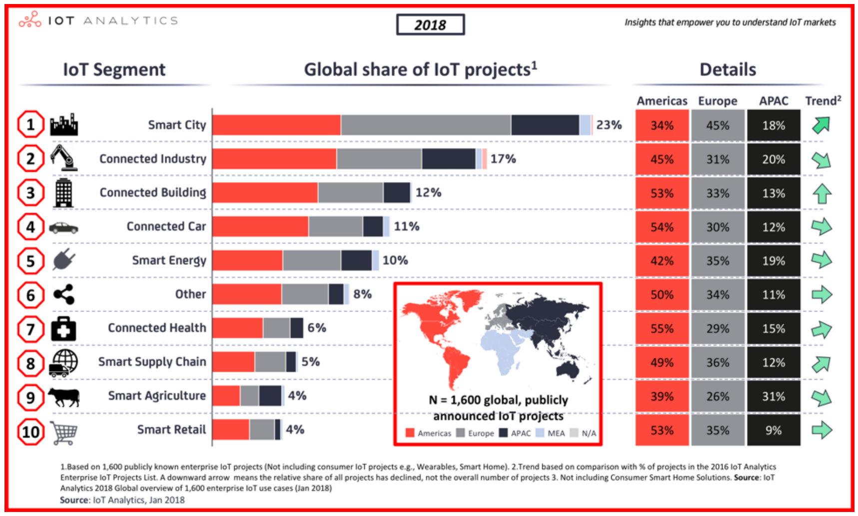

Figure 2.1 IoT Application Ranking

(*https://iot-analytics.com/top-10-iot-segments-2018-real-iot-projects/*)

2.1.5 Geographic

Geographic focuses on the physical features of the earth. The purpose of knowing the geographic of an area is to know the elevation of the land which is one of the reasons why there is an occurrence of flood. By knowing the land elevation of an area, we can plan strategically where to place the flood detection, alarm and monitoring system for it to work efficiently. As seen in **Figure 2.2**, the lowest part of the path is located near the river where the flood comes from when the water rises. There is a basin at 100 meters from the river which is at the middle of the district. With this information, it would be wise to place the device near the river where water first rises.

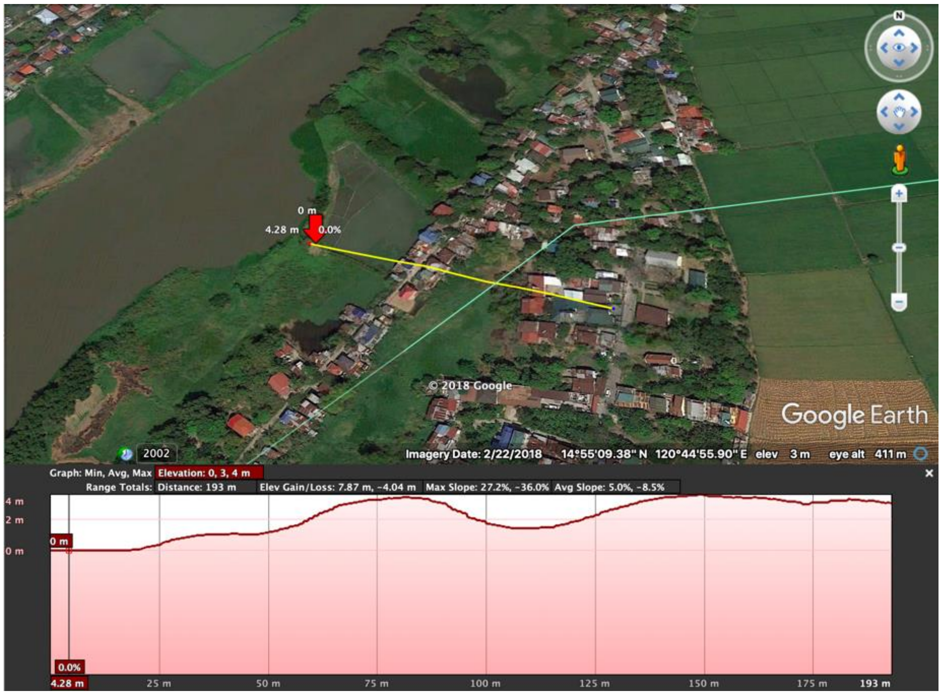

Figure 2.2 Path Elevation of Brgy. Frances, Purok 5, Calumpit, Bulacan (*Google Earth Pro*)

2.1.6 Sensors

2.1.6.1 Flow Rate Sensor

This sensor monitors the flow of water through the propeller, then rolls the propeller and adjusts the speed at various flow rates. This improvised flow rate meter sensor consists of a steel valve body, a 3D-printed propeller and a hall-effect sensor.

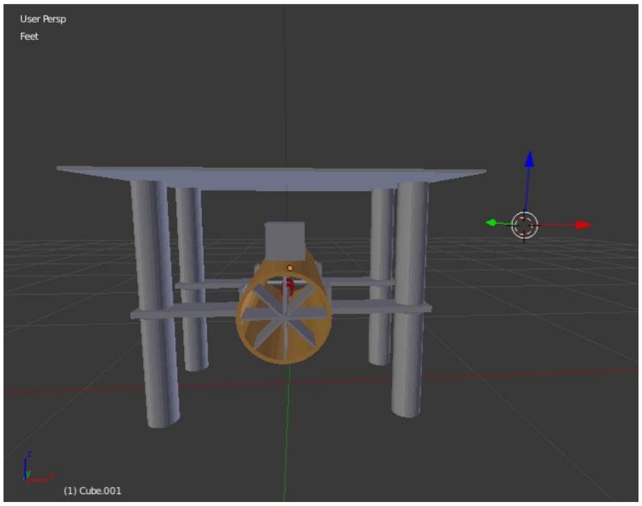

Figure 2.3 Flow Rate Sensor

2.1.6.2 Hall-Effect Sensor

The corresponding pulse signal that can be used with Arduino is provided by a hall-effect sensor.

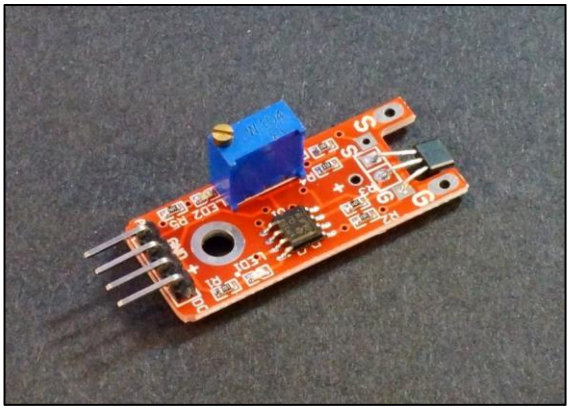

Figure 2.4 Hall-Effect Sensor

(*https://protosupplies.com/product/linear-hall-effect-sensor-module/*)

2.1.6.3 Rain Gauge

Precipitation Sensors are sensors that are based of the tipping bucket principle. It is device for measuring the amount of precipitation or rainfall during a given time interval at a certain location.

Figure 2.5 Rain Gauge & Precipitation Sensor

(*https://observator.com/en/meteohydro/products/meteorological-sensors/raingauges-precipitation-sensors/rim8400#productdetail*)

2.1.6.4 Float Water Level Switch Sensor

A float water level switch sensor has the function of opening or closing a circuit as the water level rises or falls. A float water level switch is normally closed when the float is at its lowest point and opens when water rises and reaches the float. This sensor would serve as a trigger or switch for the camera module to capture images once the water rises due to high tide.

Figure 2.6 Float Water Level Switch Sensor

(https://www.makerlab-electronics.com/product/water-level sensor-float-switch/)

2.1.6.5 Raspberry Pi NoIR Camera V2

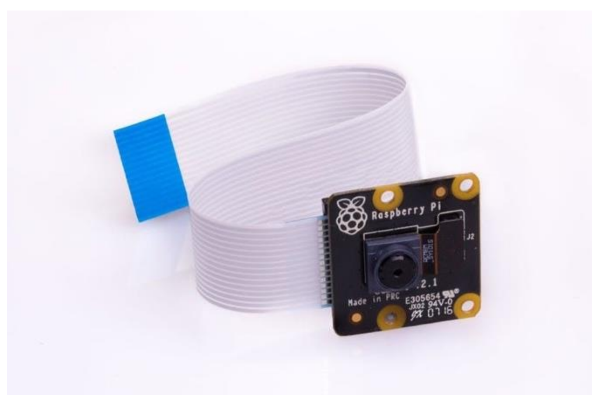

Figure 2.7 Raspberry Pi NoIR Camera V2

(https://www.raspberrypi.org/products/pi-noir-camera-v2/)

An infrared Camera Module is a replacement of the original Pi NoIR Camera Module. This camera does not have an infrared filter but has an in-frared lighting that gives the ability to see images in the dark. It has a Sony

IMX219 8-megapixel sensor which features a fixed focus lens capable of capturing 3280 x 2464-pixel static images and supports 1080p30, 720p60, and 640x480p60/90 video. The camera works on all models of Raspberry Pi.

2.1.7 Metal Chassis

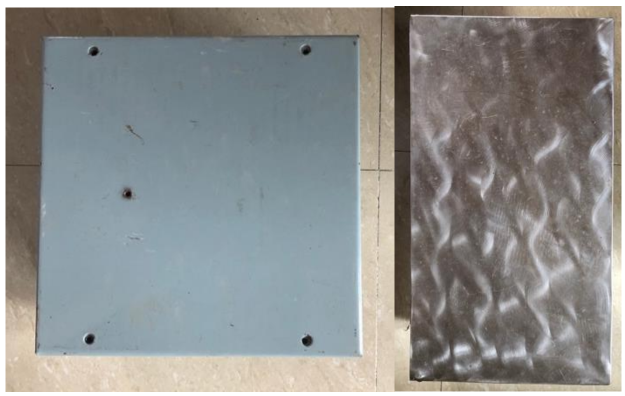

Figure 2.8 Metal Chassis

The metal chassis is a frame which will serve as the vessel for the device's electrical components.

2.1.8 Raspberry Pi 3

A raspberry pi is a small single board that can be used to program and control electronic components for physical computing and exploration of IoT (Internet of Things). Raspberry Pi will be used to program image processing for flood level detection.

Figure 2.9 Raspberry Pi

(https://www.amazon.in/Raspberry-Pi-ModelRASPPI3Motherboard/dp/B01CD5VC92)

2.1.9 Python Programming Language

Python is a language for open-source programming. Combined with dynamic typing and dynamic linking, its high-level built-in data structures make it very appealing for Rapid Application Creation and for use as a scripting or glue language to link existing components together. The plain, easy-to-learn syntax of Python emphasizes readability and thus reduces software maintenance costs ("What is Python?", n.d.).

2.1.10 Android

Android is an operating system developed by Google and is the running OS of a wide variety of mobile phone manufacturers. This operating system will be the platform of the mobile application of the flood detection, alarm, and monitoring system.

2.1.11 Solar Power Technology

Solar power technology is used to harness the energy that comes from the sun and converts it to renewable source of power.

2.1.11.1 Solar Panel

Figure 2.10 80W Solar Panel

Solar panels are photovoltaic panels that absorbs sunlight as its source of energy. It is a cost-efficient source of energy that would self-power the device in the long run.

2.1.11.2 Solar Charge Controller

Figure 2.11 Solar Charge Controller

(https://www.acesolarproducts.com/product/sc-20a-automatic/)

It is a tool to prevent overcharging or over discharging to protect the battery. It provides load control to prolong the battery's life.

2.1.12.3 Step Down Converter

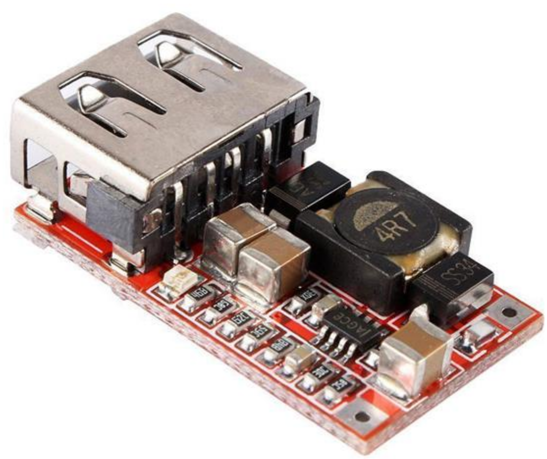

Figure 2.12 6-24V to 5V 3A USB DC-DC Buck Step-Down Converter *(https://www.makerlab-electronics.com/product/6-24v-to-5v-3a-usb-dc dc-buck-step-down-converter/)*

The step-down transformer converts the input voltage of 6V to 24V to 5V fixed USB voltage output. This converter is ideal for providing a USB output of regulated 5V to charge small devices or any USB-powered devices.

2.2 Related Studies

In the study *L-Band SAR Interferometric Analysis for Flood Detection in Urban Area* by Natsuaki et al., (2018), they used Synthetic Aperture Radar (SAR) to monitor flood due to its capability of observing targets in any weather. With the help of Interferometric analysis, they were able to obtain accurate flood detection. They used Advanced Land Observing Satellite-2 (ALOS-2) dataset. First, SAR detects the flood by its amplitude information. Once the ground is filled with water, the water will then decrease the amplitude of the ground as the SAR depends on the surface roughness. This will then result to the detection of the flooded region by change detection methods whether the ground is flat plain, low vegetation, or farmland. This study will serve as a basis for identifying flood level needed in order for the study to be done. Unlike Natsuaki et al., (2018), the proponents will use sensor and a camera to detect flood water level.

According to the study of Baydargil et al., (2018), *Flood Detection and Control Using Deep Convolutional Encoder-decoder Architecture*, they choose one from these two main approaches in which: (1) is focused on CCTV cameras monitoring areas vulnerable to flood and (2) on different satellite image processing systems. Their research focuses on the approach to CCTV camera development. Using CCTV cameras that would run in areas vulnerable to flood utilizes deep learning segmentation architecture or SegNet. In order to help with flood prediction, they built a system that would train the architecture and critical information that could be sent for early warning.

Their study uses 12 classes and 11 outputs from the road segmentation using a video camera and custom class weightings. SegNet is then trained using custom-made dataset. It is optimized to learn the environment with a learning rate of 0.0001, with a max iteration of 40000 and a batch size of 2. It took them 22 hours and 56 minutes for best results. Their study proved that with the help of SegNet, the accuracy of the flood detection was very satisfactory. They were able to achieve their expected accuracy. This study will serve as a basis for early warning system by training the system with different classes and outputs. Similar to this study, the proponents will utilize a camera to have an image recognition system to verify the sensors acquired data for better accuracy.

Based on the study *Flood Detection System Using Wireless Sensor Network* (Pasi et al., 2015), the three major components of their developed system are: 1) sensor network, 2) processing and transmitting modules, and 3) database and base station server. Through wireless tunnels the connectivity is done. While the processing and transmission module is used to transmit measured data to the database and application server, the sensor network measures water-related data. The database and application server is implemented as an application that allows users to view water-related and historical data in real-time. The application server is also able to send warnings in the event of an emergency to the responsible authorities. Their flood monitoring system is sufficient in terms of real-time data acquisitions. Similar to this study, the proponents will implement the use of an application to display the data and update users regarding the real-time status of flood levels.

In a study entitled *Real-time flood water level monitoring system with SMS notification* (Yumang et al., 2017), they proposed a system incorporating the use of an Arduino UNO, GSM shield, and sensors to be powered by a solar panel with a generator. An early alert system using three LEDs mounted on a PVC pipe can give individuals in the group an SMS alert. In another study by Pagatpat et al., (2015) entitled *GSM & web-based flood monitoring system,* Using GSM sim900 and Arduino Super 2560, their water level tracking hardware data is transmitted and received by the computer device using the GSM USB Dongle. Different water level detectors were combined into one device from distant areas. It is quite reliable because it has a wide coverage area since it uses the cellular network used in mobile phones. The device could cover the entire country as cellular networks are included in the module. It is possible to collect information from devices placed anywhere in the Philippines. Similar to these studies, the proponents will be utilizing a GSM module for early warning and notification.

In the study *Flood Detection and Mapping of the Thailand Central Plain using RADARSTAT and MODIS under a Sensor Web Environment* (Auynirundronkool et al., 2012), to produce dynamically real-time flood charts, an automated instant-in-time flood detection solution consisting of flood sensor observation service (SOS) and flood detection web processing service (WPS) under the sensor web environment is implemented. They used techniques of threshold analysis to differentiate approaches under generic flood assumptions. The outcome that their project is intended to accomplish is the RADARSAT and MODIS imagery classification of flooded regions, with the process automated using a technology called sensor network, allowing users to process and view data and construct map templates. The suggested solution has been demonstrated to be feasible for automated instant flood prediction in the Central Plain of Thailand. This research would serve as the basis for geo-mapping to find the best position for the system to be mounted. Another study using MODIS is *MODIS-based Flood Detection, Mapping and Measurement: The Potential for Operational Hydrological Applications* (Brakenridge et al., 2006). In the study, MODIS-based reports of inland floods in streams and rivers have presented three possible operating applications. Applications include flood prediction and warning, flood inundation mapping for rapid response, and flood hazard assessment (by map compilation, over time, of MODIS-observed inundation). Compared to this study, the proponents will be using image processing for flood detection instead of MODIS (Moderate Resolution Imaging Spectroradiometer) sensors.

In the study *FloodEye: Real-time Flash Flood Prediction for Urban Complex Water Flow* (Hiroi & Kawaguchi, 2016), it focuses on flood monitoring and prediction using the deep learning method of Linear Regression with data assimilation. Their study mainly focuses on early and accurate prediction of floods in complex water flow using water-level sensors. They developed a compact sensor architecture that only consists of an infrared camera as its sensor, a data transmission communication device, and a server for image processing to process the acquired images. The system proposes an auto-monitoring function without pre-configuration of the information where there is no need for the dike line to be set to detect floods that results the rise of water level. The auto-configuration technique offers the following process: (1) recognizing the higher RGB value as the infrared picture water area, and (2) recognizing the lower RGB area as the riverbank area using the characteristics of the infrared spectrum of the absorbing water and reflecting plants. In the event that the plants are not identified in the process, the sensors will ignore the area of the plant and consider the upper straight line as the line of the river bank and then measure the lower point in the area of the plant and a set of upper points on each horizontal axis of the picture for the water level area. After calibration, the device can then measure the difference in value between the water and the dike axis. If the value between the two lines becomes zero, so flooding is detected.

The research *Model-based Monitoring for Early Warning Flood Detection* (Basha et al., 2008) proposed a sensor network consisting of two layers of communication, four types of nodes and support for a range of types of sensors. They based, specifically in Honduras, on the event of river flooding. Locally, on the upper Charles River at Dover, they mounted 3 nodes and collected 5 weeks of data that went through their prediction algorithm, showing both the simplicity of the device and the algorithmic functionality. This study will be one of the bases for the predictive model of the device.

In the study *Flood Prediction Using Multi-Layer Artificial Neural Network in Monitoring System with Rain Gauge, Water Level, Soil Moisture Sensors* (Cruz et al., 2018), the sensor they used for flood detection is an ultrasonic sensor. It is a non-contact measurement method. Any form of light and color would not have any effects in measuring the distance, making it efficient especially in dark, dusty, and smoky places. Also, instead of using the built-in magnetic reed switch of the tipping bucket rain gauge, they replaced it with a photo interrupter. The use of a photo interrupter would benefit in the accuracy of measuring rainfall as there are usually errors using a magnetic reed switch.

In the study *Video Surveillance System for Real-Time Flood Detection and Mobile App for Flood Alert* (Menon & Kala, 2017), it focuses on dynamic flood detection and flood overflow detection. To eliminate the surrounding objects in the video, they developed a region-based image segmentation technique. The segmentation of the image can be divided into four types of algorithms: (1) point-based segmentation; (2) segmentation based on edge detection; (3) segmentation based on region; and (4) hybrid segmentation incorporating at least two of the above algorithms. The video processing module then calculates the real-time flood overflow range in which the flood alarm will be triggered immediately if the flood overflow percentage exceeds any of the warning points provided. The study will be a basis for flood recognition using image processing instead of video streaming process.

In *Automatic Water Detection Method in Flooding Area for GF-3 Single-Polarization Data* (Tang, et al., 2018), It focuses on water identification using image processing in which water extraction can be separated into two parts in their proposed study: image processing and extraction of the water body. This study will also be a basis for image processing. Unlike Tang's, our study will incorporate an Android application to inform the residents about the flood water level within the area.

Chapter 3

METHODOLOGY

This chapter presents the methods and procedures used in the development and implementation of the project. The proponents also included researching related ideas, design flow process, hardware parts acquisition, software selection, equipment interfacing, user interface creation, generation of algorithms for image processing, and testing and evaluation procedures in making the whole system.

INPUT
KNOWLEDGE REQUIREMENTS:

- Geographic
- Demographics
- Water flow rate
- Disaster risk reduction
- Image Processing

HARDWARE REQUIREMENTS:

- Arduino Uno
- Raspberry Pi
- Pocket WiFi
- Rain Gauge
- Flow Rate Meter Sensor
- Solar Panel
- Solar Charge Controller
- Rechargeable Battery
- Metal Chassis

SOFTWARE REQUIREMENTS:

- Python
- Arduino IDE

PROCESS
HARDWARE DEVELOPMENT:

- Designing a wireless sensor network.
- Assembling the main device with the proposed components.

SOFTWARE DEVELOPMENT:

- Python programming using image processing algorithm.

OUTPUT

Smart Flood Detection, Alarm and Monitoring System Using Image Processing

Figure 3.1 Input Process Output (IPO) Model of the Study

Figure 3.1 shows the Input Process Output Model of this study which includes the requirements that must be met in order to make the project efficient and operational. It also shows the hardware components the project will be needing and how to develop its system.

For the input part of the IPO, the knowledge requirements are Geographic, Demographics, water flow rate, disaster risk reduction, and image processing. The hardware requirement includes Arduino UNO, raspberry pi, Pocket WiFi, water sensors, solar panel, solar charge controller, rechargeable battery, and a metal chassis. The software requirement includes Python and Arduino IDE.

The process part of the IPO Model includes the case design for the hardware development. The software development consists of an Android application, image processing, wireless sensor network, and a database. The testing consists of evaluations of the project.

Lastly, the output of the IPO Model is the actual project which is the Smart Flood Detection, Alarm, and Monitoring System Using Image Processing.

3.1 Research Locale

The study was conducted at Barangay Frances, Purok 5, Calumpit, Bulacan. The community was interviewed inside their own houses or wherever they find comfortable to be at. The researchers also interviewed the barangay officials regarding their situation during flood and what preparations they make before flood worsens. The researchers chose the place because of their lack of access to immediate help, their lack of flood detection and alarm system due to their location being in a remote area.

3.2 Research Process

3.2.1 Step by Step Analysis

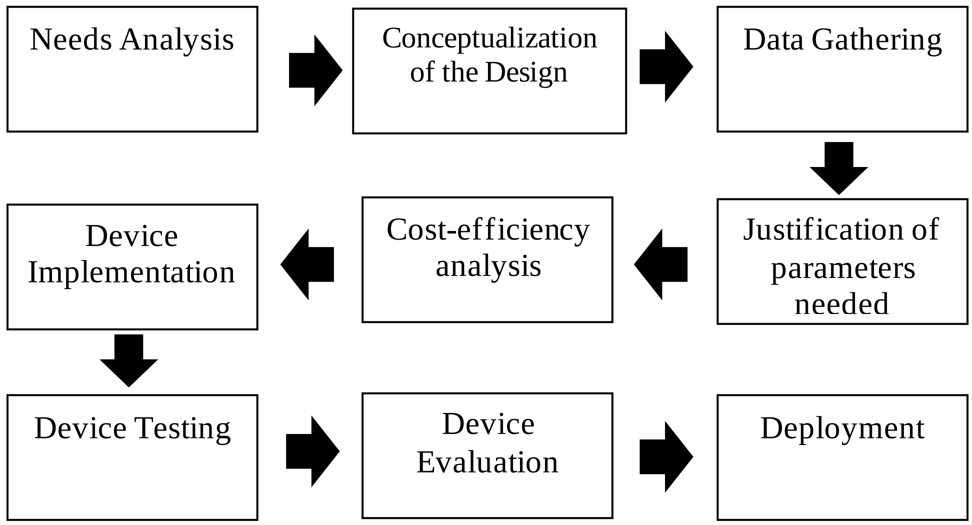

Figure 3.2 Step-by-Step Analysis of the Study

3.2.1.1 Needs Analysis

The first step done was to identify the present needs at a barangay. To make the proposed study significant, it has been decided to focus on problems regarding with natural disasters to help a community. The community that will be given aid is assessed to be the location that is the most vulnerable to the stated problem.

3.2.1.2 Conceptualization

This process occurred after the main problem to be solved is specified. This process involved the predictive model, algorithm to be used, and limitation of the device.

The three parameters from the rain gauge, flow rate meter sensor, and the flood detection system will be optimized to enable the prediction system to work accurately. The flood detection system captured images from the flood marker across it through a camera. The system then pulled out the RGB values from the image then processed it along with the precipitation rate and flow rate to produce a prediction of a flood that was about to occur based on the parameters it analyzed. All of the output was sent to an android mobile application for the notification system and a siren with three level alarm sounds.

The entire system was powered by a solar panel which collects solar energy for power consumption.

3.2.1.3 Data Gathering

A process which was the most vital. Collection of data from: the proposed location, valuable resources, and experts on the fields which were of same interests occurred here.

- Obtained data from researching related literatures about flood detection, alarm, monitoring system, and early prediction system.
- Conducted interviews from the barangay officials and residents regarding their concerns about flood.
- Requested advise and calibration from institutions such as The Philippine Atmospheric, Geophysical, and Astronomical

Services (PAGASA) and Premier Physic Metrologie regarding the rain gauge and flow rate meter sensor.

- Researched about image processing for flood level detection.
- Conducted site visits to assess the placement of the system and ensure that no damage was caused to the residents and the devices.
- Computed the power management necessary to operate the whole system 24/7.

3.2.1.4 Justification of parameters needed

To avoid insignificance of application, this process has to be done. Within this process occurred the switching of parameters which were the precipitation rate, flow rate, and flood level were the most significant.

3.2.1.5 Cost-efficiency analysis

A process which scales how innovative the proposed project is. Instead of using an ultrasonic sensor which is a high-cost sensor, it will be more cost-efficient to use a flood marker and a camera for image processing. The proponents designed a flow rate meter sensor which could also be made with raw materials to reduce the cost instead of buying a commercially-made flow rate sensor. Since our target were rural areas, the proposed project was expected to be low-cost with reliable outputs.

3.2.1.6 Device Implementation

This process was the assembly of the components bought to build the actual device. The main guides for this step are the proposed: circuit designs, block diagram, and target output. For this step to be completed, the built device should be 100 percent working.

3.2.1.7 Device Testing

A step more commonly known as “pilot testing”. In this process, the proposed device was subjected to a situation in which it will perform its task. Manmade rain showers was used to test the rain gauge while the flood markers and flow rate meter sensor were submerged in an aquarium to obtain the flood level and flow rate. This process was a small-scale deployment conducted by the researchers.

3.2.1.8 Device Evaluation

This step was the assessment of the overall functionality of the device. Some of the parameters here were taken from the cost-efficiency analysis like: power consumption and portability. That being said, main parameters like accuracy, operational speed, and range were included in this step.

3.2.1.9 Deployment

The last step of the research to be considered complete. This step aimed to gain valuable output from the device that can serve the target community. The barangay officials and residents also evaluated the efficiency, and functionality of the device. Also, this last step was the product of the second step which was conceptualization.

3.2.2 Block Diagram

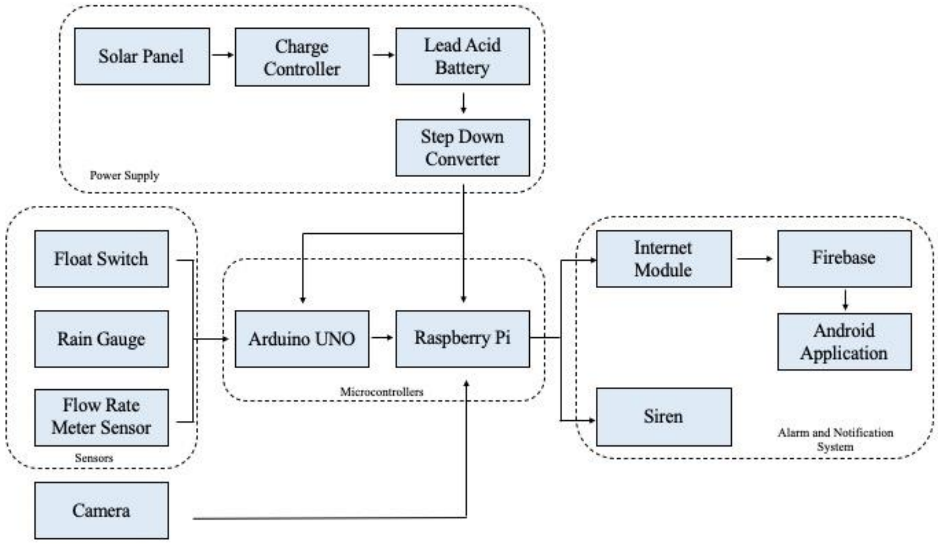

Figure 3.3 Block Diagram of the Study

For the block diagram, the proposed main device is enclosed within a section illustrated from above. The block that contains the sensors send analog signals to the Arduino UNO and is then passed to the Raspberry Pi to be analyzed. The image that is captured by the camera is also sent to the Raspberry Pi for image processing. The precipitation rate and flow rate are also essential parameters to predict the chance of flood.

The block that contains the microcontrollers receive the analog signals sent from the sensors and the image from the camera. When the Arduino UNO has finished processing the input data, it will send its output to the Raspberry Pi along with the image. After the image undergoes image processing, the output will be propagated through the internet with the help of an internet module and a notification regarding the intensity of the rain fall in millimeters/hour (mm/hr), the flow rate in liter per hour (L/hr), and also the predicted flood level that will occur in 3 hours. The float switch acts as a backup to confirm that there is a rise of water level.

The flood detection system is powered by a solar panel which is connected to a solar charge controller and a lead acid battery to reduce electrical consumption. A step-down converter is used to regulate the input voltage into a 5V DC that supplies the internet module, Arduino UNO, and Raspberry Pi.

3.3 Project Development

3.3.1 Software Development

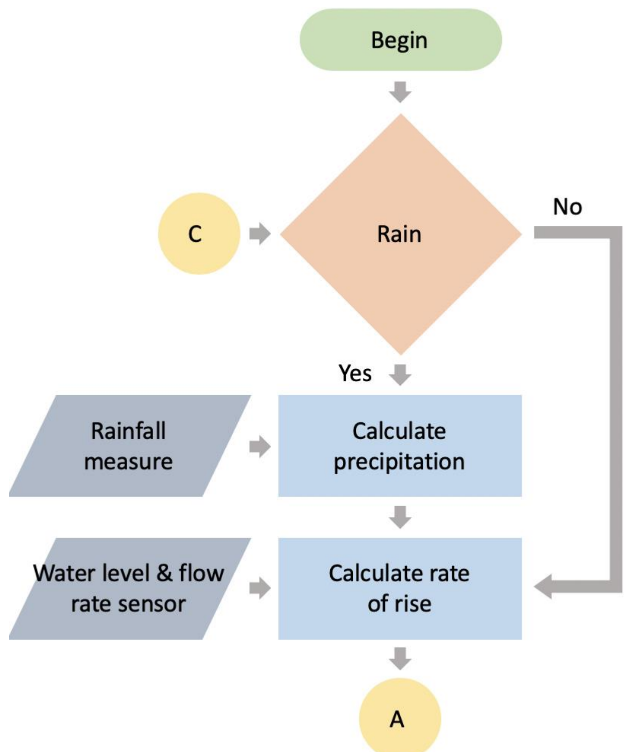

Figure 3.4 Flowchart of the Flood Detection System

The system will check first whether there is occurrence of rain or not using a rain gauge. At the event of one, it will determine the rainfall amount to measure liquid precipitation over a set period of time. It will then look for changes in the water level as well as the flow rate of the river, and calculate the water's rate of rise. If there is no rain, it will skip the first process and move on to the next. These readings will serve as the parameters for the predictive system.

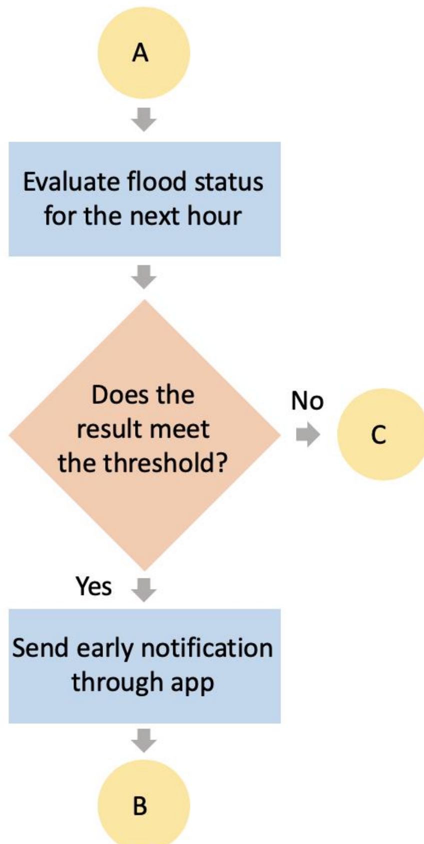

Figure 3.5 Flowchart of the Monitoring and Alarm System 1

The program will then evaluate the gathered data to anticipate flood status for the next hour. If the readings do not meet the threshold for an impending flood, the system will consider the values insignificant and go back to the first process. But if there is a risk of flooding, it will notify concerned agencies and individuals through an app that will serve as an early safety measure.

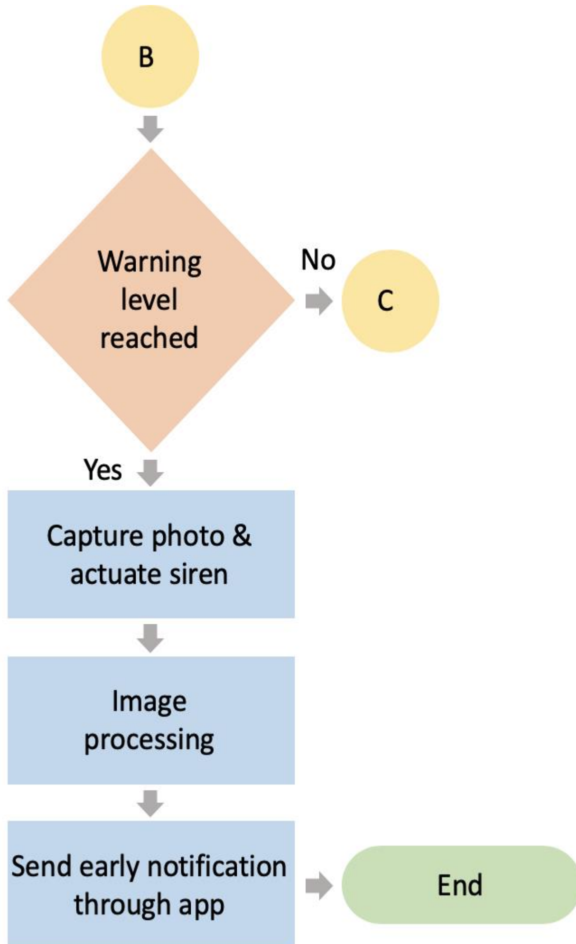

Figure 3.6 Flowchart of the Monitoring and Alarm System 2

The system will then monitor whether the flood has reached the warning level indicators through the use of image processing. If it hasn't reached warning levels yet, it will check the parameters again to see if there are any changes or if the water level is already going down. If it does reach the warning levels, it will actuate the siren immediately to notify the communities and send updates through the mobile application.

3.3.1.1 Image Processing

1.) Region of Interest – an important algorithm which limits the size of the image taken by cropping using NumPy slicing since every pixel of an image is composed of matrices.

2.) Brightness and Contrast – a basic operation of image processing which is used to get a brighter image. The brighter image will then be converted to grayscale.

3.) Otsu's Method – creates a threshold for converting the grayscale image into a binary image in which every pixel only represents 0 and 1. This algorithm is required before proceeding into any type of edge detection algorithms.

4.) Canny Edge Detection – the algorithm for taking the outline of the flood line which is necessary for the calculations.

5.) Hough Line Transform – draws a line from the edges acquired by the previous algorithm [10]. The height of the line drawn will be measured in pixels.

Since the line height is in pixels, it will be converted by dividing it with a constant.

$$\text{Line height in ft} = \frac{light\ height\ in\ pixels}{2800}$$

After the said algorithms, the final formula will be:

$$\text{Flood height} = \text{image height} - \text{line height}$$

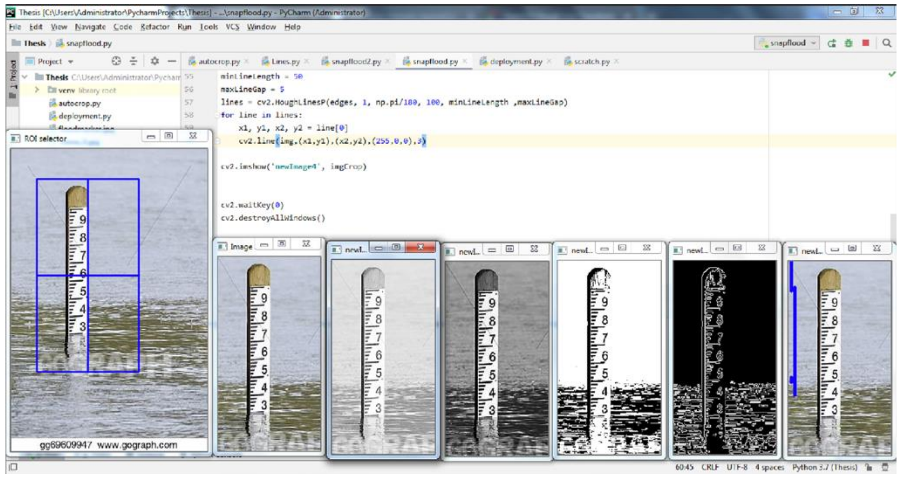

Figure 3.7 Image Processing Step by Step Process. (a) Region of Interest, (b) Brightness and Contrast, (c) Otsu's method, (d) Canny edge detection, (e) Hough line transform

3.3.1.2 Predictive Model

The system uses multiple linear regression as the mathematical model which uses 1 dependent variable: predicted flood level and 3 independent variables: 1) Precipitation rate, 2) Flow rate, and 3) Present flood level. Based from running the program in Python, the mathematical model yielded an accuracy of 91.81%.

Multiple linear regression formula:

$$\mathbf{y = B_o + B_1x_1 + B_2x_2 + e}$$

Where:

y = predicted flood level

B_o = precipitation rate

B_1 = flow rate

B_2 = present flood level

e = error term

Figure 3.8 Sample of Flood Height Prediction

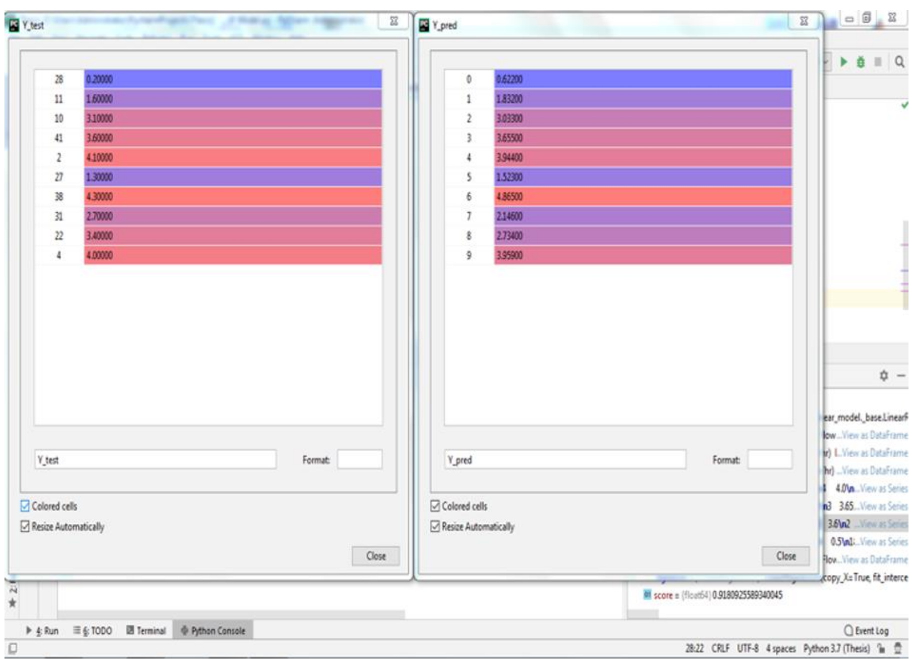

Figure 3.9 Actual vs. Predicted Flood Level Comparison in Python

Figure 3.8 shows the values of predicted flood levels correlating the precipitation rate, flow rate, and present flood level with predicted flood level using multiple linear regression. Once the 3 independent variables are obtained from the system, the predictive model automatically computes for the essential output which is the predicted flood level. The model obtained an accuracy of 91.8% stating that there are still some limitations from the algorithm itself.

3.3.2 Hardware Development

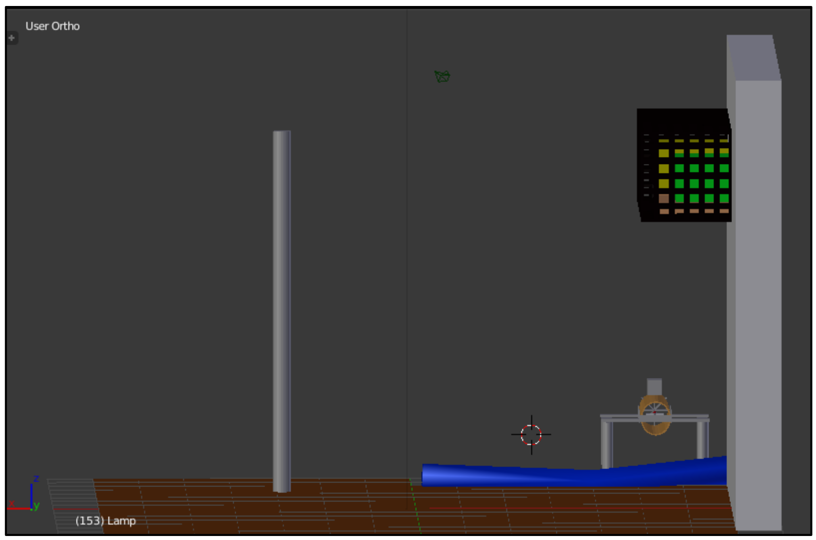

Figure 3.10 3D Model of the Smart Flood Detection, Alarm, and Monitoring System at the Deployment Site

3.3.2.1.1 Gathering of Materials

The materials and equipment for the project were obtained from places such as Raon, eGizmo, Jamming Hard-ware, and MakerLab.

The equipments included in the Smart Flood Detection, Alarm, and Detection System are the following:

Stores	Materials/Equipment
Makerlab	• Raspberry Pi 3 Model B+ • Arduino UNO • Raspberry Pi Camera NoIR V2 • Float Switch • Jumper Wires • 6-24V to 5V USB Step Down Converter
Raon	• Aluminum Tube • Metal Chassis • CAT 5E Cable (30 meters) • Cable ties • 80W Solar Panel • Lead Acid Battery • L-bars
eGizmo	• Hall Magnetic Effect Sensor • EW-512 • A3144LU
Jamming Hardware	• Boysen Paint (Red) • Boysen Paint (White) • Paint Brush
3D Printing Commission	• Propeller

Table 3.1 Materials and Equipments

3.3.3 Interfacing Procedure

3.3.3.1 Sensor Calibration

a. Prepare the detection modules needed to monitor the following parameters: precipitation rate, flow rate and water level.

b. With the assistance of IRDU Calibration Services of PAGASA, calibrate the rain gauge and flow rate for accuracy and functionality.

c. Once it is calibrated and tested, place the rain gauge in its designated areas and connect it to the Arduino UNO R3.

3.3.3.2 Raspberry Pi Camera NoIR for Image Processing

a. Prepare the Raspberry Pi Camera NoIR and check the functionality of the camera through the terminal in Raspberry Pi.

b. After testing, place the camera pins on its designated pins in the Raspberry Pi.

3.3.3.3 Float Switch Testing

a. Prepare the float switch for construction of its set up.

b. Place the flood marker with the float switch on its designated position.

c. Connect the float switch on its designated pins at the Arduino UNO R3.

3.3.3.4 Raspberry Pi Microcontroller Interface

a. Connect the Raspberry Pi Microcontroller to a monitor and a keyboard then upload the program.

b. Connect all the sensors and devices to its designated pins.

c. Check the functionality by testing and verifying the results of each sensor. Troubleshoot, should it be necessary.

3.3.4 Programming

Python is the programming language used.

3.4 Testing Procedure

The functionality test involves feeding inputs to the system and analyzing the output, while the reliability test under similar conditions is calculated by the accuracy of the results. Tests will be conducted to assure the accuracy of each sensor readings in the Smart Flood Detection, Alarm, and Monitoring System.

Date	**Time**	**Flood Level (ft)**

Table 3.2 Flood Detection Readings

Table 3.2 shows the flood level readings along with their date and time. The flood level is expressed in feet. The data will be shown in a .csv file format.

Date	Time	Precipitation Rate (mm/hr)

Table 3.3 Precipitation Rate Readings

Shown in Table 3.3 is the precipitation rate readings expressed in millimeters per hour with it's corresponding date and time.

Date	Time	Flow Rate (L/m)

Table 3.4 Flow Rate Readings

Table 3.4 shows the flow rate readings expressed in liters per minutes along with the date and time it was taken.

A paired t-test will be used to find if there is a signifant difference between the actual flood level and the predicted flood level.

3.4.1 Evaluation Procedure

Figure 3.8 shows an example of the survey form to be answered by the barangay residents. This evaluation form will determine the effectiveness, acceptability, and relevance of the project to Barangay.

NAME: ____ AGE:__________
ADDRESS:____
CONTACT NUMBER: ___________________ E-MAIL: _______________________
COMPANY: ____________________________ POSITION: ____________________

Dear Madam/Sir:

The following questions bellow are for evaluation of the project, entitled ***SMART FLOOD DETECTION, ALARM AND MONITORING SYSTEM USING IMAGE PROCESING***. Please rate the following by grading 1 to 5 (5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, and 1 strongly disagree) by putting check (✓) on the box provided. If you have questions, clarification, comments or suggestion, kindly put on the space provided below.

	1	2	3	4	5
EFFICIENCY					
1. Using the camera for capturing the flood movement that is being used for Image processing.					
2. The flood status is being monitored real-time.					
3. It detects the precipitate in real-time.					
RELIABILITY					
1. Sending real and fast notification of rain and flood.					
2. The system accurately measures the water current in the river.					
3. The system accurately measures the intensity of the rain.					
FUNCTIONALITY					
1. The system can run 24 hours daily.					
2. The system is resistant to heavy rains and flood					

3. The device requires minimum supervision.					
4. The device measures accurate parameters.					

COMMENTS AND SUGGESTIONS:

Signature over printed name

Figure 3.11 Evaluation Form

Barangay officials and residents will be the evaluator of the flood detection system. A technical evaluation form will be answered by them. The aim of the evaluation form is to know whether the device is userfriendly, cost efficient, reliable, and conventional, which also includes a grading system shown in Table 3.5 below.

Description	**Rating**
Outstanding	5
Good	4
Acceptable	3
Marginal	2
Unacceptable	1

Table 3.5 Statistical Analysis

3.5 Gantt Chart

The Table 3.6 below shows the Gantt chart which served as the project time frame.

Activity	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr
Conceptualization												
Data Gathering												
Chapter 1: Problem and its Setting												
Topic Defense												
Justification of parameters												
Cost-efficiency analysis												
Design Layout												
Chapters 2 and 3												
Title Defense												
Device Implementation												
Progress Defense												
Hardware and Software Development												
Pre-final Defense												
Deployment												

Project Evaluation												
Document Finalization												
Final Defense												

Table 3.6 Gantt chart

Chapter 4

RESULTS AND DISCUSSIONS

This chapter provides the technical overview of the project, the structure of the project, data interpretation and analysis, and the findings relevant to the tests carried out.

4.1 Project Technical Description

The system is comprised of three major parts: monitoring and detection, early prediction system, and notification system. The flood level, flow rate, and precipitation are monitored for the optimization of the monitoring and detection system. Moreover, these parameters are used by the predictive model to ensure accuracy of the system's early prediction. The image processing system captures a photo of the flood marker when the float switch is triggered where it is analyzed alongside the three parameters to generate a certain flood level 3 hours early before a flood occurs. The final output of the system will be sent to an android phone using a prepaid or postpaid internet modem to notify the user regarding the flood status.

A Raspberry Pi microcontroller operates the entire system. An Arduino UNO is exclusively for the use of reading data from the sensors such as rain gauge, flow rate meter sensor, and float switch sensor. The image processing operates around-the-clock and captures images at a constant time interval of fifteen minutes.

The whole system is power-driven by an 80 W solar panel, a solar charge controller, and a lead acid battery.

4.2 Project Structure

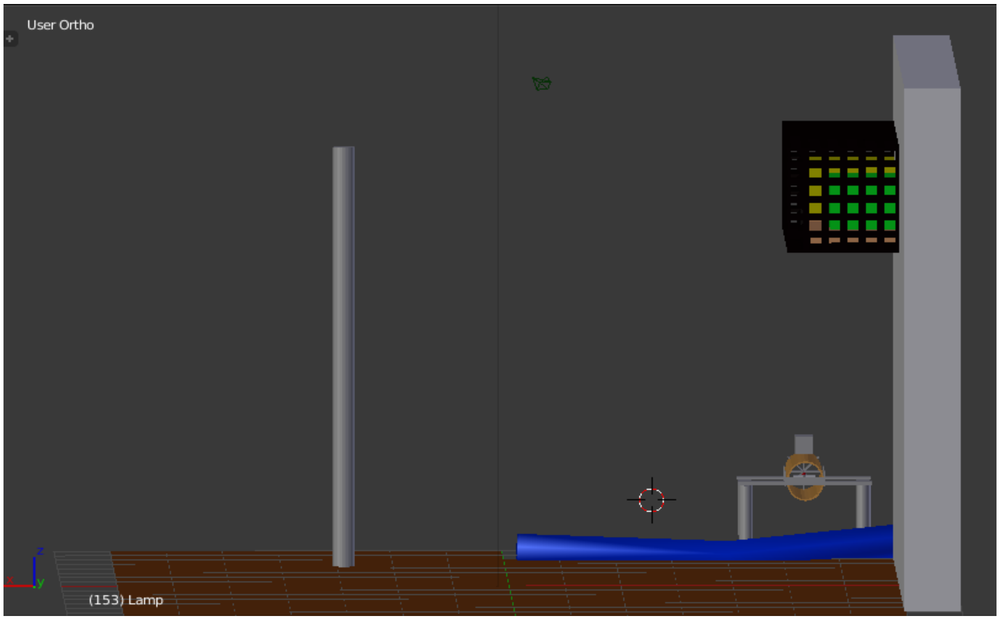

Figure 4.1 3D Setup of the Flood Detection System

Figure 4.1 shows the setup of the flood detection system at the deployment site. The monitoring and detection system is mounted at the wall of a house while the flood marker is placed 6 meters across the monitoring system. The rain gauge and the solar panel are placed at a higher location to provide the proper elevation as shown in Figure 4.2

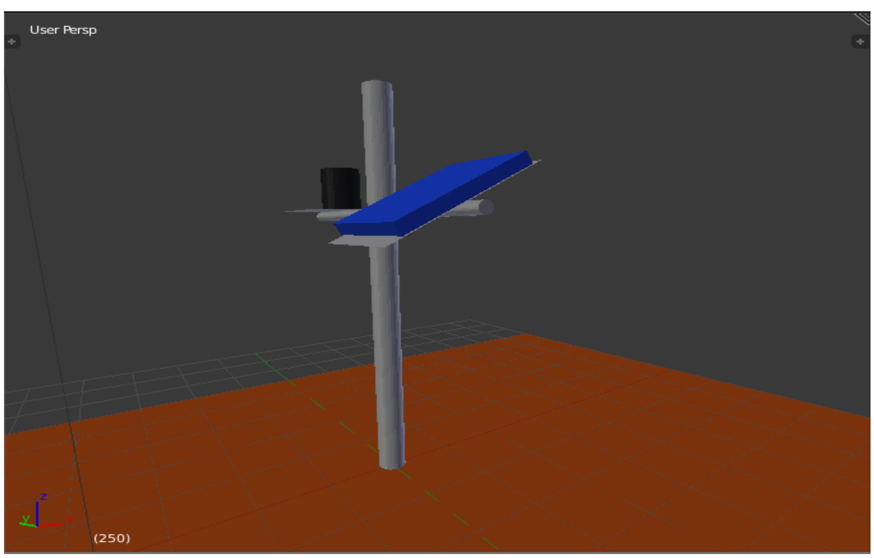

Figure 4.2 3D Setup of Rain Gauge and Solar Panel

4.2.1 Detection, Alarm and Monitoring System

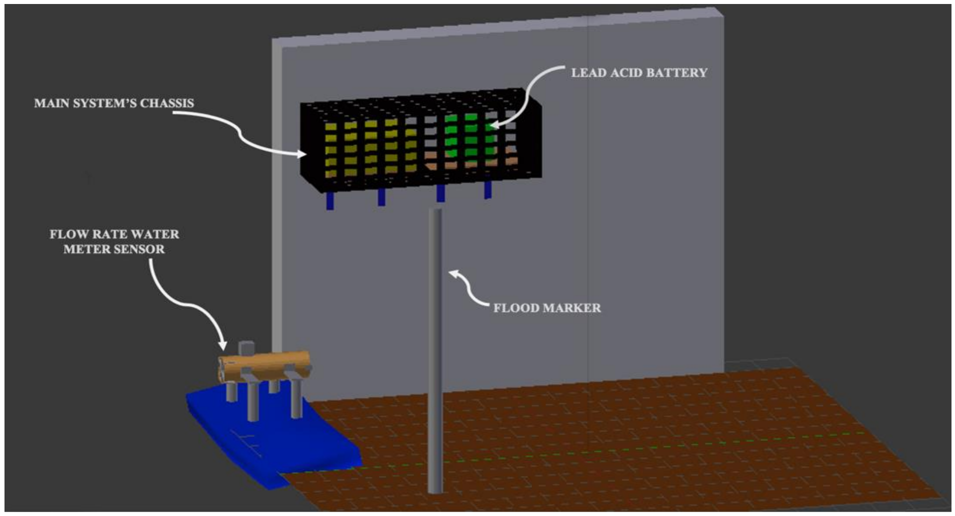

Figure 4.3 Detection and Monitoring System

Figure 4.3 shows the setup of the microcontrollers and sensors used for the flood detection system. Two were used to accurately measure the precipitation rate and flow rate. The rain gauge, flow rate meter sensor, and float switch are connected to the Arduino UNO and reads the signal sent by the sensors. The float switch only acts as a back-up detection to confirm that there is indeed a rise of water level.

4.2.2 Vision System

The setup of the camera used for the flood detection system is a Raspberry Pi NoIR Camera 2 to capture images of the flood. The camera is connected to the Raspberry Pi controller which collects and processes images every 15 minutes. A flood light is also used to provide clear lighting for the flood marker during the night. Once the flood level reaches a certain level on the flood marker, the system will send data to the mobile application and trigger the siren with its corresponding sound based on the flood level classification shown in Figure 4.4 below.

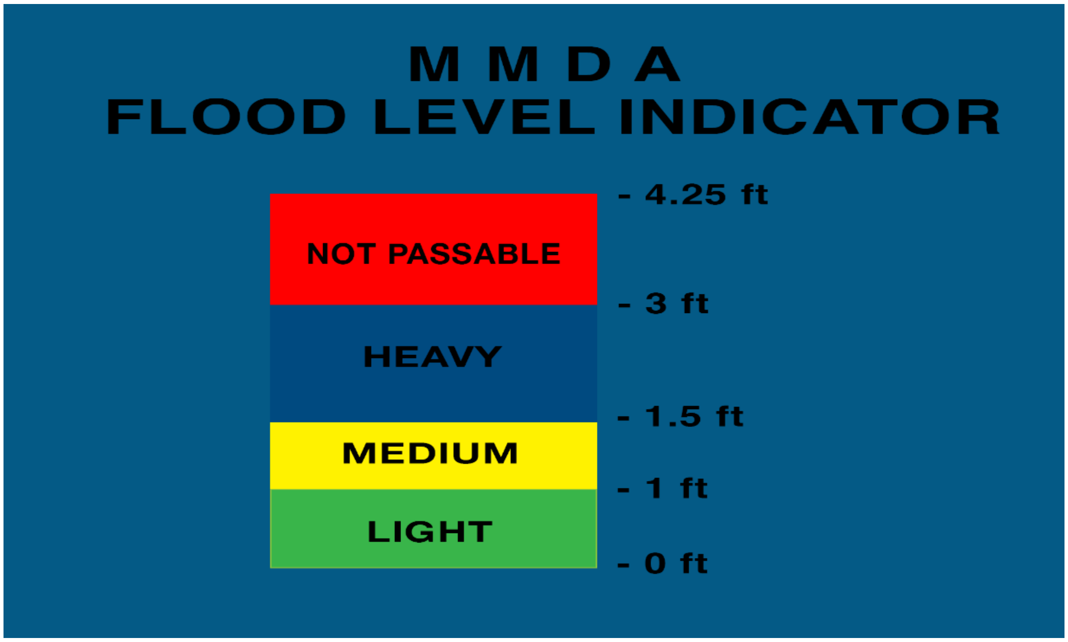

Figure 4.4 Flood Level Classification from MMDA

4.3 Project Limitations and Capabilities

The system is limited to detecting, alarming, monitoring, and notifying of an occurring flood. It is also capable of predicting a flood early, 3 hours before it occurs with a 91.8% accuracy. The system does not include geographic mapping and the prediction of the flood's duration. It can only predict how high the flood will be 3 hours before it happens.

4.4 Project Evaluation

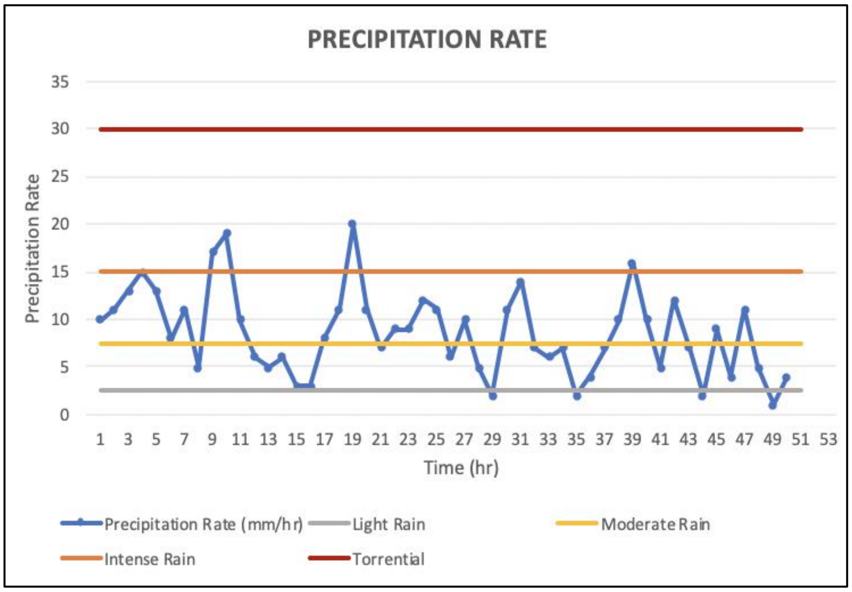

Figure 4.5 Precipitation rate reading in two days

Figure 4.5 shows the graph of the precipitation rate in two days of rain. The readings fell into the ranges of light, moderate, and intense rainfall. No serious flooding occurred in low-lying area, but the rain gauge measured 5 readings of orange rainfall advisories which means serious flooding.

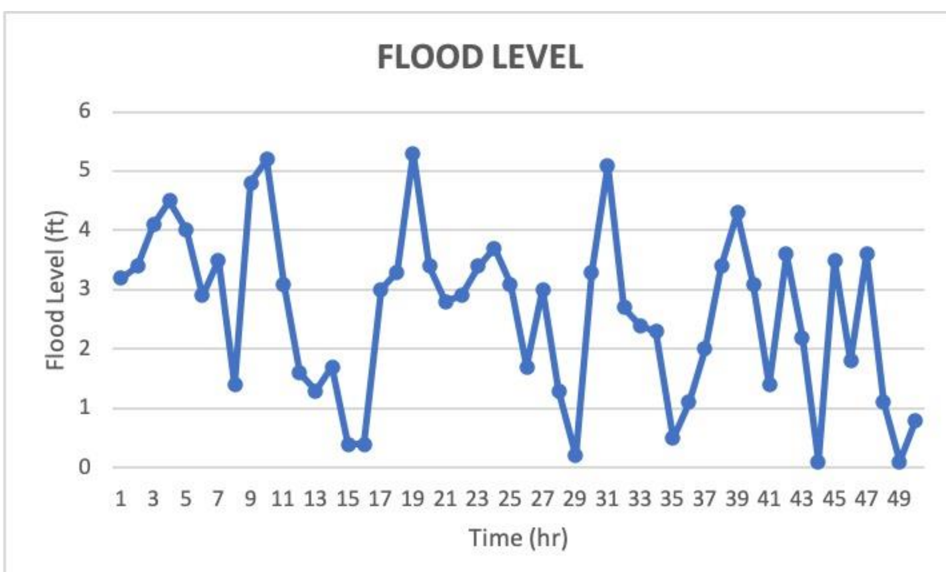

Figure 4.6 Flow Rate Reading

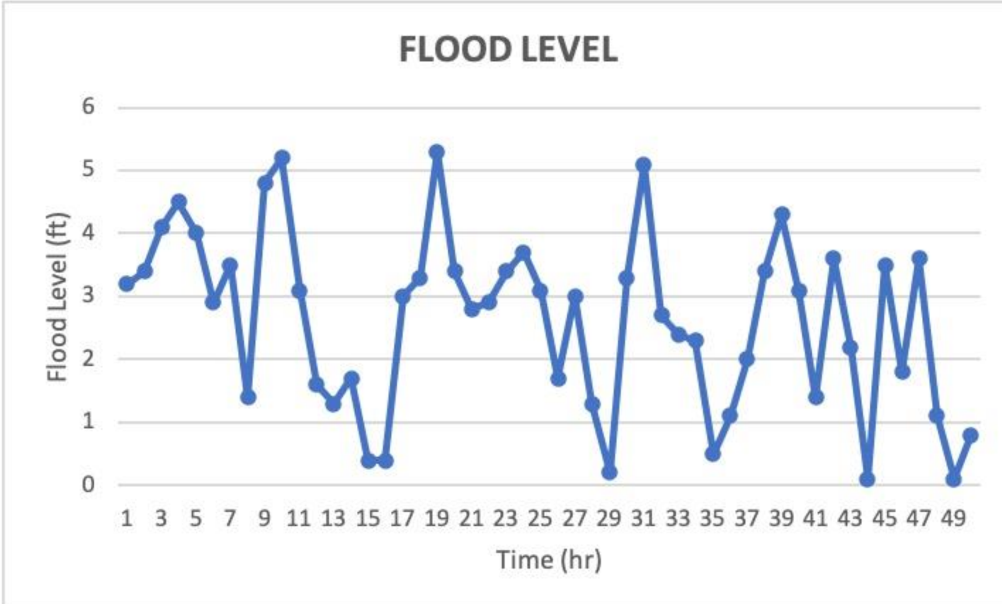

Figure 4.7 Flood Level Reading

The color-coded rainfall classification also indicates how strong the rain is. Figure 4.6 shows the variation of the river's flow rate. Figure 4.7 contains the flood level that was taken during the period of two days.

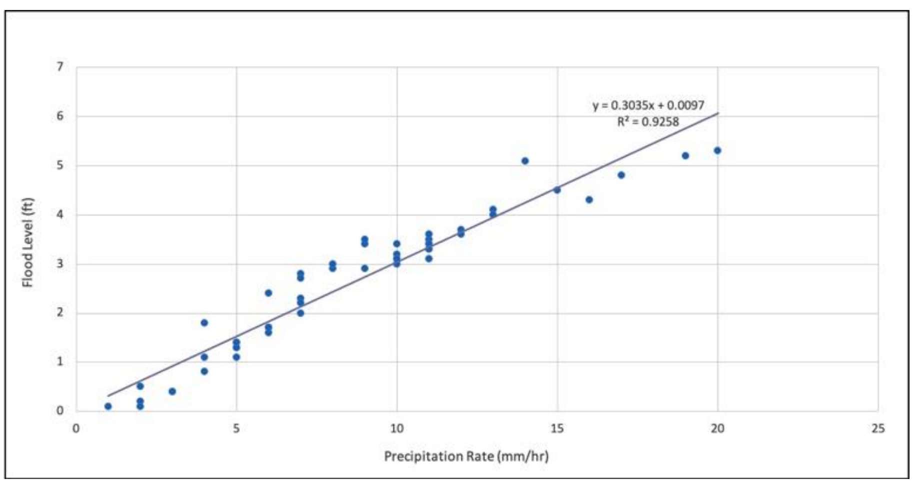

Figure 4.8 Regression plot of Flood Level and Precipitation Rate

Figure 4.8 shows the regression plot of the flood level and precipitation rate. An R^2 of 0.9258 or 92.58% was obtained indicating that there is a variation of flood level caused by the changes in the precipitation rate.

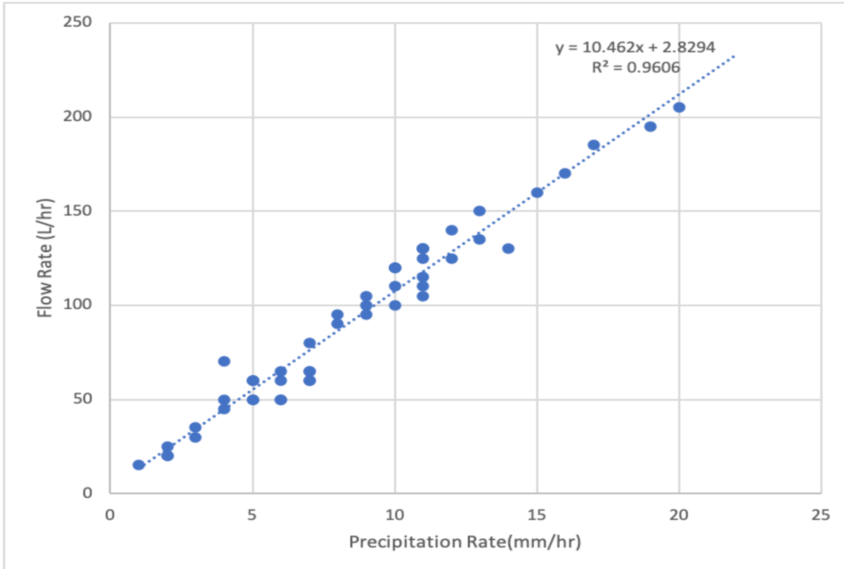

Figure 4.9 Regression plot of Precipitation Rate and Flow Rate

Figure 4.9 shows the regression plot of the flow rate and precipitation rate. The value of the R^2 is 0.9606 or 96.06% which means that as the precipitation rate rises, the flow rate also increases.

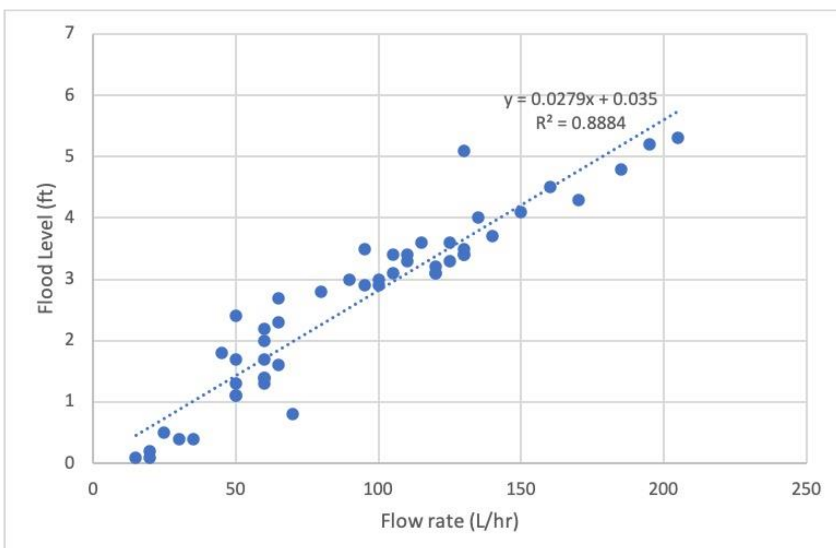

Figure 4.10 Regression Plot of Flood Level and Flow Rate

Figure 4.10 shows an R^2 value of 0.8884 or 88.84% implying that the flow rate does have a correlation with the rise of the flood level.

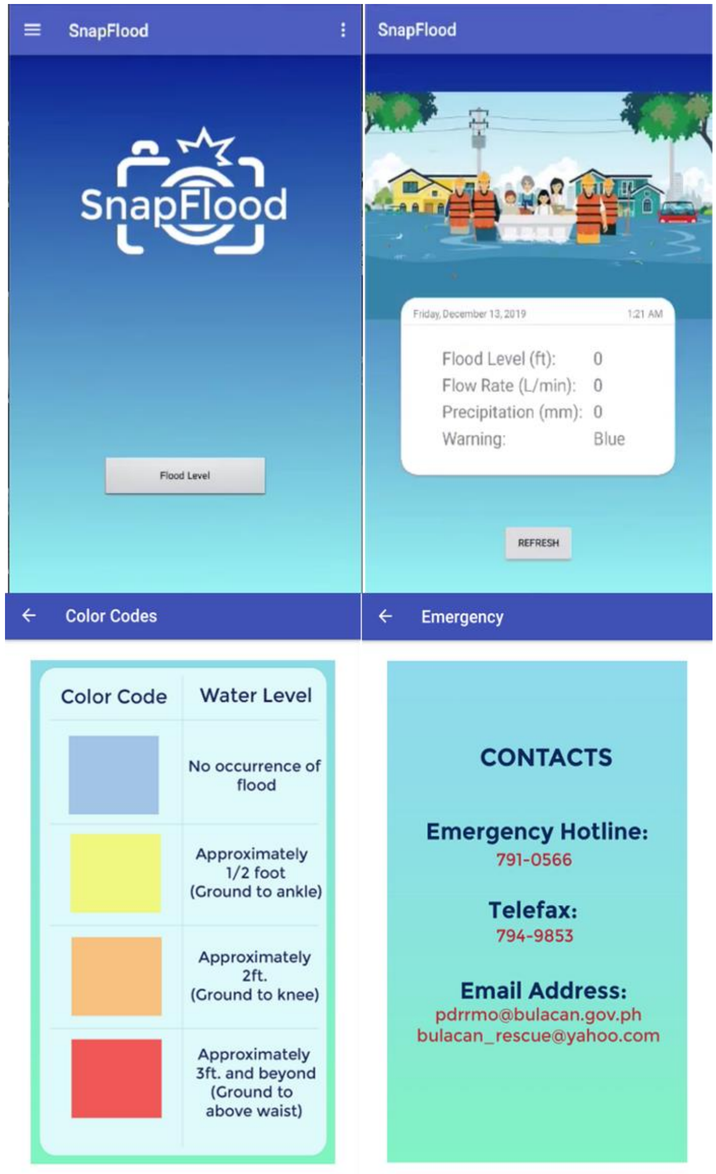

Figure 4.11 Mobile Application Interface

The SnapFlood's mobile application is shown in Figure 4.11 This application is made to collect all the data from the main system and display the current status of the site, with or without flood, every 15-minute intervals. It also displays the parameters that affects the rise of flood such as flow rate and precipitation rate. The application was made through Android Studio and Python codes are used for data transmission from the microcontroller.

It stores data in FireBase, a real-time database that provides developers to store data on FireBase's cloud.

The application shows a home screen with a single button named Flood Level, where all the parameters and information needed are shown. On the top left corner of the screen is an options button, it contains buttons for panels such as the color-coded rainfall classification and emergency hotlines of local government authorities.

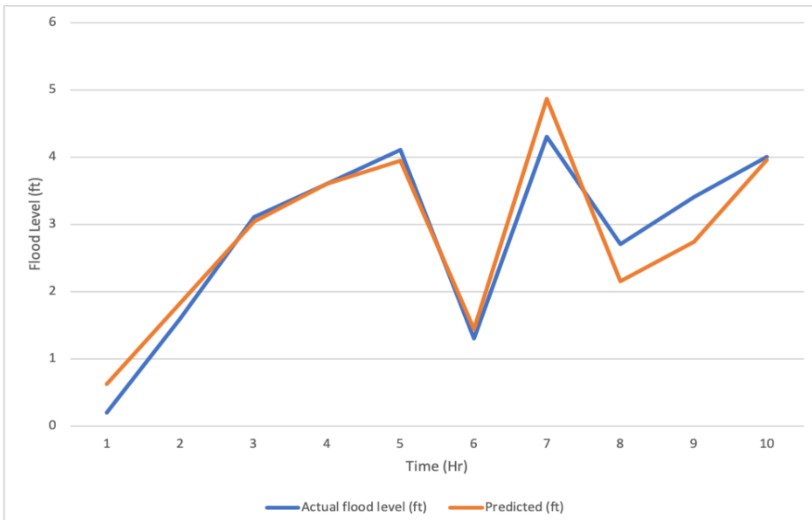

Figure 4.12 Actual Flood Level versus Predicted Flood Level

Figure 4.12 shows the comparison of the actual flood level and the predicted flood level of the system. The graph shows the flood levels that were simulated in 10 hours. To determine if there was a significant difference between the two, the proponents decided to use a paired t-test.

Paired t-test was used to determine if there was a significant difference between the actual flood level and predicted flood level. The obtained p-value (two-tail) is 0.918 with a significance level of 0.05. Since the p-value is higher than the significance level, this implies that the system's predicted flood level is relatively similar with the actual flood level indicating the high reliability of the system.

	Actual flood level (ft)	Predicted flood level (ft)
Mean	2.83	2.8171
Variance	1.880111111	1.732632322
Observations	10	10
Pearson Correlation	0.959361464	
Hypothesized Mean Difference	0	
df	9	
t Stat	0.105431554	
P(T<=t) one-tail	0.459172905	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.918345809	
t Critical two-tail	2.262157163	

Table 4.1 t-Test: Paired Two Sample for Means

	Automated	Conventional
Mean	2.83	2.8171
Variance	1.880111111	1.732632322
Observations	10	10
Pearson Correlation	0.959361464	
Hypothesized Mean Difference	0	
df	9	
t Stat	0.105431554	
P(T<=t) one-tail	0.459172905	
t Critical one-tail	1.833112933	
P(T<=t) two-tail	0.918345809	
t Critical two-tail	2.262157163	

Table 4.2 t-test: Two Sample of Assuming Equal Variances for Flood Level Detection Method

As shown in Table 4.1, t Critical < t Stat (1.984 < 0.209) and p value > a (0.835 > 0.05), which means that there is no significant difference on the means of the automated and manual results. The system's results imply that it is relatively similar with the conventional method of flood level detection which signifies high reliability of the system.

Chapter 5

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter presents the overview of the results or research work performed, the conclusion drawn from the data collected and the results of the analysis and recommendations made outgrowth from this study.

5.1 Summary of Findings

The project Smart Flood Detection, Alarm, and Monitoring System using Image Processing is a study that develops an early warning system to implement a systematized dissemination of advisories. This study is based on the precipitation level, flow rate level, and flood level which utilizes the software Python to create a processing system.

This project is composed of two devices, the rain gauge and flow rate meter sensor that were calibrated from PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration). The whole system was implemented in the rural area in Calumpit, Bulacan. The proponents simulated the sample data gathered due to Coronavirus outbreak (COVID-19).

5.2 Conclusion

Based on the data gathered and test conducted, the following are the conclusions drawn out by the proponents:

1. This project was able to provide reusable energy by gathering power from the solar panel and transferring it into the batteries.

2. The image recognition and counting system that will identify the flood level was effectively accomplished.

3. The development of the flood monitoring and early warning system that analyzes the precipitation level, flow rate, and flood level through image processing using multiple linear regression model was successfully implemented using Python and has 91.8% accuracy.

4. The application developed by the proponents using Android Studio was able to immediately receive the gathered data from the flood monitoring system.

5.3 Recommendation

The project was successfully implemented and done; however, the proponents would like to make the following recommendations to further improve the project.

1. Collect more data of the rain fall to generate more accurate results.

2. Use more compatible sensors for the flood monitoring system to avoid conflicts in the data.

3. Add a cooling system for the batteries to prevent it from overheating.

4. Improve the prediction algorithm.

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APPENDIX A
Evaluation Form

NAME: ____ AGE:___________
ADDRESS:____
CONTACT NUMBER: _____________________ E-MAIL: __________________________
COMPANY: _______________________________ POSITION: ______________________

Dear Madam/Sir:

The following questions bellow are for evaluation of the project, entitled ***SMART FLOOD DETECTION, ALARM AND MONITORING SYSTEM USING IMAGE PROCESING***. Please rate the following by grading 1 to 5 (5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, and 1 strongly disagree) by putting check (✓) on the box provided. If you have questions, clarification, comments or suggestion, kindly put on the space provided below.

	1	2	3	4	5
EFFICIENCY					
1. Using the camera for capturing the flood movement that is being used for Image processing.					
2. The flood status is being monitored real-time.					
3. It detects the precipitate in real-time.					
RELIABILITY					
1. Sending real and fast notification of rain and flood.					
2. The system accurately measures the water current in the river.					
3. The system accurately measures the intensity of the rain.					
FUNCTIONALITY					
1. The system can run 24 hours daily.					
2. The system is resistant to heavy rains and flood					

3. The device requires minimum supervision.

4. The device measures accurate parameters.

COMMENTS AND SUGGESTIONS:

____

____

____

____

____

____

Signature over printed name

APPENDIX B

Data

Precipitation Rate Reading

Date	Time	Trial	Precipitation Rate (mm/hr)
10/03/2020	2:51:00 PM	1	10
10/03/2020	3:10:00 PM	2	11
10/03/2020	3:23:00 PM	3	13
10/03/2020	3:34:00 PM	4	15
10/03/2020	3:41:00 PM	5	13
10/03/2020	3:50:00 PM	6	8
10/03/2020	4:05:00 PM	7	11
10/03/2020	4:11:00 PM	8	5
10/03/2020	4:22:00 PM	9	17
10/03/2020	4:29:00 PM	10	19
10/03/2020	4:40:30 PM	11	10
10/03/2020	4:44:00 PM	12	6
10/03/2020	4:51:00 PM	13	5
10/03/2020	4:55:00 PM	14	6
10/03/2020	5:01:30 PM	15	3
10/03/2020	5:04:30 PM	16	3
10/03/2020	5:15:00 PM	17	8
10/03/2020	5:20:30 PM	18	11
10/03/2020	5:23:00 PM	19	20
10/03/2020	5:30:30 PM	20	11
10/03/2020	5:37:00 PM	21	7
10/03/2020	5:48:00 PM	22	9
10/03/2020	5:51:30 PM	23	9
10/03/2020	5:54:00 PM	24	12
11/03/2020	3:02:00 PM	25	11
11/03/2020	3:08:00 PM	26	6
11/03/2020	3:14:00 PM	27	10
11/03/2020	3:20:00 PM	28	5
11/03/2020	3:30:30 PM	29	2
11/03/2020	3:42:00 PM	30	11
11/03/2020	3:50:00 PM	31	14
11/03/2020	4:03:00 PM	32	7
11/03/2020	4:10:00 PM	33	6
11/03/2020	4:22:00 PM	34	7
11/03/2020	4:40:30 PM	35	2
11/03/2020	4:48:00 PM	36	4
11/03/2020	5:01:00 PM	37	7

11/03/2020	5:16:00 PM	38	10
11/03/2020	5:25:30 PM	39	16
11/03/2020	5:36:00 PM	40	10
11/03/2020	5:41:00 PM	41	5
11/03/2020	5:48:30 PM	42	12
11/03/2020	6:00:00 PM	43	7
11/03/2020	6:06:00 PM	44	2
11/03/2020	6:12:30 PM	45	9
11/03/2020	6:18:00 PM	46	4
11/03/2020	6:30:00 PM	47	11
11/03/2020	6:33:00 PM	48	5
11/03/2020	6:41:30 PM	49	1
11/03/2020	6:48:00 PM	50	4

Flow Rate Reading

Date	Time	Trial	Flow Rate (L/hr)
10/03/2020	2:51:00 PM	1	120
10/03/2020	3:10:00 PM	2	130
10/03/2020	3:23:00 PM	3	150
10/03/2020	3:34:00 PM	4	160
10/03/2020	3:41:00 PM	5	135
10/03/2020	3:50:00 PM	6	95
10/03/2020	4:05:00 PM	7	130
10/03/2020	4:11:00 PM	8	60
10/03/2020	4:22:00 PM	9	185
10/03/2020	4:29:00 PM	10	195
10/03/2020	4:40:30 PM	11	120
10/03/2020	4:44:00 PM	12	65
10/03/2020	4:51:00 PM	13	50
10/03/2020	4:55:00 PM	14	60
10/03/2020	5:01:30 PM	15	35
10/03/2020	5:04:30 PM	16	30
10/03/2020	5:15:00 PM	17	90
10/03/2020	5:20:30 PM	18	125
10/03/2020	5:23:00 PM	19	205
10/03/2020	5:30:30 PM	20	130
10/03/2020	5:37:00 PM	21	80
10/03/2020	5:48:00 PM	22	100
10/03/2020	5:51:30 PM	23	105
10/03/2020	5:54:00 PM	24	140
11/03/2020	3:02:00 PM	25	105
11/03/2020	3:08:00 PM	26	50
11/03/2020	3:14:00 PM	27	100
11/03/2020	3:20:00 PM	28	60
11/03/2020	3:30:30 PM	29	20
11/03/2020	3:42:00 PM	30	110
11/03/2020	3:50:00 PM	31	130
11/03/2020	4:03:00 PM	32	65
11/03/2020	4:10:00 PM	33	50
11/03/2020	4:22:00 PM	34	65
11/03/2020	4:40:30 PM	35	25
11/03/2020	4:48:00 PM	36	50
11/03/2020	5:01:00 PM	37	60

11/03/2020	5:16:00 PM	38	110
11/03/2020	5:25:30 PM	39	170
11/03/2020	5:36:00 PM	40	120
11/03/2020	5:41:00 PM	41	60
11/03/2020	5:48:30 PM	42	125
11/03/2020	6:00:00 PM	43	60
11/03/2020	6:06:00 PM	44	20
11/03/2020	6:12:30 PM	45	95
11/03/2020	6:18:00 PM	46	45
11/03/2020	6:30:00 PM	47	115
11/03/2020	6:33:00 PM	48	50
11/03/2020	6:41:30 PM	49	15
11/03/2020	6:48:00 PM	50	70

Flood Level Reading via Image Processing

Date	Time	Trial	Flood Level (Ft)
10/03/2020	2:51:00 PM	1	3.2
10/03/2020	3:10:00 PM	2	3.4
10/03/2020	3:23:00 PM	3	4.1
10/03/2020	3:34:00 PM	4	4.5
10/03/2020	3:41:00 PM	5	4
10/03/2020	3:50:00 PM	6	2.9
10/03/2020	4:05:00 PM	7	3.5
10/03/2020	4:11:00 PM	8	1.4
10/03/2020	4:22:00 PM	9	4.8
10/03/2020	4:29:00 PM	10	5.2
10/03/2020	4:40:30 PM	11	3.1
10/03/2020	4:44:00 PM	12	1.6
10/03/2020	4:51:00 PM	13	1.3
10/03/2020	4:55:00 PM	14	1.7
10/03/2020	5:01:30 PM	15	0.4
10/03/2020	5:04:30 PM	16	0.4
10/03/2020	5:15:00 PM	17	3
10/03/2020	5:20:30 PM	18	3.3
10/03/2020	5:23:00 PM	19	5.3
10/03/2020	5:30:30 PM	20	3.4
10/03/2020	5:37:00 PM	21	2.8
10/03/2020	5:48:00 PM	22	2.9
10/03/2020	5:51:30 PM	23	3.4
10/03/2020	5:54:00 PM	24	3.7
11/03/2020	3:02:00 PM	25	3.1
11/03/2020	3:08:00 PM	26	1.7
11/03/2020	3:14:00 PM	27	3
11/03/2020	3:20:00 PM	28	1.3
11/03/2020	3:30:30 PM	29	0.2
11/03/2020	3:42:00 PM	30	3.3
11/03/2020	3:50:00 PM	31	5.1
11/03/2020	4:03:00 PM	32	2.7
11/03/2020	4:10:00 PM	33	2.4
11/03/2020	4:22:00 PM	34	2.3
11/03/2020	4:40:30 PM	35	0.5
11/03/2020	4:48:00 PM	36	1.1
11/03/2020	5:01:00 PM	37	2

11/03/2020	5:16:00 PM	38	3.4
11/03/2020	5:25:30 PM	39	4.3
11/03/2020	5:36:00 PM	40	3.1
11/03/2020	5:41:00 PM	41	1.4
11/03/2020	5:48:30 PM	42	3.6
11/03/2020	6:00:00 PM	43	2.2
11/03/2020	6:06:00 PM	44	0.1
11/03/2020	6:12:30 PM	45	3.5
11/03/2020	6:18:00 PM	46	1.8
11/03/2020	6:30:00 PM	47	3.6
11/03/2020	6:33:00 PM	48	1.1
11/03/2020	6:41:30 PM	49	0.1
11/03/2020	6:48:00 PM	50	0.8

Predicted Flood Level Reading vs Actual Flood Level Reading

Date	Trial	Flood Level (ft)	
		Actual	Predicted
03/12/2020	1	0.2	0.622
03/12/2020	2	1.6	1.832
03/12/2020	3	3.1	3.033
03/12/2020	4	3.6	3.655
03/12/2020	5	4.1	3.944
03/12/2020	6	1.3	1.523
03/12/2020	7	4.3	4.865
03/12/2020	8	2.7	2.146
03/12/2020	9	3.4	2.734
03/12/2020	10	4	3.959

APPENDIX C

Bills of Materials

Bills of Materials

ITEM	QTY	PRICE (Php)	TOTAL (Php)
Lead Acid Battery	2	1,800	3,600
Flood Light	1	270	270
Solar Panel	1	2,800	2,800
Charge Controller	1	520	520
Wire	5 meters	33	165
Rain Gauge	1	15,000	15,000
L-Bars	4	54	216
Epoxy	1	199	199
Metal Cage for Chassis	1	1,208	1,208
Raspberry Pi B	1	2,299	2,299
Arduino Uno	1	229	229
Cat 5E	8 meters	35	280
TOTAL			**Php 26,786**

APPENDIX D

Source Codes

MOBILE APPLICATION (ANDROID)

```
package com.example.snapflood;

import android.content.Intent;
import android.net.Uri;
import android.os.Bundle;

import androidx.core.view.GravityCompat;
import androidx.appcompat.app.ActionBarDrawerToggle;

import android.util.Log;
import android.view.MenuItem;

import com.google.android.material.navigation.NavigationView;

import androidx.drawerlayout.widget.DrawerLayout;

import androidx.appcompat.app.AppCompatActivity;
import androidx.appcompat.widget.Toolbar;

import android.view.Menu;
import android.view.View;
import android.widget.Button;

public class MainActivity extends AppCompatActivity
    implements NavigationView.OnNavigationItemSelectedListener,
parameter.OnFragmentInteractionListener, specie.OnFragmentInteractionListener,
overview.OnFragmentInteractionListener {

  private static final String TAG = "MainActivity";

  @Override
  protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);
    Log.d(TAG, "onCreate: Starting.");

    Button mButton = findViewById(R.id.rainview);

    mButton.setOnClickListener(new View.OnClickListener() {
      @Override
      public void onClick(View view) {
        Log.d(TAG, "onClick: Clicked mbutton.");

        Intent intent = new Intent(MainActivity.this, FloodLevel.class);
        startActivity(intent);
```

```
            }
        });

        Button nButton = findViewById(R.id.parameters);

        nButton.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {
                Log.d(TAG, "onClick: Clicked nbutton.");

                Intent intent = new Intent(MainActivity.this, Param.class);
                startActivity(intent);
            }
        });

        Toolbar toolbar = findViewById(R.id.toolbar);
        setSupportActionBar(toolbar);

        DrawerLayout drawer = findViewById(R.id.drawer_layout);
        NavigationView navigationView = findViewById(R.id.nav_view);
        ActionBarDrawerToggle toggle = new ActionBarDrawerToggle(
                this, drawer, toolbar, R.string.navigation_drawer_open,
R.string.navigation_drawer_close);
        drawer.addDrawerListener(toggle);
        toggle.syncState();
        navigationView.setNavigationItemSelectedListener(this);

    }

    public void setActionBarTitle(String title) {
        getSupportActionBar().setTitle(title);
    }

    @Override
    public void onBackPressed() {
        DrawerLayout drawer = findViewById(R.id.drawer_layout);
        if (drawer.isDrawerOpen(GravityCompat.START)) {
            drawer.closeDrawer(GravityCompat.START);
        } else {
            super.onBackPressed();
        }
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is present.
```

```
        getMenuInflater().inflate(R.menu.main, menu);
        return true;
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {
        // Handle action bar item clicks here. The action bar will
        // automatically handle clicks on the Home/Up button, so long
        // as you specify a parent activity in AndroidManifest.xml.
        int id = item.getItemId();

        //noinspection SimplifiableIfStatement
        if (id == R.id.action_settings) {
            return true;
        }

        return super.onOptionsItemSelected(item);
    }

    @SuppressWarnings("StatementWithEmptyBody")
    @Override
    public boolean onNavigationItemSelected(MenuItem item) {
        // Handle navigation view item clicks here.
        int id = item.getItemId();

        if (id == R.id.nav_controls) {
            Intent i = new Intent(MainActivity.this, Control.class);
            startActivity(i);
            // Handle the camera action
        } else if (id == R.id.nav_feeder) {
            Intent i = new Intent(MainActivity.this, Feed.class);
            startActivity(i);
        } else if (id == R.id.nav_records) {
            Intent i = new Intent(MainActivity.this, Record.class);
            startActivity(i);
        } else if (id == R.id.nav_about) {
            Intent i = new Intent(MainActivity.this, About.class);
            startActivity(i);

        } else if (id == R.id.nav_developers) {
            Intent i = new Intent(MainActivity.this, Developers.class);
            startActivity(i);
        }

        DrawerLayout drawer = findViewById(R.id.drawer_layout);
        drawer.closeDrawer(GravityCompat.START);
```

```
        return true;
    }

    @Override
    public void onFragmentInteraction(Uri uri) {

    }

}

package com.example.snapflood;

import android.annotation.TargetApi;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.TextView;

import androidx.annotation.NonNull;
import androidx.annotation.Nullable;
import androidx.appcompat.app.AppCompatActivity;

import com.google.firebase.database.DataSnapshot;
import com.google.firebase.database.DatabaseError;
import com.google.firebase.database.DatabaseReference;
import com.google.firebase.database.FirebaseDatabase;
import com.google.firebase.database.ValueEventListener;

import java.text.DateFormat;
import java.text.SimpleDateFormat;
import java.util.Calendar;
import java.util.Objects;

public class FloodLevel extends AppCompatActivity {
TextView a,b;
Button show;
DatabaseReference ref;

    @Override
    protected void onCreate(@Nullable Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_flood_level);

        a = (TextView)findViewById(R.id.floodview);
        b = (TextView)findViewById(R.id.colorview);
        show = (Button)findViewById(R.id.show);
```

```
        show.setOnClickListener(new View.OnClickListener() {
            @TargetApi(19)
            @Override
            public void onClick(View view) {
                ref = FirebaseDatabase.getInstance().getReference().child("data");
                ref.addValueEventListener(new ValueEventListener() {
                    @Override
                    public void onDataChange(@NonNull DataSnapshot dataSnapshot) {
                        String                                    floodlevel                                    =
Objects.requireNonNull(dataSnapshot.child("floodlevel").getValue()).toString();
                        String                                    warning                                    =
Objects.requireNonNull(dataSnapshot.child("warning").getValue()).toString();
                        a.setText(floodlevel);
                        b.setText(warning);

                    }

                    @Override
                    public void onCancelled(@NonNull DatabaseError databaseError) {

                    }
                });
            }
        });

        Calendar calendar = Calendar.getInstance();
        SimpleDateFormat time = new SimpleDateFormat("h:mm a");
        String                                    currentDate                                    =
DateFormat.getDateInstance(DateFormat.FULL).format(calendar.getTime());
        String currentTime = time.format(calendar.getTime());

        TextView textViewDate =(TextView) findViewById(R.id.date_id);
        textViewDate.setText(currentDate);
        TextView textViewTime =(TextView) findViewById(R.id.time_id);
        textViewTime.setText(currentTime);

    }
}
```

PYTHON PROGRAM FOR IMAGE PROCESSING AND FLOOD PREDICTION

```
#Operating System of Raspberry Pi 3: Raspbian Stretch
#Modules installed from the terminal:
#1.) OpenCV 3.0
#2.) Numpy
#3.)Pyrebase

#Installing OpenCV 3.0

$ sudo raspi-config
#Select “Advanced Options” >> “Expand filesystem”

$ sudo reboot
#Restarts the Raspberry Pi

$ sudo apt-get purge wolfram-engine
$ sudo apt-get purge libreoffice*
$ sudo apt-get clean
$ sudo apt-get autoremove
#Reclaims almost 1GB of memory from SD card

$ sudo apt-get update && sudo apt-get upgrade
#Updates and upgrades any existing packages

$ sudo apt-get install build-essential cmake pkg-config
#Installs some developer tools including CMake

$ sudo apt-get install libjpeg-dev libtiff5-dev libjasper-dev libpng12-dev
#Installs some image I/O packages

$ sudo apt-get install libavcodec-dev libavformat-dev libswscale-dev libv4l-dev
$ sudo apt-get install libxvidcore-dev libx264-dev
#Installs some video I/O packages

$ sudo apt-get install libgtk2.0-dev libgtk-3-dev
#Installs the GTK development library for compiling the highgui module

$ sudo apt-get install libatlas-base-dev gfortran
#Installs extra dependencies for matrix operations

$ sudo apt-get install python3-dev
#Installs python


$ cd ~
$ wget -O opencv.zip
```

https://github.com/Itseez/opencv/archive/3.3.0.zip
$ unzip opencv.zip
#Downloads the OpenCV source code and grabs the opencv repository

$ wget -O opencv_contrib.zip
https://github.com/Itseez/opencv_contrib/archive/3.3.0.zip
$ unzip opencv_contrib.zip
#Grabs the opencv_contrib repository

$ wget https://bootstrap.pypa.io/get-pip.py
$ sudo python get-pip.py
$ sudo python3 get-pip.py
#Installs *pip* which is a Python package manager

$ sudo pip install virtualenv virtualenvwrapper
$ sudo rm –rf ~/.cache/pip
#Installs a virtual environment for Python

export WORKON_HOME=$HOME/.virtualenvs
export VIRTUALENVWRAPPER_PYTHON=/usr/bin/python3
source /usr/local/bin/virtualenvwrapper.sh

$echo –e "\n# virtualenv and virtualenvwrapper" >> ~/.profile
$echo "export WORKON_HOME=$HOME/.virtualenvs" >> ~/.profile
$echo "export VIRTUALENVWRAPPER_PYTHON=/usr/bin/python3" >> ~/.profile
$echo "source /usr/local/bin/virtualenvwrapper.sh" >> ~/.profile
#Updates the ~/.profile directory

source ~/.profile

$ mkvirtualenv cv –p python3
#Creates a new Python virtual environment using Python 3

$ source ~/.profile
$workon cv
#Checks if the user is in the "cv" virtual environment

$pip install numpy

```python
import cv2
import numpy as np
import pyrebase
from pylab import array, arange, uint8

#Region of Interest
```

```
if __name__ == '__main__' :

 img = cv2.imread('test.jpg')
 r = cv2.selectROI(img)
 imgCrop = img[500:900, 300:700];
 cv2.imshow('ROI', imgCrop)

#Brightness and Contrast

gray = cv2.cvtColor(imgCrop, cv2.COLOR_BGR2GRAY)
maxIntensity = 255.0
x = arange(maxIntensity)
phi = 1
theta = 1
newImage0 = (maxIntensity/phi)*(gray/(maxIntensity/theta))**0.5
newImage0 = array(newImage0, dtype=uint8)

#cv2.imshow('newImage0', newImage0)

y = (maxIntensity/phi)*(x/(maxIntensity/theta))**0.5

newImage1 = (maxIntensity/phi)*(gray/(maxIntensity/theta))**2
newImage1 = array(newImage1, dtype=uint8)

#cv2.imshow('newImage1', newImage1)

z = (maxIntensity/phi)*(x/(maxIntensity/theta))**2

#Image Segmentation using Otsu's Method
ret,thr = cv2.threshold(newImage0, 0, 255, cv2.THRESH_OTSU)
#cv2.imshow('newImage2', thr)

#Canny Edge detection

edges = cv2.Canny(thr, 50, 150, apertureSize = 3, L2gradient=True)
#cv2.imshow('newImage3', edges)

#Hough Line Transform

lines = cv2.HoughLines(edges,1,np.pi/180,5)
for rho,theta in lines[0]:
    a = np.cos(theta)
    b = np.sin(theta)
    x0 = a*rho
    y0 = b*rho
    x1 = int(x0 + 1000*(-b))
```

```
    y1 = int(y0 + 1000*(a))
    x2 = int(x0 - 1000*(-b))
    y2 = int(y0 - 1000*(a))

    cv2.line(imgCrop,(x1,y1),(x2,y2),(255,0,0),2)
    cv2.imshow('newImage4', imgCrop)
#print(lines.shape)
#print(imgCrop.shape)
img_height = imgCrop.shape[0]
H = lines.shape[0]
x = H/2800
#flood_level = img_height - height
#print(flood_level)
height = round(x, 3)
print("The Flood level is:", height, "feet")
cv2.waitKey(0)
cv2.destroyAllWindows()


#Predictive model using multiple linear regression

import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import numpy as ro

#Gather dataset and declare dependent and independent variables
df = pd.read_csv("dataset.csv")
X = df.iloc[:, :-1]
Y = df.iloc[:, 2]

#Testing
from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.2, random_state =
0)

#Creating the Model
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, Y_train)

#Prediction of Flood Level
Y_pred = regressor.predict(X_test)

#Good or Bad Model
from sklearn.metrics import r2_score
```

```
score = r2_score(Y_test, Y_pred)

Y_pred = ro.round(Y_pred, 3)
Y_pred = pd.Series(Y_pred)
```

Arduino code:

```
#include <TimerOne.h>
int pulse = 0;
int flowmeter = 2;
volatile int flow_frequency;
volatile int reed = 3;
unsigned int j;
unsigned int led = 6;
unsigned int mm;
unsigned int minute;
unsigned long time;


void setup() {
  Serial.begin(9600);
  pinMode(reed, INPUT);
  pinMode(led, INPUT);
  pinMode(flowmeter, INPUT);
  digitalWrite(flowmeter, HIGH);
  //Timer1.initialize(1000000);
  //Timer1.attachInterrupt(RainGauge);
  attachInterrupt(digitalPinToInterrupt(pulse), flow, RISING);

}

void loop() {
  time = millis();
  minute = (flow_frequency * 3600 / 7.5); // (Pulse frequency x 60 min) / 7.5Q = flowrate
  flow_frequency = 0; // Reset Counter
  Serial.print(minute, DEC);
  Serial.println(" L/min");
  Serial.print("\t");
  delay(5000);

 if(digitalRead(led) == HIGH)
  {
   Serial.print("Flood is occuring");
  }
  else{
   Serial.print("There is no flood");
   }
```

```
  Serial.print("        ");
delay(10000);
```

APPENDIX E

System User Manual

USER MANUAL

SNAP*FLOOD*:

SMART FLOOD DETECTION, ALARM, AND MONITORING SYSTEM USING IMAGE PROCESSING

USER MANUAL

SNAP*FLOOD*:

SMART FLOOD DETECTION, ALARM, AND MONITORING SYSTEM USING IMAGE PROCESSING

© SnapFlood

SnapFlood is a device to detect flood 3 hours early before it occurs. It comes with an android mobile application where you can see the flood level and the other parameters that contributes to the level of the flood such as the precipitation rate and flow rate. A siren is also used as an additional notification when the flood reaches a certain flood marker level.

Through SnapFlood, the residents won't have to settle with the conventional way of detecting flood and notifying people.

SnapFlood
Ayala Blvd, Ermita,
Manila, 1000 Metro
Manila

SAFETY PRECAUTIONS

1. To avoid injuries or accidents, please refer to the instructions.

2. The wirings of the device are sealed with pvc hose. Make sure that it is far from water when fixing or checking the wires to prevent electrocution.

3. Do not drop the device especially the chassis where the main circuitry are placed as it will cause malfunction to the whole system.

A.

SETTING UP THE DEVICE

1. Attach the float switch to the flood marker. The float switch must be placed near the ground.

2. Place the flood marker 90 degrees perpendicular to the ground. Make sure that the pole is properly mounted.

3. We have two boxes. The first box includes Arduino, Raspberry Pi, and Solar charge controller. Place it at least four (4) feet above the ground and four (4) feet away from the flood marker. The second box includes batteries used in the system. We advise to place it next to the first box.

4. Install a pole for rain gauge and solar panel. Place it at least 6 feet above the ground.

5. Secure the wiring connections of the devices. The wires should be placed somewhere that is not accessible to people to prevent damage of the devices.

B.

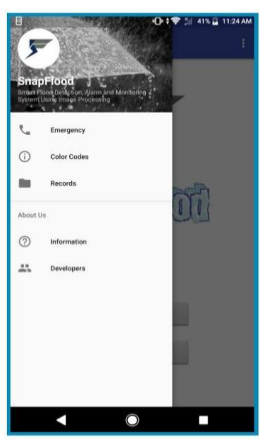
USING THE MOBILE APPLICATION

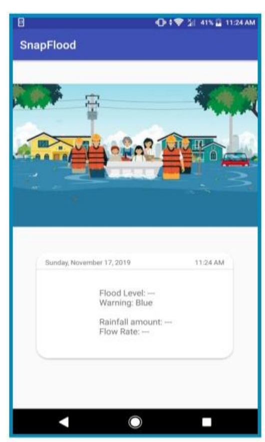
1. Install the application "Snapflood"

2. After installing, open the application. You will see the home screen with two buttons: flood level and the parameters.

3. Navigate to the menu. The emergency, rain advisory colour coding, records, information are there.

4. To view the current level of the flood with it the other parameters, click Parameters from the home screen.





MAINTENANCE SECTION

Perform this basic troubleshooting first if you are experiencing any problem with the system.

1. Make sure that the devices connected to the solar charge controller are: solar panel, battery, and the loads that are connected to the battery.

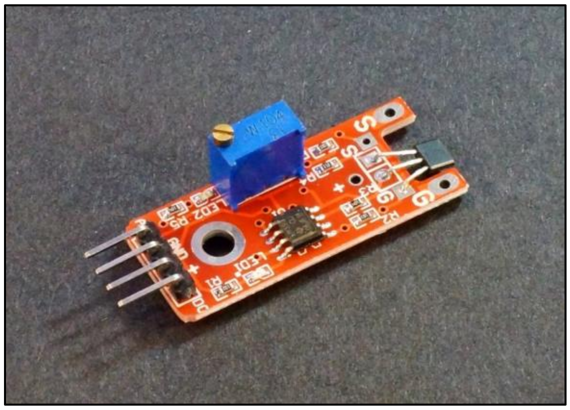
2. The devices that must be connected to the Arduino are: ***float switch, rain gauge, and flow rate meter.***

3. Check if the Arduino and siren are connected to the raspberry pi.

APPENDIX F

Specifications

LINEAR HALL EFFECT SENSOR MODULE



Specifications:

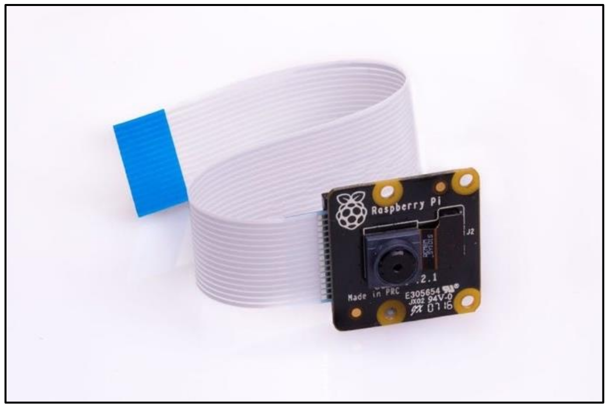
- Uses 49E analog Hall Effect sensor
- Can differentiate between North and South pole of the magnet
- Detects the relative strength of the magnetic field
- Provides analog output representative of relative magnetic strength
- Provides digital output when magnetic strength exceeds the adjustable set-point
- Module Connections
    - There is a 4-pin header on the module for making connections.
    - **1 x 4 Header**
    - **GND / G** = Ground
    - **'+'** = Vcc (3.3 – 5V)
    - **A0 =** Analog output, connects to analog input on uC
    - **D0** = Digital output, connects to digital input on uC

RAINEW 111 Tipping Bucket Wired Rain Gauge

Specifications:

- Self-emptying
- 60 feet of cable included
- Single Display
- Meets NWS Specifications

RASPBERRY PI NOIR CAMERA V2



Specifications:

- 8-megapixel camera capable of taking infrared photographs of 3280 x 2464 pixels
- Capture video at 1080p30, 720p60 and 640x480p90 resolutions
- All software is supported within the latest version of Raspbian Operating System
- Applications: Infrared photography, low light photography, monitoring plant growth, CCTV security camera

RASPBERRY PI 3 MODEL B+

Specifications:

- 1.2GHz 64-bit quad-core ARMv8 CPU, 1 GB RAM
- 802.11n wireless LAN, 10/100Mbps lan speed, Upgraded switched Micro USB power source up to 2.5A
- Bluetooth 4.1, Bluetooth low energy
- 4 USB ports, 40 GPIO pins, full HDMI port, combined 3.5mm audio jack and composite video
- Camera interface (CSI), Display interface (DSI), Micro SD card slot (now push-pull rather than push-push), Video Core IV 3D graphics core

80W SOLAR PANEL

Specifications:

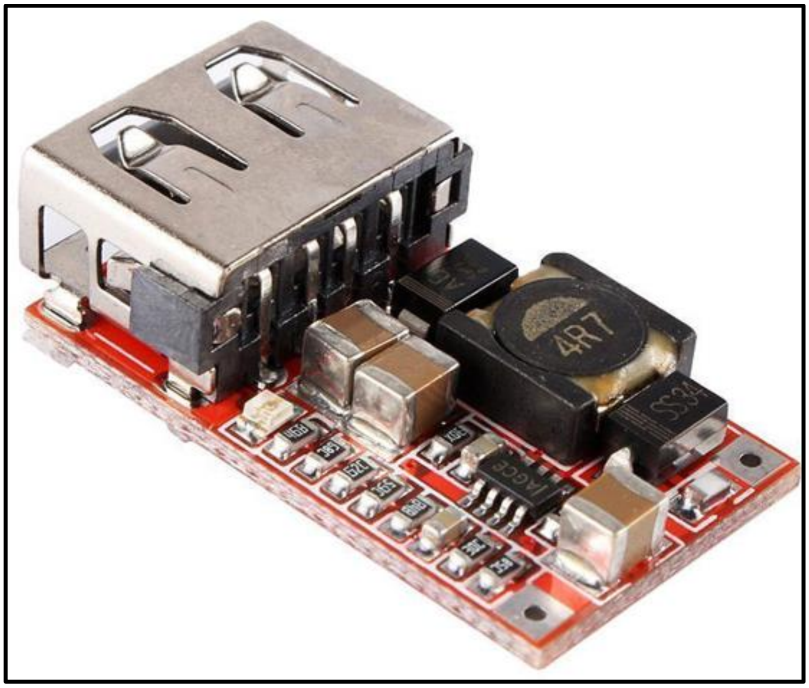
- Type: Mono Crystalline
- Wattage: 80W 12V
- VOC: 21.8V
- IMP: 5.10A
- Weather Proof Tempered glass
- Aluminum frame

SOLAR CHARGE CONTROLLER

Specifications:

- DC12V/ DC24V Auto-Switching
- Smart CPU Design
- Photo Sensor
- With Timer
- Over charging Sensor
- Low Battery Sensor

6-24V TO 5V 3A USB DC-DC BUCK STEP-DOWN CONVERTER

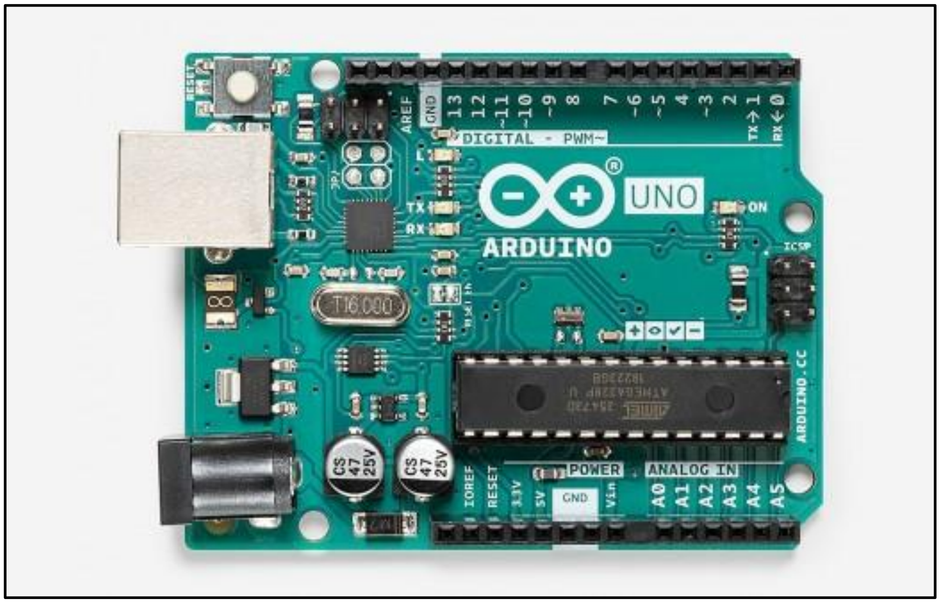


Specifications:

- Small size, 26.4 (L) * 15 (W) * 7.4 (H) mm
- Input with reverse polarity protection diode, will not damage when input connect incorrect
- Ultra-low static current, 0.85 mA only.
- Module Properties: non-isolated buck module (BUCK) synchronous rectification
- Input voltage: DC 6-24V Output voltage: 5.1-5.2V
- Output current: 3A MAX (please enhance heat dissipation when full load using), the actual test result input 12V output current 2A do not need to enhance heat dissipation.

- Conversion efficiency: can up to 97.5% (6.5V step down to 5V 0.7A) (after short reverse protection and fuses test value)
- Switch frequency: 500KHz
- Output ripple: 10mV around (12V to 5V3A) 20M bandwidth
- Output indicator: Output voltage indicator is red
- Operating temperature: Industrial grade (-40 ℃ to + 85 ℃) (the higher the ambient temperature, the lower the output power)
- Output over-voltage protection: Yes, input 1.5A fuse, output 5V have 300W TVS tube clamp protection.
- Full load temperature: 30 ℃
- Static current: 0.85 mA
- Load regulation: ± 1%
- Voltage Regulation: ± 0.5%
- Dynamic response speed: 5% 200uS
- Output short circuit protection: Yes, but please do not short circuit for a long time
- Input reverse polarity protection: Yes, there is reverse polarity protection diode
- Output mode: USB

ARDUINO UNO



Specifications:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins: 6
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328P)

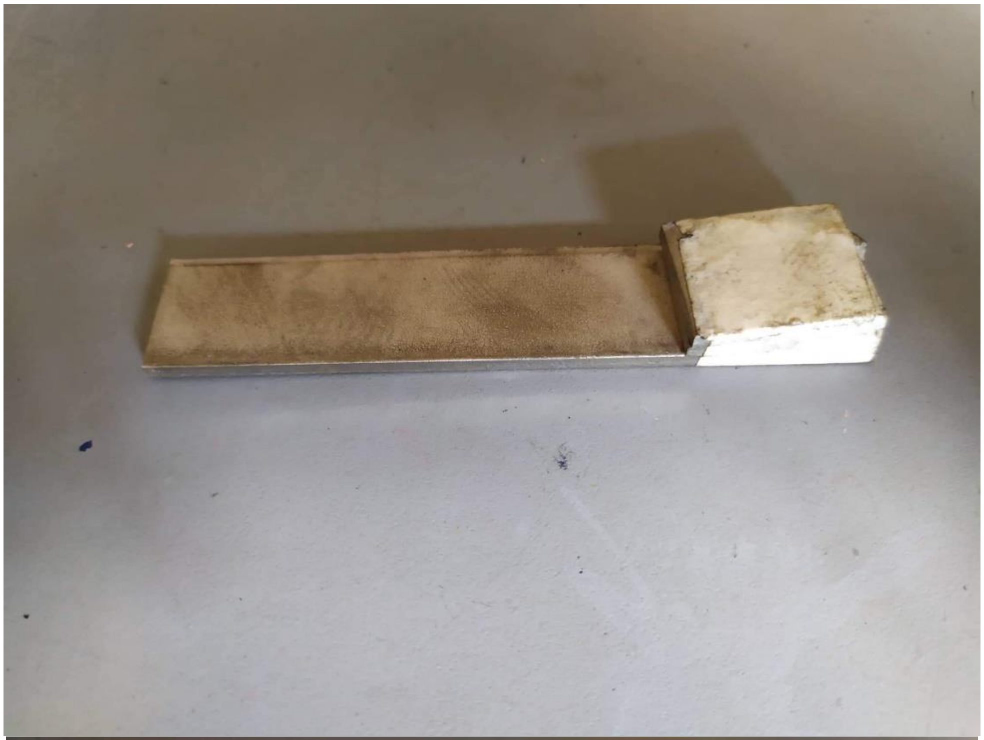
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz
- LED_BUILTIN: 13
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

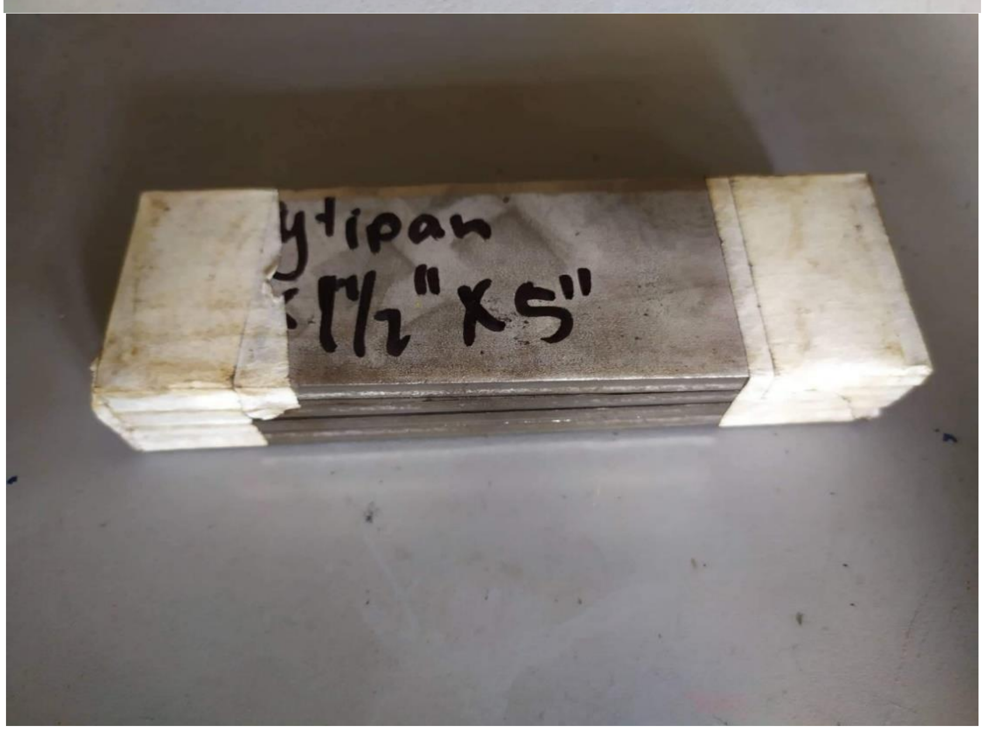
APPENDIX G

Project Documentation

MATERIALS


Raspberry Pi 3
Model B+
Raspberry Pi
Pi NoIR Camera V2
UNO
ARDUINO

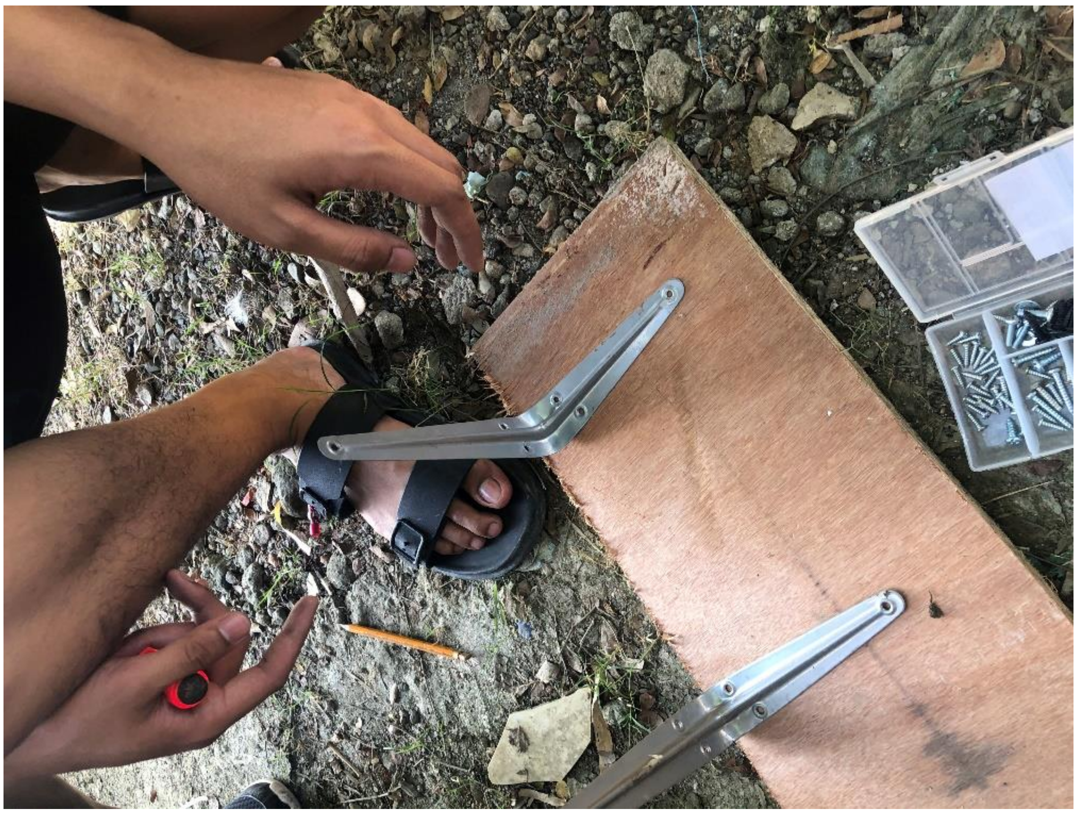



ytipan
1½" X 5"


RainWise® Inc.
0
Hundredths

TESTING AND ASSEMBLY

INSTALLING



DEFENSES AND OTHER DOCUMENTATIONS


Search
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ECE ONLINE SYMPOSIUM 2020
Rochelynne Baron
Jay Fel Quijano
John Bryan Fronda
Ira Valenzuela
Dave Carlo de Guzman
Jose Miguel Aliswag
Lean Karlo Tolentino
Celestine Antonette Blaza
Regina Valeriano
03:10:18
4:29 PM
7/28/2020

APPENDIX H
Proponent's Profile Layout

JOSE MIGUEL D. ALISWAG,

PROFILE

BIRTHDATE: SEPTEMBER 15, 1998
AGE: 21 YEARS OLD
GENDER: Male
RELIGION: ROMAN CATHOLIC
CIVIL STATUS: SINGLE
CITIZENSHIP: FILIPINO

EDUCATION

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd., Ermita, Manila
AY 2014-2020
BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING

NEWVILLE HEIGHTS ACADEMY
Bacoor City, Cavite
AY 2010-2014

YOUNG SHEPHERD'S SCHOOL
Bacoor City, Cavite
AY 2004-2010

CONTACT ME

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ORGANIZATIONS AFFILIATED

INSTITUTE OF ELECTRONICS ENGINEERS OF THE PHILIPPINES
(IECEP-MANILA STUDENT CHAPTER) - MEMBER (2016-2019)

ORGANIZATION OF ELECTRONICS ENGINEERING STUDENTS
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA – MEMBER (2014-2019)

SKILLS

- PYTHON PROGRAMMING
- CASCADING STYLE SHEETS
- BASIC LINUX
- HYPERTEXT MARKUP LANGUAGE
- IP ADDRESSING AND SUBNETTING

SEMINARS ATTENDED

BRODKAST NG TALINO 2019 EST TALK 101: FUTURE OF PHILIPPINE BROADCASTING AND TELECOMMUNICATIONS INDUSTRY
Technological University of the Philippines, Manila
February 8, 2019

TRENDS Technical Seminar (Topics in Research, Electronics, Networking and Data Science)
Technological University of the Philippines, Manila
July 30, 2018

WORK EXPERIENCE

ASERCO - ALABANG
ON-THE-JOB TRAINEE
Alabang, Muntinlupa City
January 2020 – March 2020

In the span of 3 months, my critical way of thinking improved because of the daily experience of troubleshooting devices.

CHARACTER REFERENCE

ENGR. LEAN KARLO S. TOLENTINO
Director
University Extension Service
P.O. Box 3171 Ayala Boulevard cor. San Marcelino St Ermita Manila, 1000
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leankarlo_tolentino@tup.edu.ph

JOSE MIGUEL D. ALIWAG
APPLICANT

ROCHELYNNE E. BARON

PROFILE

BIRTHDATE: APRIL 4, 1999
AGE: 21 YEARS OLD
GENDER: FEMALE
RELIGION: ROMAN CATHOLIC
CIVIL STATUS: SINGLE
CITIZENSHIP: FILIPINO

EDUCATION

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
Ayala Blvd. Ermita, Manila

AY 2014-2020
BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING

CALOOCAN HIGH SCHOOL
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AY 2010-2014

GRACE PARK ELEMENTARY SCHOOL MAIN
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AY 2004-2010

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ORGANIZATION OF ELECTRONICS ENGINEERING STUDENTS
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA – MEMBER (2014-2019), SCHOLASTIC COMMITTEE HEAD (2017-2018)

SKILLS

CIRCUIT TROUBLESHOOTING

MS OFFICE

MATLAB

AUTODESK AUTOCAD CERTIFIED USER

SEMINARS ATTENDED

ACROSS BORDERS: Electronics Engineering in the Philippines and the ASEAN Economic Community
National University, Manila
November 24, 2018

TRENDS Technical Seminar (Topics in Research, Electronics, Networking and Data Science)
Technological University of the Philippines, Manila
July 30, 2018

WORK EXPERIENCE

CULTURAL CENTER OF THE PHILIPPINES
PART-TIME USHERETTE
CCP Complex, Roxas Boulevard, Pasay City, 1300, Metro Manila
(August 2019- February 2020)

Assigned as part of the Ushering Service Team.

Where we are tasked to:
1. Collect admission tickets and passes from patrons.
2. Usher theater patrons to their designated seats.
3. Ensure the safety, welfare and convenience of theater patrons during the show.

CHARACTER REFERENCE

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Director
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leankarlo_tolentino@tup.edu.ph

ENGR. YUGEL RUDOLF ALBA
Technological University of the Philippines- Manila
09274019066

ROCHELYNNE E. BARON
APPLICANT

CELESTINE ANTOINETTE C. BLACER, ECT

PROFILE

BIRTHDATE: FEBRUARY 8, 1998
AGE: 21 YEARS OLD
GENDER: FEMALE
RELIGION: ROMAN CATHOLIC
CIVIL STATUS: SINGLE
CITIZENSHIP: FILIPINO

EDUCATION

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
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ORGANIZATIONS AFFILIATED

TUP – UNIVERSITY STUDENT GOVERNMENT PHILIPPINES
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA
- SENATOR & HEAD, STUDENTS' RIGHTS AND WELFARE (2016-2017)

ORGANIZATION OF ELECTRONICS ENGINEERING STUDENTS
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA
– MEMBER (2014-2019)

SKILLS

CIRCUIT TROUBLESHOOTING
C++
PYTHON PROGRAMMING
MATLAB
NETWORK APPLICATIONS

SEMINARS ATTENDED

BRODKAST NG TALINO 2019 EST TALK 101: FUTURE OF PHILIPPINE BROADCASTING AND TELECOMMUNICATIONS INDUSTRY
Technological University of the Philippines, Manila
February 8, 2019

TRENDS Technical Seminar (Topics in Research, Electronics, Networking and Data Science)
Technological University of the Philippines, Manila
July 30, 2018

WORK EXPERIENCE

SPi GLOBAL TECHNOLOGIES
DATABASE SUPPORT ASSOCIATE

January 2019 – January 2020

Responsibilities: Provided technical support and maintenance on existing business systems for issues encountered by clients. Compiled the monthly accomplishment of the team.

CHARACTER REFERENCE

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CELESTINE ANTOINETTE C. BLACER
APPLICANT

DAVE CARLO E. DE GUZMAN

PROFILE

BIRTHDATE: JUNE 20, 1997
AGE: 23 YEARS OLD
GENDER: MALE
RELIGION: PROTESTANT
CIVIL STATUS: SINGLE
CITIZENSHIP: FILIPINO

EDUCATION

TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES
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AY 2017-present
BACHELOR OF SCIENCE IN ELECTRONICS ENGINEERING

AY 2014-2017
BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATIONS ENGINEERING TECHNOLOGY

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Silang, Cavite
AY 2010-2014

MALABAG ELEMENTARY SCHOOL
Silang, Cavite
AY 2004-2010

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(IECEP-MANILA STUDENT CHAPTER) - MEMBER (2017-PRESENT)

ORGANIZATION OF ELECTRONICS ENGINEERING STUDENTS
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA – MEMBER (2017-PRESENT)

SKILLS

CIRCUIT TROUBLESHOOTING
MultiSim
LABVIEW
MATLAB
NETWORK APPLICATIONS

SEMINARS ATTENDED

BRODKAST NG TALINO 2019 EST TALK 101: FUTURE OF PHILIPPINE BROADCASTING AND TELECOMMUNICATIONS INDUSTRY
Technological University of the Philippines, Manila
February 8, 2019

TRENDS Technical Seminar (Topics in Research, Electronics, Networking and Data Science)
Technological University of the Philippines, Manila
July 30, 2018

WORK EXPERIENCE

ASERCO - MAKATI
ON-THE-JOB TRAINEE
Makati City
March 2019 – January 2020

CHARACTER REFERENCE

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University Extension Service
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ORGANIZATION OF ELECTRONICS ENGINEERING STUDENTS
TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, MANILA – MEMBER (2016-2020)

SKILLS

CIRCUIT TROUBLESHOOTING
MS OFFICE
MultiSim
LABVIEW
MATLAB

SEMINARS ATTENDED

APPRECIATE: Annual Presentation of Project in Electromechanical, Civil, Information and Telecommunications Engineering 2019 – "Shaping the World's Future through Engineering Innovations"
Technological University of the Philippines, Manila
February 23, 2019

ACROSS BORDERS: "Electronics Engineering in the Philippines and the ASEAN Economic Community"
National University
November 2018

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ELECTRONICS AND COMMUNICATIONS ENGINEERING TECHNOLOGY

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CIRCUIT TROUBLESHOOTING

MS OFFICE

COMPUTER LITERACY

SEMINARS ATTENDED

BRODKAST NG TALINO 2019 EST TALK 101: FUTURE OF PHILIPPINE BROADCASTING AND TELECOMMUNICATIONS INDUSTRY
Technological University of the Philippines, Manila
February 8, 2019

TRENDS Technical Seminar (Topics in Research, Electronics, Networking and Data Science)
Technological University of the Philippines, Manila
July 30, 2018

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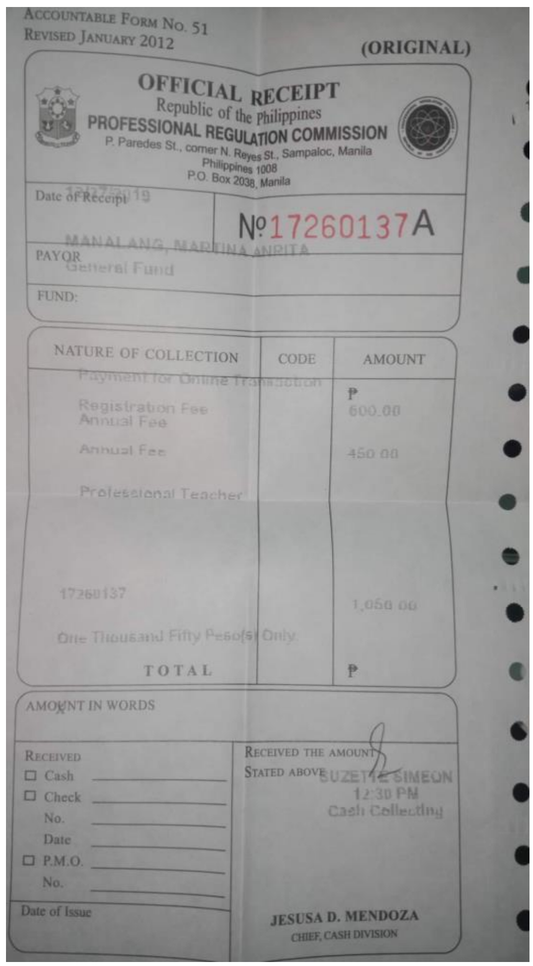

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