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Remote Operation of Pumping Station for Trash and Flood Monitoring

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Abstract: Flooding has always been a major problem in our country and many factors can affect this situation. One of these factors is that the water from *esteros* are so high and stagnant that water from our drainage systems cannot flow properly out of the city.

This study aims to emulate an actual pumping station which is modeled based on the Libertad Pumping Station that covers the Pasay and Makati areas. However, in this study, the pumping station prototype can be manually, remotely, and automatically operated as opposed to the current setup of manual operation. Heavy rains and calamities prohibit MMDA personnel to report for duty because of safety and security measures or their family and belongings are also affected. Thus, by remotely operating the pumping station, through an Android application, the pump's full capacity is still maintained even when heavy rains are experienced and no personnel has reported for duty. In addition, the trash rakes can also be operated manually and remotely. The speed of the trash rakes can be varied depending on the amount of garbage present in the pumping station. The amount of garbage is also video-streamed to the android phone.

With the pump rate at its full working capacity, flood and water levels of certain areas can be forecasted through the rainfall amount, land area and the number of pumps operating. The website, babahaba.com, shows the flood forecast for certain places in Makati and Pasay. It can also show the forecast the time which the flood will subside.

Key Words: flood monitoring; android application; babahaba.com

1. INTRODUCTION

Flood is the body of water's rising and overflowing onto the land that is normally dry. According to Philippine Atmospheric, Geophysical & Astronomical Services Administration (PAGASA) floods can be artificial or natural. It is a natural hydrological phenomenon that is caused by prolonged and intense rainfalls and storm surges that affects the coastal and estuarine water levels. It is also caused by seismic activities like tsunamis and earthquakes.

According to Paulo Alcazaren of the Philippine Star, "It floods because it rains; the rains and the typhoons that bring them have increased in magnitude." Because of the climate change, typhoon paths became unpredictable. "It floods because we have less drainage than before." According to the reports half of our metropolitan esteros and canals are lost.

Flooding in the Metro Manila can be solved but will take years to be implemented given the kind of infrastructure that has to be built, since flood ways and waterways must be fixed, rehabilatated or constructed. With his limitation, the existing flood control mechanisms like pumping stations must be developed to somehow make it more effective and efficient especially in times of typhoons or downpours.

In Metro Manila, pumping stations are used for flood control. Currently, there are 25 pumping stations and 11 of these are scheduled to be rehabilitated to enhance its pmping capacity and most especially because of how long it has been used. These stations are found in the following locations: (1) Libertad, (2) Quiapo, (3) Tripa De Galina, (4) Pandacan, (5) Valencia, (6) Binondo, (7) Aviles, (8) Paco, (9) Makati, (10) Balete and (11) Arroceros. As an example, to date the Libertad pumping station is already more than 30 years old. Nowadays, efficiency and the quickhess of how the flood rises are affected by the trashes found in the sewage and canals controlled by these pumping stations. For the Libertad Pumping Station, the efficiency of the

pumping station is decreased from 100% to 40% when the amount of trash in the pumping station is too much.

In this research, a proposed monitoring and control system for the rehabilitation project of the pumping stations is presented. Currently, pumping stations are controlled manually by a personnel situated in the station. But as natural disasters strike, the personnel at some point in time, fails to report to duty. As an enhancement, the pumping stations can be controlled automatically via an installed application in a smartphone, plus the data can be uploaded in the website www.babahaba.com.

2. METHODOLOGY

The research study is divided in three sections namely: (1) Prototype Construction, (2) Application Development and (3) Website Deloyment.

Figure 1 depicts the block diagram of the proposed monitoring and control system. The amount of rainfall is being transmitted by the Automated Rain Gauge (ARG) system of PAG-ASA while the MMDA APP will input the status of the pumps in the station. These data are called the Rainfall_Amount and PumpingStation_Status respectively. The MMDA app has a function to remotely control the stations. With remote control, the user can turn ON the pumping motors, thrash rake and station gates.

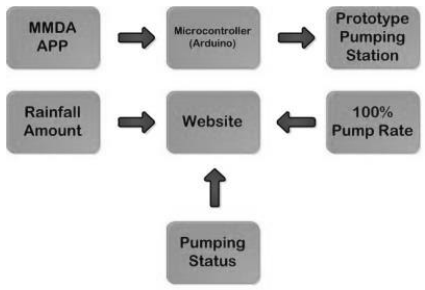
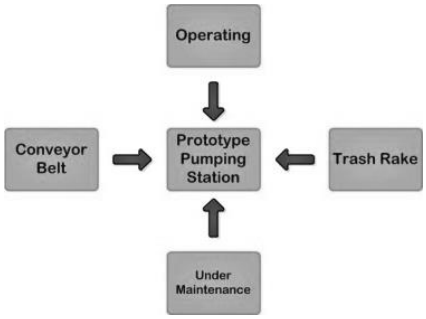


Figure 1: Basic Block Diagram

Within the website is a program that will monitor the flood. The website will use the rainfall amount, pumping status and the 100% pumping rate of the pumping station. A program will compute for the pumping duration of the pumping station hourly. The project will use surveillance camera video embedded in the MMDA App to monitor trash amount in the stations. In monitoring the trash, data will be captured by the camera and will be transmitted to the MMDA APP via Wireless Fidelity.

2.1. Prototype Construction

Figure 2 (a) shows the construction of a pumping station prototype while Figure 2 (b) depicts the actual pumping station prototype.



(a)

(b)

Figure 2: (a) Basic Input for Prototype Pumping Station (b) Actual Prototype Pumping Station

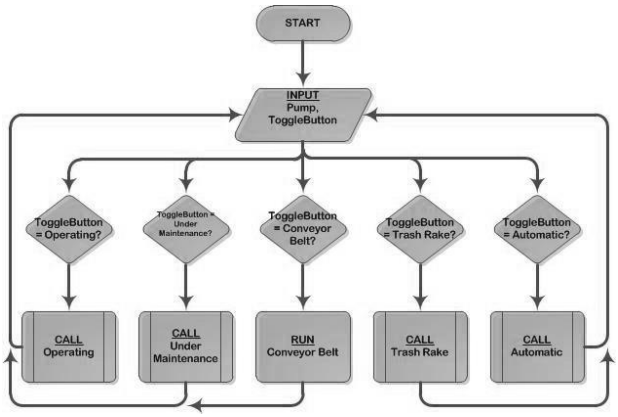
The prototype follows the actual Libertad station having six gates. As added features, each gate now has control pushbuttons. These are used to activate the eight basic operation of the prototype (Operating, Under Maintenance, Moving Conveyor Belt, Automatic Control, and Trash Rake speeds of 50%, 70%, 90%, and 100%). An LED indicator will light up depending on the active operation. An LCD allows the user to see the status of the pumping station aside from the LED indicator.

To achieve automatic control, a water level sensor is used. Readings are sent to an Aceduino

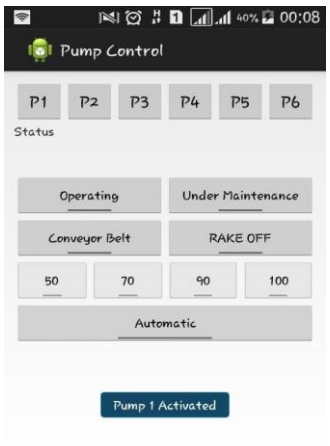
microcontroller that determines what specific actuation must be implemented.

2.2. Application Development

Figure 3 illustrates the basic algorithm for the MMDA application software in (a) and the screenshot of the actual developed MMDA application. The program will start with a Splash Screen and after five seconds, the main menu will show up in which you can go to the control or view the pumping station. The Android App communicates through the Arduino via internet using a router and an Ethernet shield. It is possible by using the HttpClient and HttpGet methods in Android Programming. The six buttons on top will determine which pump must be activated. The same operations of the pumping station are presented in the (b).



(a)



(b)

Figure 3: (a) Basic Algorithm for the MMDA App and (b) MMDA app for Pump Monitoring and Control

2.3. Website Deployment

The Home Page of the "babahaba.com", shown in Figure 4 below, lets you choose a location and answers the question "babaha ba?" The system replies with either "OO, BABAHA" or "HINDI BABAHA." The flood outlook is where you can see the predicted height of water. Flood Detail is where you can see the rainfall amount, the predicted time of flooding and the predicted time the flood will subside if flooding may occur. In this page, you can select an area to know the details of flooding.

Only an administration or an authorized personnel can modify the rainfall amount, number of pumps working, and sea level using the login page. This is where you can select which database do you want to update.

Figure 4: Real-time Flood Monitoring Website

3. RESULTS AND DISCUSSION

The prototype, application and website were tested by using tap water as representation of the water at the gates of the pumping station while trashes are ordinary school supplies. The application was loaded in one of the smartphones of the researchers.

3.1. Manual Operation of Pumping Station

Figure 5 shows the basic operation of the pumping station controlled manually. Testing the manual

controlling of the Pumping Station, the pushbuttons available in the controller itself was used. Controlling the system manually means that the person in charge in the pumping station will manually hit the button for the pumps, conveyor belt and trash rakes for it to run. The y-axis is the number of total trials for each manual operation. As seen in the figure, manual operation works 100% accurate.

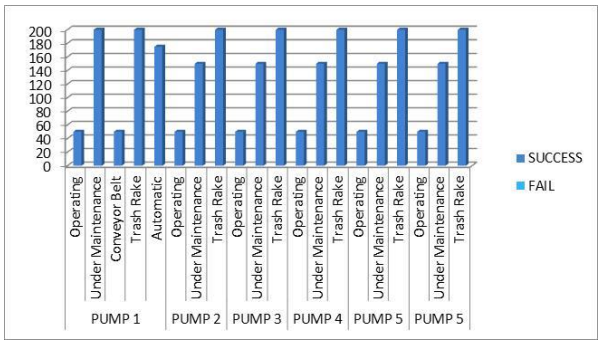


Figure 5. Manual Operation of Pumping Station

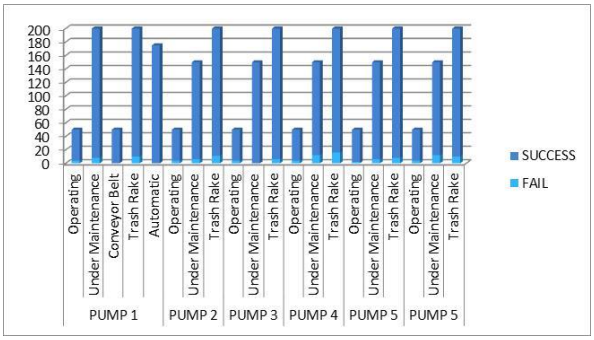


Figure 6. Remote Operation of Pumping Station

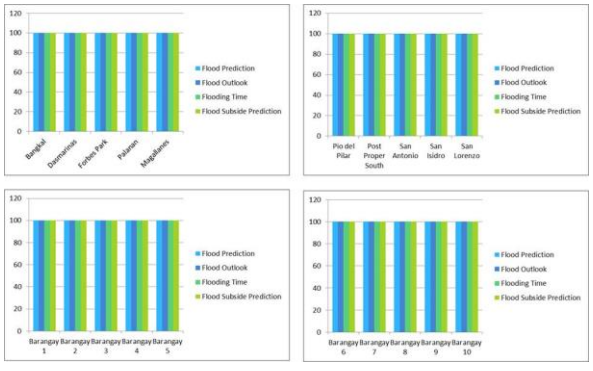


Figure 7. Website Data

3.2. Remote Operation of Pumping Station

On the other hand, Figure 6 illustrates the basic operation of the pumping station controlled remotely using the Android Application developed. Remotely operating the system requires that the officials of MMDA can control the pumping station even if they are not present onsite. Errors in the figure are described due to some internet connectivity problems encountered during testing and poor signal in the chosen location of testing.

3.3. Website

From Figure 7, four tests were made on the website. Each test has twenty trials. The first trial denotes the flood prediction. For all the twenty places covered by our system, it reflects 100% accuracy when reflecting the responses "OO, BABAHA" and "HINDI BABAHA".

The Flood Outlook test also reflects 100% accuracy when it reflects the level of flood. The Flooding Time also reflects 100% accuracy when determining the time it will start to flood. It also reflects a 100% accuracy when predicting the time that the flood will subside.

The testing was based on the actual rainfall of Typhoon Ondoy (Ketsana) and the data presented by PAG ASA's Project NOAH with their flood map that shows which areas were flooded during the said typhoon. Based on this, 80% accuracy has been obtained. There are four places that were tested that output "OO, BABAHA" but in the actual data, it didn't flood. This is due to the limited scopes of the study wherein there is also a need to consider other factors like the ground's permiability, etc.

4. CONCLUSION

In this study, an enhanced monitoring and control system for MMDA pumping station was presented. From the current manual control, an automatic and remote control were introduced, thus, even in times of disasters or calamities, the pumping station is still well-monitored. This is achieved by the developed Android application easily installed in any smartphone.

Data gathered during the manual, automatic or remote control are stored in a database. Data derived are uploaded to its website www.babahaba.com. This site also gathers rainfall amount from PAG-ASA in computing water flow duration in the stations.

The website www.babahaba.com can also monitor places that will be flooded using the metrics specified as rainfall amount, land area, sea level, flow rate at 100% operation, and motor speed. Flood duration can be calculated using the mentioned metrics. All these different modules can be inter-connected as a single system.

As a future directive, full implementation of the proposed system must be taken into consideration.

5. ACKNOWLEDGMENT

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