

Development of Flood Monitoring System using WSN and IoT based on Cloud

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Abstract- The impact towards mankind Flooding is the most common natural disaster. Floods have been known to do significant damage. There are many sophisticated system widely in practice by organizations and responsible authorities in monitoring flood level in flood prone regions. Most of these devices are very costly to be used and maintained. The proposed system using N-mote and N-gateway, sensor data such as temperature, humidity, rainfall rate and water level can be sent to cloud and if threshold values of the environmental conditions increases, the warning message can be sent to responsible authorities and people lives in a flood prone region. Such a system enables both private and government organizations to work on their emergency evacuation and mitigation plans for a safer move before the flood situation get worse.

Key Words: N-Mote, N-Gateway, Sensors, Ubidots, cloud.

1. INTRODUCTION

Flooding is one of the major disasters occurring in various parts of the world. Although, we are to forecast rainfall or to track cyclone path very precisely from the satellite images, the need to have real-time monitored data such as flow, precipitation level, or water level is essential in order to make a reasonable decision on the actions necessary to be performed to prevent flooding. The cost of damage caused by flooding correlates closely with the warning time given before a flood event, making flood monitoring and prediction critical to minimizing the cost of flood damage. Although Mauritius has a surface area of only 1865 km², there is a high variation in rainfall over very short distances throughout the island owing to its topography. Annual mean rainfall varies 1400 mm on the eastern coast to 4000 mm on the Central Plateau and 600 mm on the western coast. While the number of rainy days has decreased, the frequency of heavy rainfall events accompanied by flash floods has increased in Mauritius.

Wireless sensor networks (WSNs) is a developing class of to a great degree dynamic condition on top of which a wide range of uses, for example, military frameworks, living space checking, accuracy horticulture and building observing are fabricated [6]. A Wireless Sensor Network (WSN) comprises of a possibly extensive arrangement of individual sensor

hubs [14]. Each of these hubs has extremely restricted assets, both as far as preparing velocity and memory. With the appearance of little, battery-controlled, remote figuring and detecting innovation, it is presently conceivable to screen and watch the world at phenomenal levels of granularity. Systems of such gadgets normally comprise of terms or many little, control compelled hubs sent in remote areas which they are relied upon to screen for quite a long time or years on end. The scaling down and the accessibility of various sorts of sensor hubs have permitted new organization for progressively complex applications. As of late, there has been developing enthusiasm for utilizing WSNs to perform continuous surge expectation and observing. In this paper, the issue of surges in Mauritius is portrayed and the related chips away at existing surge observing frameworks are talked about. At the point the prerequisites for a continuous surge checking framework that can reasonably be accustomed to observing flooding circumstances in Mauritius are determined and indicated. At long last, the outline of a Real -Time Flood Monitoring System (RTFMS) [8] to screen surge over a stream is portrayed and assessed.

The main cause of flood is the hydrological condition of discharge of heavy rain fall and the enormous water. The other associated cause is metrological condition i.e. poor drainage, high siltation in river, breaching of the embankments, spilling of floodwater over them also contributes to the flooding situation. The geographical condition i.e. flows of water from neighbouring states, flow of river across the states & the topographical condition up to some extent are the factor of flooding condition [17]. In developed country like US, Japan etc. the flooding problem is minimized significantly & do not affect much due to availability of emergency system.

2. LITERATURE SURVEY

A reliable computational model which could fight with the flood in developing and poor countries is the main concern. There are different models, the different energy efficiency models, different networking arrangement of wireless sensor networks. These motivate us in preparing a most efficient model for predicting and preventing flood.

Seal et al. [1] presents a forecasting model designed using WSNs (Wireless Sensor Networks). This model helps to predict flood in rivers using simple and fast calculations to provide real-time results and save the lives of people who may be affected by the flood by ringing a alarm.

Shebli et al [2] described a method to calculate the amount of energy consumption by sensor in a network, according to the data flow rate, the number of nodes and the distance between them.

Ahmad et al. [3] presented a comprehensive study of the flood analysis and prediction using Geographical Information system (GIS) i.e. they are using an Arc GIS simulation tool to identify pre and post disaster flood risk analysis and an Ad hoc wireless Sensor Network Architecture.

Jadoon et al [4] presented a least cost framework of irrigation control system based on sensor network for efficient water management in Pakistan. As that there exists a direct relationship between irrigation and growth per yield of agriculture which implies the high demand of water in the country is directly proportional to scarce water resources so an efficient management and maintenance of water resources and controlling the water wastage is required for agriculture.

Stoianov et al. [5] described a Pipe Net, a system based on wireless sensor networks which detect, localize and quantify bursts and leaks and other anomalies in water transmission pipelines such as blockages or malfunctioning control valves. Gustavo Furquim et al. [7] they investigate with machine learning (ML) classification techniques to assist in the problem of flash flood now casting. They also evaluated forecasting.

Basha et al. [9] presented a brief description about implementation of the sensor network in Honduras for an early detection of flood & alert the community. They have analyzed on the significance on sensor networks in developing countries, sensor networks for flood detection and the available current operational systems for flood detection.

Basha et al. [10] describes a system architecture and deployment to meet the design requirements and to allow model-driven control for optimizing the prediction capability of the system.

Anthone et al. [11] described about an alternative network as a substitute to the usual communication links which are unavailable during major disaster.

Degrossi et al. [12] proposed a model which is based on Open Geospatial Consortium's (OGC) Sensor Web Enablement (SWE) standards, that collects data to be shared in an interoperable and flexible manner.

Yu et al. [13] presented a wireless sensor network for real-time forest fire detection method. The forecast forest fires cannot be detected by the satellites fire spreads uncontrollable. The wireless sensor network can detect and

forecast forest fire more perfectly and accurately than the traditional satellite-based detection approach.

Jong-uk Lee et al. [15] presented the Real-time Flood Monitoring System with Wireless Sensor Networks which is deployed in two volcanic islands Ulleung-do and Dok-do located in the East Sea near to the Korean Peninsula and developed for flood monitoring. RFMS Measures River and weather conditions through wireless sensor nodes equipped with different sensors.

Mauricio Castillo-Effen et al. [16] presented the ongoing effort in providing the population of the Andean region of Venezuela with a flash-flood alerting system by making use of state-of-the-art wireless communications and information technologies. A key component of the project is a Wireless Sensor Network (WSN) that is used for monitoring the environment and tracking the disaster while it evolves.

Hughes et al. [18] described that damage due to flood is correlated to the warning time announced for a flood event. They prepared a hybrid of local and remote sensor network.

Sunkpho et al. [19] represented two main objectives of the developed system which serve a) as information channel for flooding between the involved authorities and experts to enhance their responsibilities and collaboration and b) as a web based information source for the public.

Halgamuge et al. [20] presented a comprehensive energy model for wireless sensor networks. It is based on seven key energy consumption sources i.e. processing, communication, sensing, transient, logging, actuation and cluster formation.

3. OBJECTIVES

The objectives are listed below:

- To develop the LabVIEW front panel by following block diagram Flood Monitoring System.
- To interface between hardware prototype and front panel LabVIEW.
- To develop the system that the information flash flood will be linked to user.
- To interface water level detector and warning lamp with PC-based system by using DAQ device.
- To develop the water level detector and warning lamp hardware.
- To ease the user (authorities) in monitoring water level by using the PC instead of physical or conventional monitoring. In another word, to create a user friendly interface of Virtual Instrument this can be used to monitor the water level.

4. PROPOSED SYSTEM

There are many sophisticated system widely in practice by some organizations and responsible authorities in monitoring flood level in a certain location. Most of these devices are very high in costly to be used and maintained. Apart from that, these devices are usually used only for

monitoring purposes between the flood prone location and the monitoring station. With real time detection and alert system all the responsible organization can be on their toes when there is an urge for a certain task related to their core job during flood. Such a system enables both private and government organizations to work on their emergency evacuation and mitigation plans for a safer move before the flood situation gets worse. Within a limited time and available man power the rescue team and fire fighting department has to plan for the best possible evacuation and rescue activities during flood.

4.1 Architecture

By using Bluemix/Ubidots cloud for this flood monitoring system it is possible to overcome the security and services problems from the existing system. Because there is no storage or cloud service to send the threshold environmental conditions to people who are living in the flood prone region as shown the figure 1.

In the figure 1, it is transparently visible that there are three main part, through which the communication can be done. Three parts such as n-mote, n-gateway and cloud part as mentioned above. n-mote and n-gateway has Xbee modules each. The physical data from the sensors is received by the Xbee of the n-mote. Then this collected information is send to the Xbee module of the gateway, that means Xbee to Xbee communication had happened. From the Xbee of the gateway, the collected data is send to the Bluemix or Ubidots cloud, that provides platform for different programming languages and it can also be used for storage and different services. The detailed operation of this will be explained further as flow diagram of the n-mote, n-gateway and cloud part.

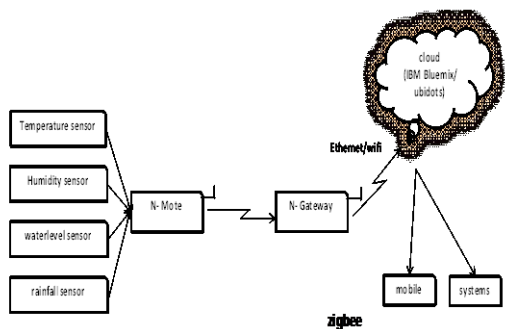


Figure 1. Proposed system for Flood Monitoring

4.2 Flow Diagram

The flow diagrams related to this project will be explained here. It has three parts such as n-mote, n-gateway and cloud part. These are explained below.

- 1) *N-Mote*: In the n-mote operation, sensors for different physical environmental conditions are interfaced with n-mote. N-mote has a Xbee module, through which the monitored data from the sensors can send to the mote and followed by n-gateway as shown in the figure 2. Initially the monitored data is received by the n-mote through its Xbee beneficiary port and transmit it to gateway by a transmitter port.

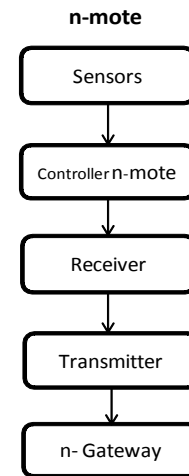


Figure 2. Flow diagram for n-mote operation

- 2) *N-Gateway*: The figure 3 shows the flow diagram for operation of n-gateway. As mentioned before gateway also has a Xbee module to make Xbee to Xbee communication with mote because it is necessary to communicate between n-mote and n-gateway. After receiving the monitored data from the mote, it displays the monitored values on terminal display of the computer. Evenmore the received data will be in the serial format because the communication is serial. Then the data will be send to the cloud through ethernet or wifi and it will be in the form of python script.

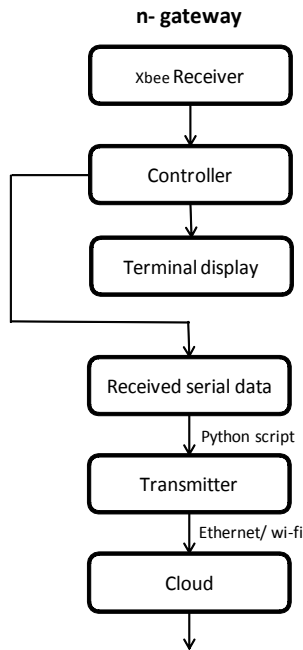


Figure 3. Flow diagram for n-gateway operation

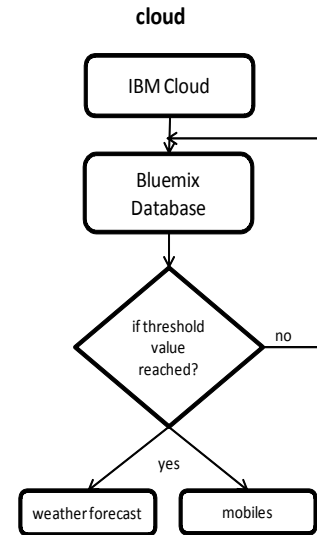


Figure 4. Flow diagram for cloud operation

- 3) *cloud*: The cloud used in this project is Ubidots. It provides platform for different programming languages and used for storage and to provide services. The received data will be stored in the Bluemix/Ubidots database. It will be having a separate database to store every incoming and outgoing data. If any sudden variations or threshold occurs in environmental conditions related to flood such as temperature, humidity, water level of specified river and rate of rain fall, it send the warning message to the related authorities or government and people lives in the flood prone region. The flow is shown in the figure 4.

5. PERFORMANCE RESULTS

The embedded c program is written to interface the sensors to N-mote. After the successful interfacing, read the values send by the N-mote to gateway on the serial monitor of the Arduino, as shown in the below figure 5. From the gateway using python script of 'python UbidotsPython.py' on VNC viewer, send the collected environmental data to cloud called Ubidots. To send values from mote to Ubidots through gateway, the API credential key of the Ubidots account and the different variable keys are necessary to put in sender program of the N-mote to address the destination properly. Then the collected environmental variables can be sent to Ubidots. Figure 6 shows the continuous receiving of monitored data from environment.

If threshold value of any environmental variables varies related to flash flood such as, temperature and humidity variations can be used to find the amount of rainfall and from the rainfall rate, water level can be found easily by monitoring the environmental variables continuously as shown in the figure 6. These variations can be sent to people who lives in flood prone region through SMS, e-mail and telegram etc, by creating events on Ubidots. The steps for creating events are shown in the figure 7. The warning message has been sent to numbers which are given while creating the event, is shown in the figure 8. In this way warning message can be sent via e-mails, telegrams etc,.

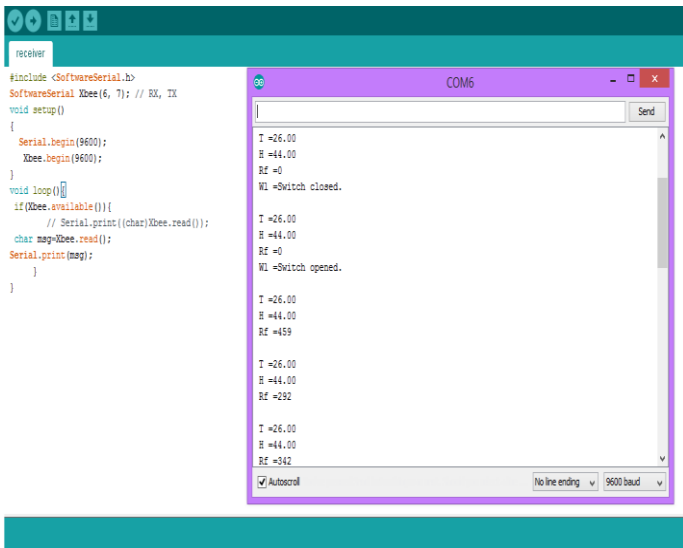


Figure 5. Serial monitor for N-Gateway

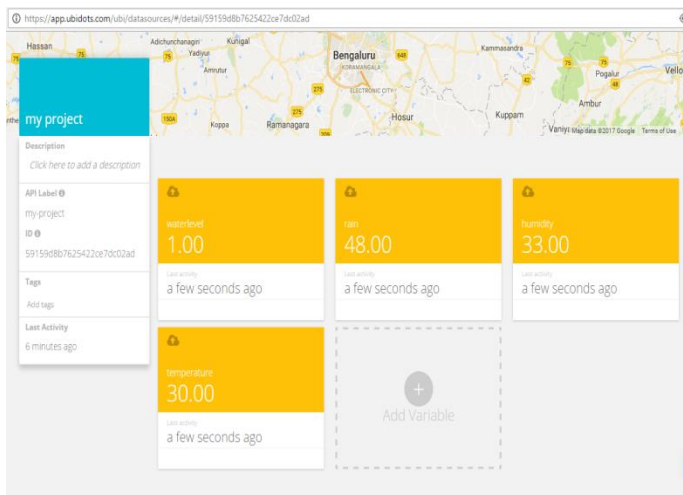
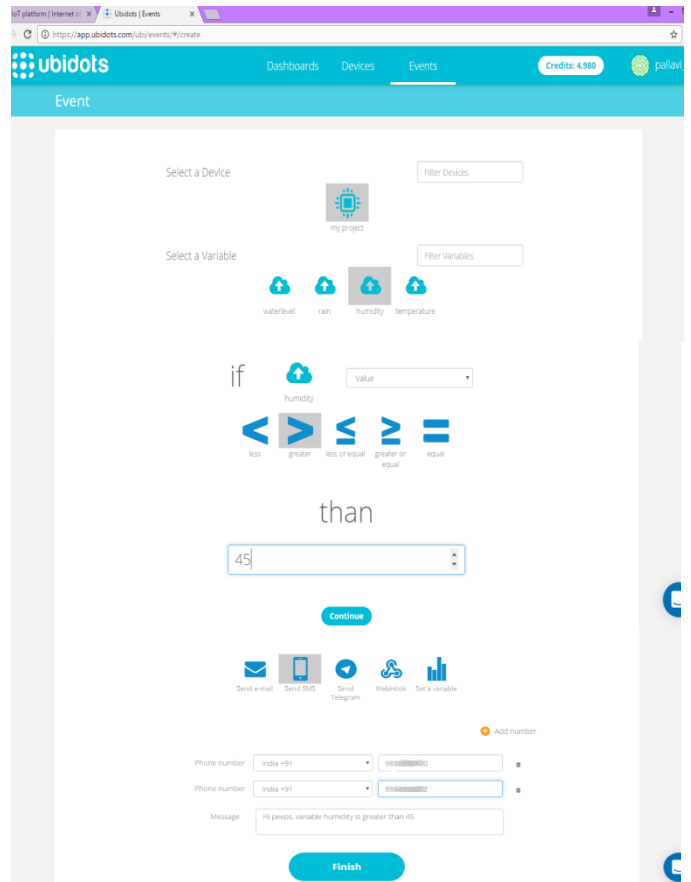
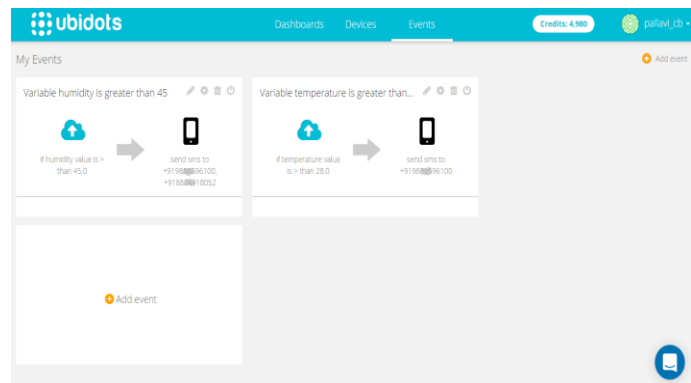


Figure 6. Environmental data on cloud



(a)



(b)

Figure 7. (a) Steps for creating events
 (b) showing created events on Ubidots

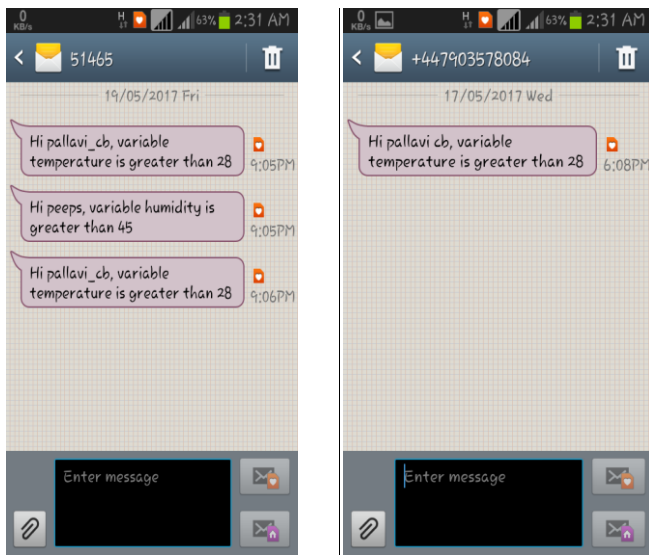


Figure 8. SMS reached to numbers which are given while creating events

6. CONCLUSION

It is based on the design and implementation of WSN-based Flood Monitoring and Detection System (FMDS) using relative humidity, temperature, water level and rate of rainfall as flood indicators, whose values are detected by sensors in the sensor field. The flood monitoring and detection system monitors the probability of occurrence of floods and then send flood notification SMS to the inhabitant of such zones for necessary action. WSN nodes are used for flood measurements due to tiny size and low power consumption. This project is providing a solution to enhance the safety of the trains, automobiles at the bridges against flood water and avoid the lost to life and property.

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