IoT Based Flood Monitoring Using Artificial Neural Network

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***Abstract*- Flood is the most common natural disaster which causes damage to the life and economy. This paper work focuses on the flood forecasting system using Internet of Things(IOT) and Artificial Neural Network(ANN). Along with this the Digital Image Processing technique is implemented to save the life of the victims affected by the flood. The algorithmic approaches have been proved as better flood forecasting scheme and it is used for data analysis in this project. This design incorporates certain monitoring features like water level, humidity, pressure, water flow and rainfall. These parameters for predicting the flood are determined by various sensors and the sensor aggregates data's and these data's are collected by the Wireless Sensor Network(WSN) from controller and it is transferred by the GPS to Internet Processing Centre(IPC). The IPC alerts the people community through siren. After flood, the digital image processing technique detects the victims affected by flood depending on the factors like body positioning and the surrounding environment. ANN is used for better accuracy. This information is passed to rescue team using IOT. The results of the analysis which are also appended show a considerable improvement over the currently existing methods.**

***Index Terms*- flood forecasting, Internet of Things, Wireless Sensor Network, Digital Image Processing, Artificial Neural Network.**

I. INTRODUCTION

Floods are the most common natural disaster in India. The heavy southwest monsoon rains cause the Brahmaputra and other rivers to distant their banks, often flooding surrounding areas. Almost all of India flood-prone and extreme precipitation events, such as flash floods and torrential rains, have become increasingly common in central India over the several past decades, coinciding with rising temperature.

Meanwhile the annual precipitation totals have shown a gradual decline, due to a weakening monsoon circulation as a result of the rapid warming in the Indian Ocean and in the reduced land-sea temperature difference. This means that there are most extreme rainfalls intermittent with longer dry spells over central India in the recent decades.

Certain factors such as rainfall or storm paths can be accurately tracked with current technology. However, several other factors are required, such as water level, flow rate which can be collected from sensors. The Internet of Things (IoT) paradigm allows combining a wireless sensor network and a communication framework to rapidly transmit the data to specific control centers. These centers, in turn, can analyze the data and provide suitable countermeasures against floods. Flood control presents several challenges for an IoT approach. It involves a complex set of parameters, with several interdependencies; this includes rainfall, pressure and flow rate. Depending on the parameters chosen, the sensor network has to be designed. The number of sensors and their interconnection depends significantly on the dimensions of the river itself. However, in general, a significant number of sensors are required for accurate prediction. Therefore, choice of topology determines communication time, with the likelihood of poor conditions during floods being another point of consideration .Several flood prediction schemes have been proposed in literature.

In this paper we propose a system which uses IoT based flood monitoring using various sensors like humidity, temperature, rain, float etc,. Here we also detect the victims during flood through image processing and ANN is used for better accuracy. In this article, an embedded system development platform based on GSM communication is proposed. Embedded systems in today's real-time response are increasingly playing an important role. An embedded system is one that is made for a particular task instead of general multiple tasks.

In section two we discuss about the existing methods to detect the flood. The section three gives a detailed idea about the proposed method.Section four discusses the flood prediction model using the artificial neural network. Section five lists the results obtained and Section 6 is the concluding section discussing the paper.

II. EXISTING METHOD

In [1] novel data-collecting algorithm using a mobile robot to acquire sensed data from a wireless sensor network (WSN) that possesses partitioned WSNs is proposed in this paper. This algorithm permits the improvement of data-collecting performance by the base station by identifying the locations of partitioned WSNs and navigating a mobile robot to the desired location. To identify the locations of the partitioned/islanded WSNs, two control approaches, a global- and local-based approach, are proposed. Accordingly, the navigation strategy of the robot can be scheduled based on time and location using three scheduling strategies: time based, location based, and dynamic moving based. With these strategies, the mobile robot can collect the sensed data from the partitioned/islanded WSNs.

In [7] gives the notion of water level monitoring and management within the context of electrical conductivity of the water. More specifically, the author investigates the microcontroller based water level sensing and controlling in a wired and wireless environment. Water Level management approach would help in reducing the home power consumption and as well as water overflow. Furthermore, it can indicate the amount of water in the tank that can support Global Water types including cellular data loggers, satellite data transmission systems for remote water monitoring system.

In [3] the embedded systems can reduce risks due to an increase of climate change in Rwanda with potentially devastating impacts of floods on local communities and their properties. Advances in embedded system, particularly in WSN, offer us critical opportunities to develop complex real-time early warning and monitoring systems. The WSN technology has been applied in monitoring natural disasters for the last couple of decades. This paper further proposes an innovative and inexpensive framework designed to provide early warning for natural disaster via a siren.

III. PROPOSED SYSTEM

In our system wireless sensing element networks (WSN) [2] nearly used everyplace i.e.., both residential areas, and undeveloped places on the subject of the stream. Therefore embedded systems plays important role to cut back risks to a rise water level swollen affected areas. The present system warning alert regarding the flood is send through (SMS) and sirens therefore have a delay to send an early flood warning. The govt. spends ton of cash for flooding injury. In order to cut back the value, government has to implement such reasonably advanced technology (i.e. flood observation system exploitation open hardware and software) as a warning and alert system to expeditiously monitor the crucial flood prone areas in real time basis.

Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. It is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your controller and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

The processing unit receives inputs from various sensors are described below

1. Level Sensor
2. Humidity Sensor
3. Temperature Sensor
4. Rain Sensor
5. PIR Sensor

In [6] the design of a temperature sensor is based on the integrated poly-silicon thermistors. The thermistors are incorporated in a Wien-bridge RC filter, which, in turn, is embedded in a frequency-locked loop. The loop's output frequency is then determined by the filter's temperature-dependent phase shift, thus realizing an energy-efficient and high resolution temperature sensor.

The water level sensor gives the information about the level of the water in the river or lake in which it is

placed. Hence, any person can identify the level of water which is displayed on LCD.

A humidity sensor (or hygrometer) senses, measures and reports the relative humidity in the air. It therefore measures both moisture and air temperature. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature. Humidity sensors work by detecting changes that alter electrical currents or temperature in the air.

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity though a potentiometer. It works as an input device. The details about detection of rain are displayed on the screen by controller.

The PIR sensor itself has two slots in it and each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. Thus the controller acting as a brain of hardware module gathers the details from sensors and does the further processing with output unit and displays them on LCD screen as well.

PIC16F877A [5] controller is used in a predominant way because it is rich in peripherals and hence many devices can be interfaced at ease, it is also very cheap and can be easily assembled and programmed. The PIC controller controls the devices and sends the sensor values to the PC. PIC Microcontroller: There are a wide variety of microcontrollers available to implement various tasks, among them the 8051 and PIC are the mostly used.

The 8051 is probably the most popular 8-bit microcontrollers ever. Many different I/O features are integrated around the 8051 core to create a microcontroller which needs only very little extra hardware to do most of the jobs. The main disadvantage of the standard 8051 core is that there's only one 16 bit pointer register available. Moving a block of data is a very tedious job which takes far too much data moving overhead. It also does not have an internal Analog to Digital Converter (ADC).

PIC16F877A is an 8-bit microcontroller which has 40 pin DIP and is based on Harvard Architecture. PIC stands for Peripheral Interface Controller and F for flash memory. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an LCD, 2 Comparators, 8 channels of 10-bit Analogue-to-Digital converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface for the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter. The PIC16F877A has 8kb flash memory which can be used to erase and rewrite the programs for the controller. Hence the devices can be re-programmed up to 100,000 times. The controller works with a low power supply such as 5V DC. Easy programming, cheap and reliable: It is easy to program the PIC microcontroller in embedded C language or assembly level language. There is a built in A to D converter which is used in such cases. Multiplexer circuits are also used.

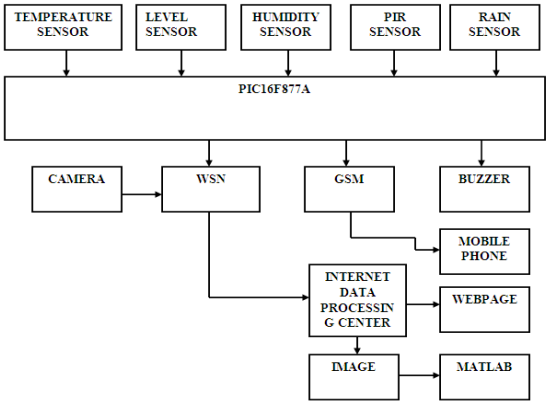

Fig.1. Block Diagram of Flood monitoring system and wireless Forecast

Image processing is a method to perform some operations on an image, inorder to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps: Importing the image via image acquisition tools, analyzing and manipulating the

image, output in which result can be altered image or report that is based on image analysis.

IV FLOOD PREDICTION MODEL

A. Artificial Neural Network

An artificial neural network (ANN) is a computer program that models the human brain with units called neurons akin to the biological counterpart in the brain. This has applications in pattern learning, that is, training the algorithm with a relevant data set and utilizing it for future predictions. An ANN is trained to give correct output to a specific problem. The ANN is fed the input data and output values and the initial weights to the connections are assigned randomly. The ANN adjusts these weights between the neurons until it produces the correct output for the set of inputs it is given. Hence, accuracy of an ANN is affected by the number of data, more so than the number of variables. The interconnection weights are the mechanism used by the ANN to learn the solution to the specific problem.

B. Digital Image Processing

This module uses the digital image processing using MATLAB. MATLAB is a fourth-generation programming language and numerical analysis environment. Uses for MATLAB include matrix calculations, developing and running algorithms, creating user interfaces (UI) and data visualization. The multi-paradigm numerical computing environment allows developers to interface with programs developed in different languages, which makes it possible to harness the unique strengths of each language for various purposes. MATLAB is used by engineers and scientists in many fields such as image and signal processing, communications, control systems for industry, smart grid design, robotics as well as computational finance.

C. Proposed Model

The PIC controller obtains all the information from different sensors used here. The WSN collects this information's from controller and transfers it to the internet data processing centre which could be viewed in the webpage. The information's are also delivered to the locals as SMS using GSM. The siren alert is also given to the locals. The Digital Image Processing is used to detect the victims during flood. This is done by comparing the image in the MATLAB. The image of the flood affected area is obtained through a camera via WSN which is received by the IPC and further compared using MATLAB. Here ANN is used for better accuracy to detect the victims during flood.

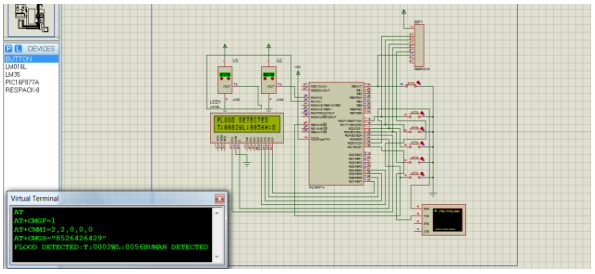

Fig. 2.Flood detection

V. RESULT

A simplified version of the WSN network topology was proposed in the model was simulated using proteus tool. For the ANN model, several testing software are available. For this experiment, we selected MATLAB tool and used the available Neural Network Toolbox. We tested a set of models and aggregated the correlation value. As a result the flood was detected using the wireless sensor network and the victims were detected using the digital image processing which was done through the MATLAB. In this paper ANN algorithm is used in the MATLAB to detect the victims through which a better accuracy is obtained.

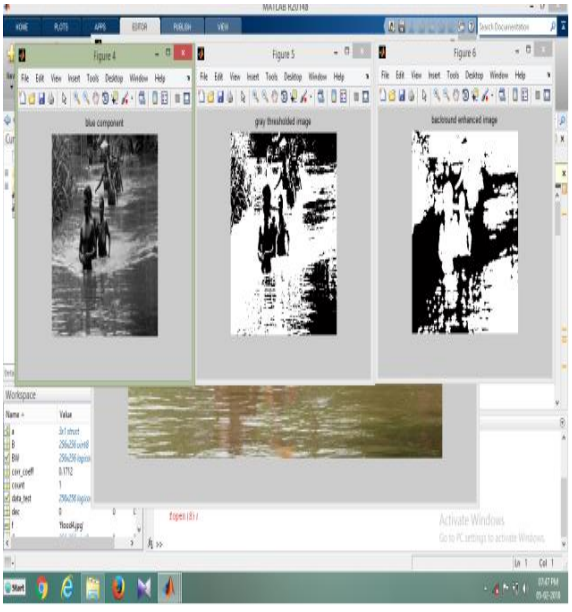

Fig. 3.Human detection

VI. CONCLUSION AND FUTURE WORK

Floods are the natural disaster which can cause hazards and damage to the human lives and properties. Flood forecasting is hence an important research area, and several possible solutions have been proposed in literature. The current work uses the Internet of Things approach by collecting data from a wireless sensor network and using a machine learning model for flood prediction.

The current results are the preliminary work for the proposed model. The MATLAB simulation results show the number of victims affected by the flood and the proposed system indicates the better performance. Our approach combines the power of artificial neural networks for better accuracy to handle data provided by a sensor network, and effective communication between these two components is essential.

The implementation of the network and using the data from the network for flood prediction is thus the next step for this work. Moreover, alerting the people about imminent floods is a challenge for the future.

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