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Flood Detection and Avoidance by Using IoT

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Abstract

Floods are basic catastrophic events that allow extreme desolation of any nation. They are typically brought about by precipitation and overflow of waterways, especially during heavy stormy season. This project aims to monitor the flood condition and send alert if there is an occurrence of risk through IOT. The measurement of rising water level is done to detect the flood. The system uses three sensors to detect temperature, humidity and water levels at every stage. The detected sensor values are processed using PIC Microcontroller and it is transmitted to IOT through Wi-Fi module. The system instantaneously uploads and broadcast sensor values through cloud. The decision tree algorithm is implemented to perform the classification process. The experimental results for correctly classified instances and minimum absolute error indicate that the proposed decision tree algorithm gives 99.6% classification accuracy with minimum mean square error than hyper pipes algorithm.

Keywords: Flood detection system, sensor data, pic microcontroller, IoT, decision tree.

1. Introduction

Flood is considered as a standout amongst the most well-known characteristic marvel on the planet, affecting human lives and making outrageous harm to people and properties[9]. Maintaining a strategic distance from floods before extreme harm can give adequate time to occupants empty in the close-by regions. The Prediction and cautioning system could have potential effect to decrease the extreme of flood influences. In a large portion of the developing nations, flood checking cell are not legitimately outfitted with savvy and versatile flood disturbing framework. Therefore, individuals from flood influenced zones are enduring the results of flood each year. This catastrophic event can't be escaped anyway suitable overseeing and pre-disturbing system can lessen its reality [10]. The main objective of this project is to develop and design a flood detection system that will detect flood automatically and transmits data through IOT. This system is used to detect the current water levels on flood by taking sensor values from outside environment and it will give real-time information to the appropriate station about severity. At the second stage, a machine learning algorithm is executed to examine the level of flood information to evaluate if the level of water is typical or unsafe condition.Several values are collected from sensor data which is trained and classified using Decision Tree algorithm.

Performance metrics such as correctly classified instances, incorrectly classified instances, Kappa statistics, Mean Absolute Error, Relative mean absolute error are obtained for several sensor data values shows better classification accuracy than the Random Forest algorithm.

2. Literature Review

Do et al have proposed a flood cautioning structure has been examined and created. The structure contains an early flood forewarning station which is charged by solar power. The flood advised station is equipped with the water level sensor. The data, which is gotten from sensors, are been stored and transmitted to observing focus by means of GPRS convention. The observing focus' capacity is to gather, research data from the stations and send results to notification focus where alerted can be created to the considered nearby areas and notification is also send through SMS from client server. A website page was made to demonstrate the water level, and the foreseen information for persistent activity. The issue with this framework is setting up the conditions for testing in the lab takes a while to have the test results as a general rule[1].

Sakib et al have proposed a neuro-fluffy controller based flood observing framework utilizing remote sensor organize. The framework utilizes IEEE 802.15.4 convention as a conveyed hub to gather the sensor data, for example, water level information from the waterway, precipitation, and wind speed information from a chosen site. In order to endorse the flood checking structure, Chadpur, a flood slanted area of Bangladesh, has been considered as picked site. The sensors information is sent to the disseminated alarm focus from main control unit by using Zigbee module. Sensor information is researched by the neuro-fluffy controller. The sensor data are processed using Raspberry Pi controller for warning condition. The remote sensor is included for sending detected data to particular location instantaneously. It is incompetent to control moving procedure with time delays and change in the MF can require a change in the rules. And it undergo multi-parameter optimization problem[2].

Mousa et al have planned new detecting gadget that can consistently screen urban flash floods and traffic blockage for flood watching. This recognizing gadget relies upon the mix of ultrasonic distance measurement for detecting temperature, using a blend of L1-regularized recreation. Second, looking at counts has been executed on a remote sensor platform. And artificial neural systems to process estimation data. The results demonstrate that water levels can be constantly assessed with reduced error, and that the pre-preparing and AI plans can continue running logically on starting at now open remote sensor stages. In the present case, ANNs show extraordinary mix properties anyway it engages us to use a low number of neurons and parameters, making it suitable to a low power installed frameworks application[3].

Khalaf et al have proposed a portrayal of an alarm making structure for flood identification with an accentuation on choosing momentum water level using sensors. The framework by then gives cautioning message about water level using Global Communication and Mobile System modem to explicit individual. Also the Short Message Service is provided for the framework rapidly exchanges and conveys information through web base open framework. AI calculations were directed to play out the classification process.

The tests were done to characterize flood information from typical and in danger condition in which arrangement precision was accomplished utilizing Random Forest algorithm. The calculation experiences complexity and tedious to develop than decision trees[4]. Dashpute et al have proposed a flood detection system to screen rising water in local locations. Utilizing ultrasonic sensor they made flood level detecting device which is connected to Node MCU controller to process the sensor's analog signal into a usable advanced estimation of separation. The client can get real-time data on observing overflowed streets over SMS based administration. The level of the flood will be partitioned into four. The flood sensor and microcontroller will be controlled by a solar based energy to assist constant activity of water flood height identification and system information transmission. The Arduino Flood Detector System is created to screen flood that will support drivers or street client to stay away from issue when flood happened. The issue distinguished in this system is, it will not predict the values or it takes previous for classification by using any machine learning algorithm[5].

3. System Design and Description

The above mentioned papers reveal about the concepts of flood detection in different methodologies. There are a few hardware that can be consolidated together to send notice utilizing water level sensor to the authorized centre. In all the above papers, they defined different approaches only for knowing current statistics of sensor values for alert which does not concentrate on early prediction by taking several data's utilizing algorithms for flood detection [6]. The project proposes the design and development of flood detection and notification system that will detect the flood automatically using sensors. To detect the current level of the flood where the system sensor will be divided into different levels at every stage. The collected values are transmitted to cloud through Wi-Fi module from PIC microcontroller for data interpretation. The proposed system uses decision tree algorithm for classification process and to analyse the level of flood data to notify if the level of water is normal or risk condition. Fig. 1 shows the block diagram of flood detection system. PIC16F877a microcontroller is the main controlling unit in this system. The water level sensors are placed at each level to determine the particular water level at every stage. The water level 1 recognizes the ordinary dimension of water, while the water level 2 distinguishes the above water level, and the water level 3 identifies the hazard state of water level.

Also DHT11 sensor is connected with microcontroller to detect the temperature and humidity of current location. The sensor values gathered from various sensors are given to the main control unit and it gets signals from sensors and transmits those sensor values to the cloud through Wi-Fi module. The framework continuously uploads the sensor data to the cloud[7].

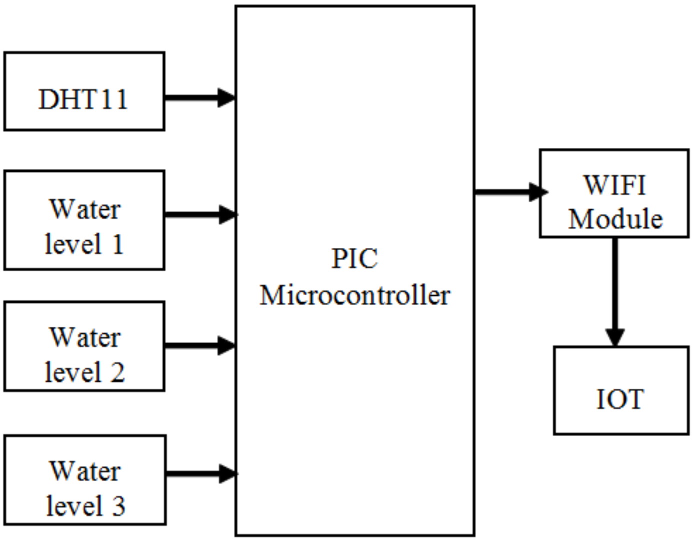

Figure 1 Proposed Block Diagram

3.1 PIC16F877a Microcontroller

The PIC16f877a finds its applications in a huge number of devices. It has total number of 40pins and there are 33 pins for input and output. The PIC16F877A features with 256 bytes of EEPROM data memory, an ICD, Self-programming. It has two comparators, 8 channels of 10-bit Analog-to-Digital converter (ADC), 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface or the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter (USART).In this project, the PIC16F877a microcontroller is the main controlling unit. The flood detection and warning is done based on code programmed from PIC microcontroller. To measure temperature and humidity, the DHT11 sensor is connected with microcontroller for finding the current climatic condition. The probe sensors are interfaced with microcontroller to measure current water level at each stage. The detected sensor data are transmitted to cloud using ESP8266 Wi-Fi module through PIC microcontroller [11].

3.2 Three level Probe Sensor

The Probe Sensor works on the principle of conductive level sensor in which the resistance between two measuring electrodes can be change when there is conductivity between water and the ground.

When the water covers the electrodes, it forms an electric current, causing current to flow. In this project, three levels Probe sensor is used to measure water level at three stages. The water level 1 recognizes the ordinary dimension of water, while the water level 2 distinguishes the above water level, and the water level 3 identifies the hazard state of water level. The detected water level data is processed using PIC microcontroller and it is transmitted to the cloud through ESP8266 Wi-Fi module.

3.3 ESP8266 Wi-Fi Module

In this project, the ESP8266 Wi-Fi module is used to provide network between controller and the cloud. The detected sensor values are transmitted to the cloud through Wi-Fi module.

4. Proposed Methodology

The figure 2 shows the proposed methodology of this work. There are two main parts in experimental methodology. The initial step is to establishing the connection between main control unit and the network for collecting flood data from different sensors and it is uploaded in the cloud periodically. While, the collected sensor values are displayed on LCD. The second part of the implementation is completely based on machine learning approach were Decision Tree classifier is utilized to examine the level of flood information to evaluate if the level of water is typical or unsafe condition [12].

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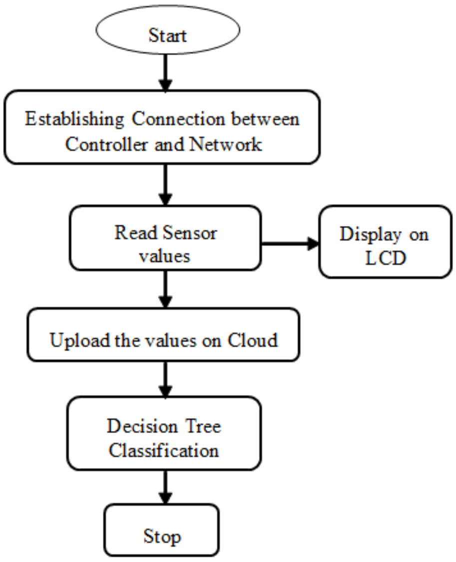

Figure 2 Flow Chart for Proposed Methodology

The raw data has been gathered from sensor values for around 120 flood values initially for arranging flood information with ordinary and in danger condition. Further, it could be classified by means of Decision Tree Algorithm to quantify the results obtained. The comparison is made on HyperPipes and Decision Tree Algorithm in which Decision Tree produces better classification accuracy with minimum number of incorrectly classified instances.

4.1 Decision Tree Algorithm

A decision tree Algorithm is utilized in this work for classification of data in which it looks like tree based structure for prediction analysis. In that, each internal node represents the property of root node were it should have best attribute, each branch addresses an outcome of the test, each leafs in the tree describes the class label of the structure. It can take care of the issue of both classification and regression. In a decision tree, each interior hub parts the occurrence space into at least two subspaces as indicated by a specific discrete function of the attribute characteristics esteems. In the least complex and most regular case, each test thinks about a solitary trait, with the end goal that the case space is divided by the characteristic's esteem. On account of numeric characteristics, the condition alludes to a range. Decision tree learning undergoes prediction of attribute which maps perceptions around a thing to decisions about the thing's objective esteem [8]. Decision tree classifiers get comparative or better precision when contrasted and other arrangement techniques. Finding the best attribute is based on two specifications mentioned below. In order to choose the best attribute, the value among the dataset should have high value of information gain.

4.2 Entropy

Entropy is the proportion of homogeneity in the information. Its esteem is ranges from 0 to 1. Its esteem is near 0 if all the precedent has a place with same class and is near 1 is there is practically equivalent part of the information into various classes. Presently the equation to ascertain entropy is:

$$\text{Entropy(S)} \sum_{i=1}^{c} - N_i \, log_2 N_i = \quad (1)$$

Here c corresponds to different types of classification and Ni represents the proportion of the data with i^{th} classification.

4.3 Information Gain

Information Gainmeasure the decrease in entropy by arranging the information on a specific attribute.The formula to calculate gainbysplitting the information on Dataset's' and on the attribute 'a'.

$$\text{Gain(s, a)} = Entropy(S) - \sum_{v \in value(a)} \frac{s_v}{s} \, Entropy(s_v) \quad (2)$$

Where Entropy(S) represents the entropy of the dataset and the S_v denotes the weighted entropy of different possible classes. The attribute which contain high information gain among the dataset is selected as an internal node for tree doing further classification.

5. Experimental Results

5.1 Experimental Setup

Figure 3 shows the experimental setup of this system. The implementation of flood detection and notification system has been proposed. The main controlling unit PIC microcontroller and different sensors are been connected with controller to detect the sensor data values. Finally, these values are been send to cloud through ESP8266 module.

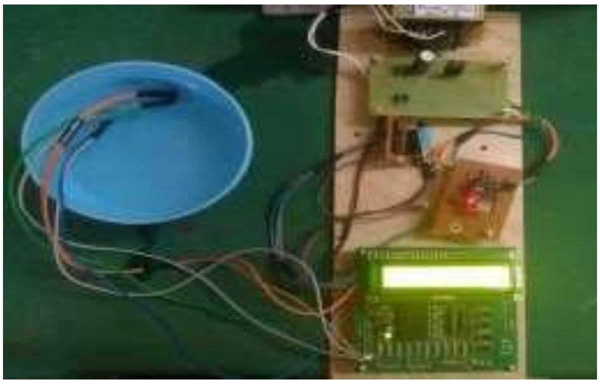

Figure 3 Experimental Setup

5.2 Hardware Results

The detected sensor values are displayed on LCD which is shown in figure 4.

Figure 4 Sensor values display on LCD

Also these data are transmitted to IOT through Wi-Fi module. The system continuously uploads and broadcast sensor values to the cloud about water condition.

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Figure 5 Values in cloud for temperature and humidity

Fig. 5 shows the detected temperature and humidity sensor values uploaded on the cloud .

Figure 6 Values in cloud for three levelsprobe sensor

The detected three levels Probe sensor values are uploaded on the cloud is shown in Fig. 6 which shows the normal or risk condition of flood level.

6. Classification Results

Around 120 Datasets of different sensor values are been taken and it is processed in this proposed work. The Decision Tree Machine learning algorithm is implemented for classifying flood data efficiently by utilizing Weka Explorer platform. Various parameters are been measured and tabulated for obtained sensor data.

6.1 Confusion Matrix Analysis

The confusion matrix has been evaluated to analyse the dataset taken from flood data for quantifying the proposed Machine learning approach in order to determine the classified flood data. In this analysis, the two algorithms were implemented such as decision tree and HyperPipes algorithm. The Sensitivity measures the correctly classified instances (or predict the positive class) while, Specificity illustrate the negative class condition respectively. The False Positives gives negative symbols and the False Negatives illustrates the positive instance. The term Accuracy defines the correctness or true value of positive instances and it is calculated as follows:

$$Accuracy = \frac{TP+TN}{(TP+FP)+(TN+FN)} \qquad (3)$$

The Equation (4) is utilized to figure the extent of positive cases to find correctly classified instances.

$$True\ Positive = \frac{TN}{TN+FN} \qquad (4)$$

Equation (5) is used to calculate the proportion of negatives that were incorrectly classified instances.

$$False\ Positive = \frac{TN}{TP+FP} \qquad (5)$$

Equation (6) shows true negative to calculate correctly classified positive instances.

$$True\ Negative = \frac{TN}{TP+FP} \qquad (6)$$

Equation (7) shows false negative to calculate incorrectly classified negative instances.

$$False\ Negative = \frac{FN}{FN+TN} \qquad (7)$$

Table 1 shows the comparative analysis of proposed Decision Tree Algorithm which processed using Weka Explorer. From the above results, it is inferred that the Decision Tree Algorithm implemented in machine learning software produces correctly classified instances with 99.6% of accuracy while, the incorrectly classified instances are 0.38% respectively with minimum Mean absolute error than the HyperPipes Algorithm. The algorithm produces high classification accuracy during the prediction of tree attributes because of calculating the information gain and entropy efficiently even for massive datasets.

Its specificity can be increased by validating all possible outcomes of each decision class label effectively. Also it reduces modelling error and setting up parameters is simple in amid grouping. The accuracy can be defined by correctly classified instances or occurrence of true value outcomes after classification. Further, it could be determined by calculating Sensitivity, Specificity, False Negative and True Negative respectively.

Table 1. Comparative analysis of classifier output

Parameters	HyperPipes Algorithm (Existing Algorithm)	Decision Tree Algorithm (Proposed Algorithm)
Correctly Classified Instances	89.35%	99.62%
Incorrectly Classified Instances	10.65%	0.38%
Kappa statistic	0.7942	0.9835
Mean absolute error	0.4599	0.0212
Root mean squared error	0.4667	0.0910
Relative absolute error	93.6543%	3.9426%
Root relative squared error	92.6775%	19.8559%
Total Number of Instance	805	805

Table 2. Accuracy of Classification

Accuracy by class	Hyper Pipes Algorithm (Existing Algorithm)	Decision Tree Algorithm (Proposed Algorithm)
True Positive	1	0.993
False Positive	0.165	0.013
Precision	0.125	0.998
Recall	1	0.993
ROC Area	0.982	0.997

Table 2 shows the accuracy of classification by class in terms of parameters such as True Positive indicates sensitivity while, False Positive indicate the specificity and further Precision, Recall, ROC area has been calculated. From the above results, it is inferred that the proposed Decision Tree Algorithm produces very low true positive and false positive rate, hence the classification accuracy is very much greater than the HyperPipes algorithm.

In order to reduce the true positive rate, the classifier statistically derive the outcome where the model correctly predicts the positive class or correctly classified instances while for reducing false positive rate, the classifier should derives the negative class efficiently.

7. Conclusions

The design and implementation of flood detection and notification system based on Decision Tree algorithm is proposed in this work. The system divides the flood level into three stages for gathering data from sensors which is processed using PIC Microcontroller. At every change in sensor values, the system continuously updates and broadcast those data to the cloud. The implementation and comparison of Decision Tree and Hyper Pipes Algorithm are made for around 120 datasets of sensor data collected from different sensors. The analysis of flood data were carried out to classify from typical and at dangerous condition in which the proposed Decision Tree algorithm gives better classification accuracy with lesser possibility of error than Hyper Pipes classification.

References

1. H. N. Do, M. Vo, V. Tran, P. V. Tan, and C. V. Trinh, “An Early Flood Detection System Using Mobile Networks,” International Conference on Advanced Technologies for Communications (ATC), pp. 599–603, 2015.
2. S. N. Sakib, T. Ane, N. Matin, and M. S. Kaiser, “An Intelligent Flood Monitoring System for Bangladesh Using Wireless Sensor Network,” International Conference on Informatics, Electronics and Vision (ICIEV), pp. 979–984, 2016.
3. M. Mousa, X. Zhang, and C. Claudel, “Flash Flood Detection in Urban Cities Using Ultrasonic and Infrared Sensors,” IEEE Sensors Journal, vol. 16, no. 19, pp. 7204–7216, 2016.
4. M. Khalaf, A. J. Hussain, D. Al-jumeily, P. Fergus, and I. O. Idowu, “Advance Flood Detection and Notification System based on Sensor Technology and Machine Learning Algorithm,” pp. 105–108, 2015.
5. K. R. Dashpute, V. B. Gaikwad, and S. S. Sawkar, “Flood detection using iot,” no. 2, pp. 1289–1292, 2018.
6. B. K. Durga, A. Ece, S. Peter, and S. E. College, “Design of Early Warning Flood Detection Systems,” vol. 5, no. 4, pp. 794–799, 2018.
7. E. Basha and D. Rus, “Design of Early Warning Flood Detection Systems for Developing Countries,” pp. 1–10, 2004.

8. D. Sun, Y. Yu, and M. D. Goldberg, “Deriving Water Fraction and Flood Maps From MODIS Images Using a Decision Tree Approach,” IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 4, no. 4, pp. 814–825, 2011.
9. Addabbo A DRefice, G. Pasquariello, F. P. Lovergine, D. Capolongo, and S. Manfreda, “A Bayesian Network for Flood Detection Combining SAR Imagery and Ancillary Data,” IEEE Transactions on Geoscience and Remote sensing, pp. 1–14, 2016.
10. N. Azlina, A. Aziz, and K. A. Aziz, “Managing Disaster with Wireless Sensor Networks,” no. December 2008,pp. 202– 207, 2011.
11. J. Aerts, W. W. Botzen, K. Emanuel, N. Lin, H. de Moel, and E. O. Michel-Kerjan, "Evaluating flood resilience strategies for coastal megacities," Science, vol. 344, pp. 473-475, 2014.
12. S. Fakhruddin and Y. Chivakidakarn, "A case study for early warning and disaster management in Thailand," International Journal of Disaster Risk Reduction, vol. 9, pp. 159-180, 2014.