Flood Risk Reduction of Alert System for Hazard Region

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ABSTRACT- Myanmar is prone to almost all natural hazards like flood, drought, storm, earthquake, and landslide and so on. Among these natural hazards, flood is most frequent hazard and being occurred every year all over the country. Flood in Myanmar are mainly caused by rainfall especially in the raining season from June to November. Flood detection is important for various areas. The flood events happening rural regions near the places along the dam and rivers. Due to the nature of flood in Myanmar, there are not only the loss of human life and property but also damage the seasonal food and cultivating in some area of the country. It is imperative to inform the public about flood-prone areas well in advance to reduce the adverse effects of flooding disasters. To achieve swift information dissemination, the implementation of an effective monitoring and flood prediction system is indispensable for alerting people ahead of flood events. The proposed system uses the technology based on the wireless sensor network (WSN).

This proposed system is IoT based flood monitoring and convolutional neural network (CNN) based flood prediction of flood management system. The main aim of this system is to monitor humidity, temperature, rainfall, water level and to send alert sms and mail alert to the government and living in prospective flood area. The IoT approach is deployed for data collection from the sensors and communication over Wi-Fi and CNN approach is used for analysis of data in flood prediction.

Keywords: Flood prediction, Internet of Things, Wireless Sensor Network, CNN

I. INTRODUCTION

A flood is a natural disaster that occurs in Myanmar almost every year that is lost Property, Loss and Life. The reason is that Myanmar faced the most serious climatic problem Natural disaster which is a monsoon flood. The resulting physical damage can be extensive, affecting everything from bridges and buildings to roads and agriculture. Thus, the implementation of a reliable flood prediction system is imperative. Flood prediction models play a vital role in evaluating these hazards and managing extreme events.

The system is composed of sensors, microcontroller (Node MCU) and Gateway. All sensors are connected to wireless nodes. Wireless nodes wirelessly send sensors data to the server via Radio Wave and Gateway. The GPS is attached to the microcontroller to get the location of the flood. A battery bank is attached to the node as power supply is a necessity to function. All these sensors collect the floods monitoring parameters such as rainfall, water level, water flows, wind direction, speed of the wind, temperature and humidity.

The Node MCU serves as the interface between the sensors and the cloud, enabling the transfer of data. Ultrasonic sensors are utilized to measure distance by sending out ultrasonic waves and detecting their reflection. The Node MCU, an open-source IoT platform with firmware for the ESP32 Wi-Fi chip, is utilized to communicate with the ultrasonic sensors. The data from the sensors is then transmitted to the cloud for processing by CNN algorithm and then system provides warning.

II. RELATED WORK

The paper [1] the prevention of such disasters heavily relies on accurate prediction. This study proposes a two-level hierarchical prediction method for flood detection using Artificial Neural Networks, which is a highly effective computational tool.

The paper [2] An Artificial Neural Network (ANN) is utilized in this approach to establish a robust methodology for flood prediction. The model is trained, validated, and optimized using data obtained from easily accessible sources to ensure appropriate input and output parameters.

An IoT sensor and big data analytics tool were employed [3]. The tool utilized a convolutional deep neural network for training the model. A preprocessing step was incorporated into the prediction system to eliminate duplicate data and encrypt any missing information. The model was trained to predict the probability of a disaster occurring.

The model considered in paper [4] is examines the application of a highly advanced flood warning system utilizing Artificial Neural Network technology. The research focuses on six parameters that can directly or indirectly affect the occurrence of a flood.

In this work, an IoT-based flood monitoring system using various sensors that are installed in

flood-prone areas. The data collected by these sensors are transmitted in real-time to an MCU, which processes the data and runs a CNN-based flood prediction model.

III. RESEARCH METHODOLOGY

The IoT and CNN-based flood prediction system is a three-stage process that includes data collection, data preprocessing, and data analysis. The data collection stage involves collecting data from various sources such as rivers, dams, and rainfall gauges. These sensors can measure different parameters such as water level, temperature, rainfall, and humidity. However, raw sensor data can be noisy and may contain errors. Therefore, data preprocessing is an essential step before analyzing the data. Data preprocessing involves cleaning the data, removing any missing or erroneous values, and selecting the most relevant features that can help in predicting the flooding.

Convolutional Neural Networks (CNNs) are a type of machine learning algorithm that is commonly used in image recognition and natural language processing. CNNs are particularly useful for processing data that has a spatial relationship, such as images or time series data. CNNs can learn spatial hierarchies of features from raw data, making them useful for analyzing sensor data.

The CNN model can be trained using historical data on flooding incidents. The model learns from the historical data to identify patterns and correlations between the sensor data and flooding events. Once the model is trained, it can be used to predict the likelihood of flooding based on the current sensor data. The model is validated by testing it on a different set of data. The data is split into training and testing datasets. The model is trained on the training dataset and tested on the testing dataset. The accuracy of the model is measured by comparing the predicted results with the actual results.

The system uses a convolutional neural network (CNN). During training, the CNN learns the weights and kernels that best fit the training data, using a loss function to evaluate its performance. The convolution operation replaces each entry of an input matrix with a spatially weighted kernel, allowing the CNN to learn spatial features that are relevant to flood prediction. The propagation rule of layer of a convolutional layer is as follows:

$$x_l + 1 = \sigma(K_l * x_l)$$

where K_l is the kernel function for the l^{th} layer, and $*$ is the convolution operator.

Illustrates the six steps in developing CNN model for flood prediction modeling:

Step-1: Data collection is a process of collecting information from all the relevant sources.

Step-2: Data preprocessing involves cleaning the data, removing any missing or erroneous values.

Step-3: The data is split into training and testing datasets.

Step-4: Generate training and validation datasets for the candidate CNN model.

Step-5: Develop, train and optimize the candidate CNN model.

Step-6: Use observed or predicted the trained CNN model to predict flood alert.

IV. RESULT AND DISCUSSION

The system assists the rescues organization to know information of flooding areas according to the sensors data. The system how-to action can be planned earlier the relocation of the resident and their belongings. Therefore, the system save the loss of human lives and prevent the serious damage of environment.

To simulate the models and predict flash floods, datasets for the year 2020 were used. In general, uncertain input datasets lead to lower accuracy in predictions. To increase the accuracy, high-quality datasets containing all possible event occurrences are necessary. Figure 1 is illustrate the actual rainfall data for the year of 2020 and Figure 2 depicts the rainfall analysis data for the year of 2020.

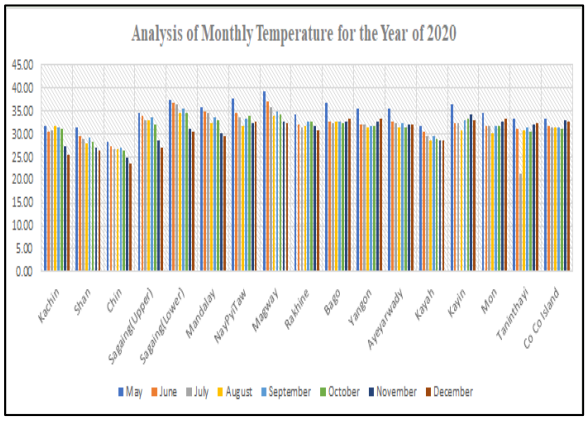

Figure1. Analysis of Temperature for year 2020

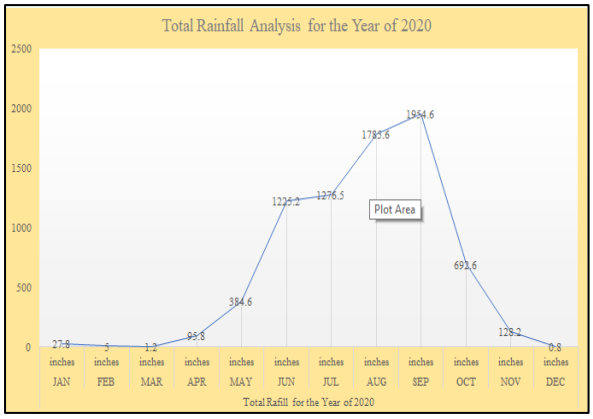

Figure2. Rainfall Analysis for the year 2020

V. CONCLUSION

The IoT and CNN-based flood prediction system offers several benefits over traditional flood prediction methods. The system can provide early warnings of potential flooding, enabling authorities and the public to take proactive measures to prevent or mitigate the damage caused by flooding. The system can continuously monitor the sensor data, providing real-time updates on the likelihood of flooding. This can be particularly useful in areas that are prone to frequent flooding. The system can be optimized to improve the accuracy of the predictions, reducing the false alarm rates and minimizing the damage.

The flood prediction system is highly pertinent for real-world implementation and offers reliability through real-time monitoring and continuous updates of environmental parameters. Its ability to accurately predict floods provides a crucial advantage. By detecting floods and promptly alerting residents in flood-prone areas, this system empowers individuals to safeguard their lives and valuable possessions. Also preventing damage when a disaster arises and provide timely measurement and modeling of flood potential to area at risk. By utilizing advanced sensor and transmission modules, the system can efficiently process real-time data. This implementation is designed to significantly improve the effectiveness of flood detection and alert systems in Myanmar.

REFERENCES

[1] Nikhil Binoy C, Arjun N, Keerthi C, Sreerag S, Ashwin H Nair, “Flood Prediction Using Flow and Depth Measurement with Artificial Neural Network in Canals ” (ICCMC 2019).

[2] T. A. Choudhury, Jackie Wei, Andrew Barton, Harpreet Kandra, Abdul Aziz. “Exploring the Application of Artificial Neural Network in Rural Streamflow Prediction – A Feasibility Study". School of Engineering and Information Technology Federation University Australia Victoria, Australia, (2018).

[3] Anbarasan, M., BalaAnand Muthu, C. B. Sivaparthipan, Revathi Sundarasekar, Seifedine Kadry, Sujatha Krishnamoorthy, and A. Antony Dasel. "Detection of flood disaster system based on IoT, big data and convolutional deep neural network." Computer Communications (2020).

[4] C.E. Imrie, S. Durucan, A. Korre. “River flow prediction using artificial neural networks: generalization beyond the calibration range”. T.H. Huxley School of Environment, Earth Science and Engineering, Imperial College of Science, Technology and Medicine, Royal School of Mines, Prince Consort Road, London SW7 2BP, UK Journal of Hydrology 233 (2000).