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Early Flood Detection and Alarming System Using Machine Learning Techniques

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***Abstract*: The Krishna river basin covering Sangli, Kolhapur districts under Koyana to Almatti dam region is affected by frequent floods in the rainy season. At present, various robust and efficient flood detection systems are available, but the field of early flood prediction systems is unexplored. Predicting the upcoming floods on the basis of rainfall and current water levels would surely help in forestalling the large scale life and property damages incurred due to the floods. In this work, we have experimented with different ML algorithms like SVM, KNN, Logistic Regression, Naive Bayes, etc., for the available rainfall dataset. Using these ML models, we have developed an end-to-end flood prediction and an alarming system consisting of a website and an android application for alerting the concerned masses and authorities.**

***Keywords*: Alarming system, Alerts, Early flood detection, Machine Learning.**

1. Introduction

Floods are one of the most destructive natural disasters, which are highly complex to model. So there is a need to create systems that might contribute to risk reduction, policy suggestion, minimization of the loss of human life, and reduction regarding the property damage related to floods. The intension is to develop a Real-time river-level monitoring and high accurate flood prediction for urban Complex Water Flow (CWF) flooding caused by Localized Heavy Rain. Due to various riverside environmental limitations, there are limitations in detecting urban river dyke height to alert about flooding. Additionally, previous prediction methods are difficult to detect CWF flooding with high accuracy because water rising differs based on a location's environment. Therefore, we propose a detection scheme for CWF by developing a CWF prediction system that produces accurate and early predictions using a deep learning approach with data assimilation. Due to the vast benefits and potential of ML, its popularity dramatically increased thus leading to upcoming of novel ML methods and hybridizing of the existing ones aim at discovering more accurate and efficient prediction models

2. Related Work

Early flood prediction involves various complex mathematical expressions of physical processes of floods. In the recent era of Artificial Intelligence (AI), various machine learning (ML) and deep learning (DL) methods are being explored for developing robust early flood prediction systems based on different types and parameters of data like rainfall, water levels, flood images, and other sensor data like temperature, humidity, etc.

According to the work by Hung Ngoc Do and co-authors [5], an early flood prediction system composed of a monitoring center, and a notification system and equipped with the water level sensor and the precipitation sensor is presented. As per the work by Swapnil Bande and Virendra V. Shete [1], the IoT approach is deployed for data collection from the sensors and communication over Wi-Fi, and an ANN approach is used for the analysis of data in flood prediction.

3. Methodology

A. Strategy: matching the problem with the solution

1. Outline the strategic goals: Develop an efficient early flood detection and alarming system.
2. Assume a solution to a problem: Assume that early predictions about upcoming flood situations would be useful.
3. Define a scope of work: The scope of the project is restricted to Sangli, Kolhapur district under Koyana to Almatti dam region.
4. Plan the development.

B. Dataset preparation and preprocessing

Data is the foundation for any machine learning project. The second stage of project implementation is complex and involves data collection, selection, preprocessing, and transformation. Each of these phases can be split into several steps:

1. *Data Collection:* This step was one of the base steps for our work that involved the collection of relevant and comprehensive data from various sources. The data used for this work is collected from various government sites and publicly available datasets.
2. *Data visualization:* The data visualization is done using libraries like matplotlib, etc., in various graphical forms to gain better insights.
3. *Data pre-processing:* The data is cleaned and

transformed by removing errors, null values and dropping unwanted features or attributes.

4. *Dataset splitting:* dataset is partitioned into two subsets - training and test sets

C. Modeling

During this stage, we explored and trained numerous models to determine which one of them provides the most accurate predictions.

1. *Model training:* This process involved feeding the chosen algorithm with training data. An algorithm will process data and output a model that is able to end a target value (attribute) in new data. Various supervised learning algorithms are used to develop models using ML frameworks like scikit-learn.
2. *Model evaluation and testing:* During this step, we evaluated the trained models using the test data on the basis of training and testing accuracies.

D. Model Deployment

The model deployment stage involved putting the trained models into use. The trained models were saved in pickle format and then integrated into the intended systems.

E. Website and Android Application Development

The Web Portal was developed for user registration and sending notifications. The website was designed to convey the status of the flood. It also contains features like emergency kit instructions, helpline numbers, information about the concerned government schemes and initiatives, and do's and don'ts during flood situations.

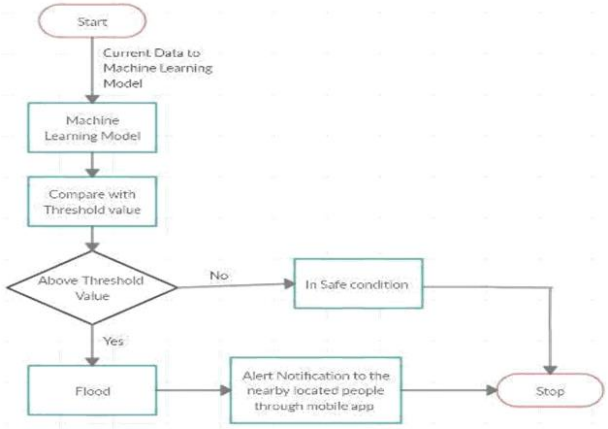

Fig. 1. System Architecture

The above figure 1, Shows the architectural view of the system and helps to visualise the workflow of the project.

4. Algorithms and Pseudo Code

The different machine learning algorithms being used were as follows:

A. Logistic Regression

Logistic regression is a statistical model that in its basic form uses a logistic function to model a binary dependent variable. Mathematically, a binary logistic model has a dependent variable with two possible values, such as pass/fail which is represented by an indicator variable, where the two values are labeled "0" and "1". Here 0 - No Flood and 1 - Flood.

B. K-Nearest Neighbours

In k-NN classification, the output is a class membership. An object is classified by a plurality vote of its neighbors, with the object being assigned to the class most common among its k nearest neighbors (k is a positive integer, typically small). If k = 1, then the object is simply assigned to the class of that single nearest neighbor.

C. Random Forest

Random forests or random decision forests are an ensemble learning method for classification that operates by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.

Random decision forests correct for decision trees' habit of overfitting to training set.

D. Support Vector Machine

A Support Vector Machine (SVM) is a discriminative classifier formally defined by a separating hyperplane. In other words, given labelled training data (supervised learning), the algorithm outputs an optimal hyperplane which categorizes new examples. In two dimensional space, this hyperplane is a line dividing a plane into two parts wherein each class lay on either side.

E. Naive Bayes

Naive Bayes classifiers are a family of simple "probabilistic classifiers" based on applying Bayes' theorem with strong (naive) independence assumptions between the features. They are among the simplest Bayesian network models. Naive Bayes classifiers are highly scalable, requiring a number of parameters linear in the number of variables (features/predictors) in a learning problem.

5. Experimental Results

This results and analysis includes,

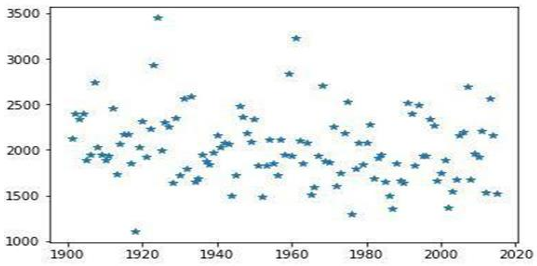

Fig. 2. Data Visualization

Where X-axis represents time period in years and Y-axis

represents average rainfall in mm. The table 1 is the comparison accuracy between the different machine learning algorithms. As per the results Logistic Regression and the SVM (Support Vector Machine) come out as the winner algorithms with accuracy of 79%.

Table 1
Algorithms

ALGORITHM	ACCURACY
Logistic Regression	0.79
K-NN	0.78
Random Forest	0.76
SVM	0.79
Decision Tree	0.68
Naïve Bayes	0.76

The Android APP images in figure 3, shows notifications regarding the flood Alert: When a person logins into the Flood Alert App, an alert would come if there are chances of flood arrival.

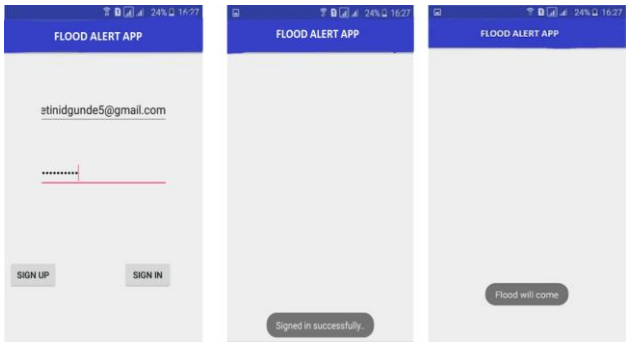

Fig. 3. Android app notification

The website shows the do's and don'ts, emergency kits, zone map, helps desks and alerts.

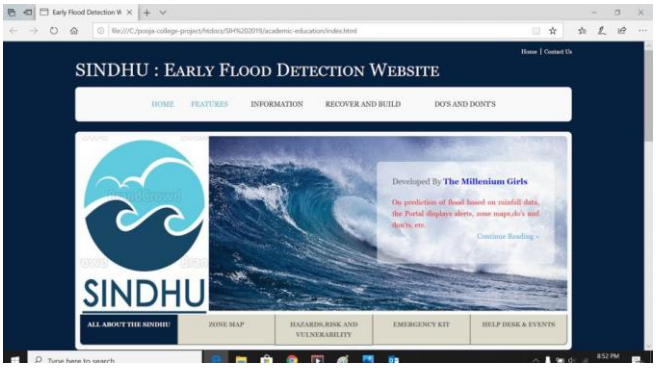

Fig. 4. Website front page 1

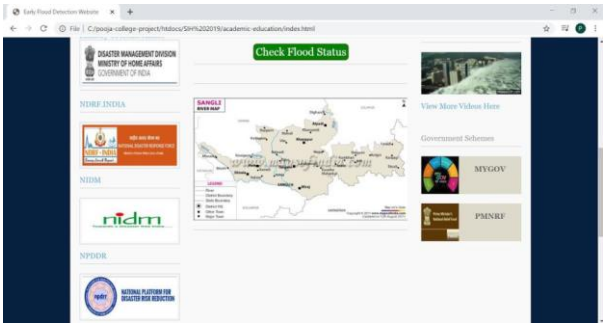

Fig. 5. Website front page 2

In the website, enter the rainfall details like - present years March to May rainfall data on average, average rainfall in past 10 days of June, average increase in rainfall from May to June.

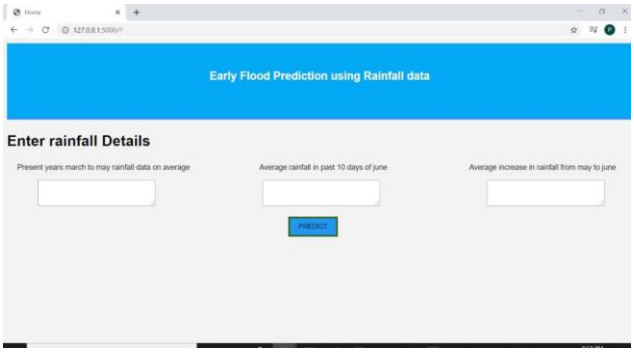

Fig. 6. Rainfall values as input

After entering the necessary rainfall details, based upon the backend machine learning trained models, the output is shown whether there is probability of flood or not.

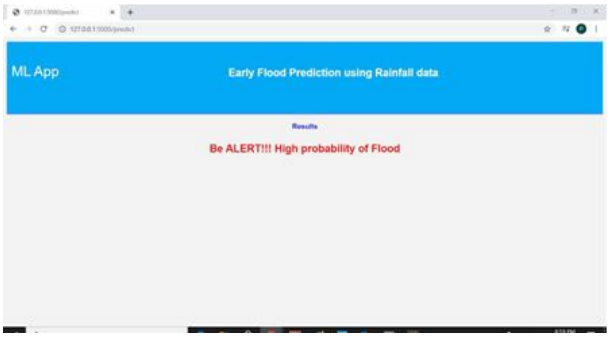

Fig. 7. Result

6. Conclusion

The research contributes towards the economy and the citizens. It envisions a safe, prepared, and less casualty-prone community before, during, and after flood devastation. The system also promotes the use of real-time monitoring through the developed Website, Android application, and SMS notification system as an easy medium in disseminating information, particularly in remote areas. Finally, the developed flood prediction and early warning system that utilizes ML to predict flood situations function perfectly according to the

specification provided.

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