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Weather Impact Based Rainfall Forecasting Model Using ANFIS Neural Network through Internet of Things

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Abstract: Internet of Things plays an important role in agriculture monitoring area. The Weather prediction supports to the farmers make prediction in rainfall season through prior identification . Farmers want help maximizing boom efficiency, protecting assets and optimizing manufacturing through IoT. Changing climate patterns have implications for all walks of existence. Shrewd and complex weather forecasting is important to early forecast to reduce the impact of climate styles. Agriculture is a huge industry that is laid low with weather change. To acquire those desires, farmers need a weather forecasting result for planting and irrigation. Rainfall prediction using Internet of Things (IOT) sensors is a tough challenge in weather forecasting. Problem in machine earning techniques have feature hidden patterns in recorded weather records. Rainfall forecast refers back to the understanding of weather condition parameters, together with temperature, air strain, humidity, wind pace, etc. Rainfall forecast is the priority for early prediction of rainfall IOT sensors which helps each farmers and the people. Because the general public in India depend on agriculture. This paper introduces the Linear Regression Rainfall Prediction Technique (LRRPT) for rainfall estimation to select the importance of features. Often there may be a range at the same time to analyze the occurrence of weather conditions with weather impact rate (WIR). The system performs a forecasting process based on historical weather information and produces Categories of rainfall, along with wind velocity and temperature. In keeping with the characteristic importance the ANFIS neural network is carried out to expect the rainfall forecasting depends on the climate records carried out to test the forecasting technique. Experiments show that the system can achieve better prediction accuracy 91% precision 93% recall 94% and f-measure 92% in rainfall forecast.

Keywords: *Machine Learning, Rainfall Prediction, Linear Regression Rainfall Prediction Technique (LRRPT), Weather Impact Rate (WIR) Internet of Things (IOT)*

1. Introduction

The agriculture development approach has various developments call for forecasting to come across rainfall in Tamil Nadu. Diverse varieties of seasonal techniques were introduced for call for forecasting in rainfall facts evaluation. This observe accomplished a comparative look at to pick out the effective model with the bottom root mean square blunders (RMSE). The consequences display that it gives excellent consequences (RMSE-ninety six.308%) compared to other techniques. Rainfall is an important indicator of the local climate and is closely related to people's production and livelihoods. Accurate rainfall forecasting helps people make the right decisions and minimize disasters caused by rainfall.

Using rainfall forecasts to determine sample size is a challenging task due to erratic rainfall patterns and climate change around the world. Rainfall forecasting helps in preventing rain and even helps in growing crops in agriculture. Machine learning helps predict rainfall using unknown patterns in past weather data. In this paper, use machine learning classification techniques for rainfall forecasting. The data used in this study was taken from the National Climatic Data Center's website. The efficiency of the model is measured by comparing the mean squared error of the training and test data.

IoT gaining knowledge of strategies can are expecting rainfall by using inferring hidden shapes from recorded meteorological records. Rainfall forecasting refers to information weather-associated parameters which includes temperature, strain, humidity, wind velocity, and so on. This paper proposes a rainfall forecasting system the use of logistic regression. The gadget runs a forecasting technique primarily based on ancient weather information and

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generates one of five categories of rainfall, in conjunction with wind pace and temperature. This rainfall forecasting system presently captures climate facts from ``underground'' for 11 of his cities in Myanmar and uses it to check the forecasting manner. The models predict water levels through river gauges and identify areas most affected by rainfall. However, these models are not able to find out hidden styles in rainfall information. Artificial intelligence has the potential to use computational methods by means of processing the hidden know-how won from special styles in historical weather statistics. This sort of rainfall forecast allows in taking early selections to prevent rainfall situations from taking place. Intense rainfall has extended considerably, inflicting hydrological and meteorological disasters. Predicting rainfall can reduce threat and predict hydro meteorological dangers. This study predicts rainfall based at the Dipole Mode Index (DMI) and weather margins, in addition to numerous parameters which includes temperature, humidity, sunshine hours, and wind velocity are preferred as important parameters.

1.1 Contribution

The contribution of the research is Rainfall prediction process using (IOT) sensor using based on the machine learning process to analyze the characteristics of rainfall runoff, cumulative rainfall and representative cumulative amount are constructed as time series data. The sources of rainfall data are taken the previous year's rainfall and water levels measured by relatively new remote sensing technologies such as ground-based rain gauges, satellites, multi-sensor systems, and radar. The proposed LRRPT algorithm is used to classify the precision of rainfall performance.

2. Related Work

Both agricultural water use and dam storage capacity are influenced by rainfall. Due to the effects of global warming and other variables, the timing and amount of rainfall is difficult to predict [1]. Artificial intelligence (AI), machine learning (ML), and deep learning (DL) can use factors such as previous year's rainfall, climate change, and weather conditions to predict the amount of rainfall in a specific region [2]. Unexpected rain events can result in precipitation and damage to guy-made structures. Complete data class, in conjunction with studies, assessment, exploration, and interpretation, is needed to uncover rainfall that can help governments avoid human deaths, agricultural screw ups, and animal deaths. [3] Device getting to know and deep studying systems are being developed to evaluate and manipulate vital rainfall information. An agricultural approach known as Yield mapping makes use of supervised device studying algorithms to locate styles in massive datasets that can be used for crop planning. A key issue in agriculture is the usage of system mastering algorithms to estimate crop yield increases [4].The current study provides an in-depth analysis of the application of machine learning to predict crop yields in various datasets. The research papers reviewed here are mainly the latest ones, which shows the importance of this research field [5].

The techniques, features, and qualities utilized in research related to crop yield prediction were extracted from these research and associated in this look at. Our studies indicates that soil type, rainfall, season, and temperature are the maximum typically influencing factors. Used features in models, with random forest being the most common method. Rainfall prediction is very important in various situations and circumstances [6]. Damage from unexpected and excessive rainfall can be greatly reduced by taking appropriate safety precautions in advance. Climate change makes accurate precipitation predictions more difficult than ever [7]. Records mining algorithms can expect rainfall by means of figuring out hidden styles of meteorological variables from preceding records [8]. This look at contributes by means of investigating the software of his information mining methods to rainfall prediction for the town of Austin. Ok-Nearest buddies (KNN) and selection bushes are some of the strategies used [9]. This dataset is from a weather forecast service and carries a big wide variety of atmospheric parameters. Accurately predicting rainfall is a completely essential venture and has a major effect on human existence [10].

The usage of machine mastering (ML) inside the meteorological discipline affords an answer to improve the accuracy of rainfall prediction [11]. Within the identical course, this examine proposes a powerful dimensionality reduction method to predict rainfall phenomena [12]. First, use packer-based feature selection (FS) technique [13] to identify the most relevant features that play a key role in predicting rainfall events from meteorological datasets. Important element afterwards, analysis (PCA) is integrated with the whole dataset and the chosen characteristic dataset to lessen the data dimensionality [14]. In the end, a comprehensive comparative evaluation of various ML prediction models with characteristic inputs of different nature became achieved. The use of these structures requires the choice of many community parameters, and the parameter choice impacts the version accuracy [15].

One way is to discover the parameters experimentally, and every other is to apply optimization algorithms [16]. In this paper, a survey of diverse optimization techniques used in computational intelligence structures for rainfall prediction is completed [17]. Optimization strategies especially used for this purpose encompass particle swarm optimization, genetic algorithms, and ant colony optimization [18]. Comparisons among fashions are difficult due to the fact all research papers present case studies of rainfall forecasting for geographical areas the usage of one-of-a-kind input information and distinctive forecast lead times [19]. For

rainfall forecasting, the choice of version inputs is as essential as the choice of model parameters, because the set of predictor variables changes depending on the geographic area and the increase or decrease in forecast lead time [20].

Significant changes in rainfall patterns may have severe impacts, such as abnormally heavy rainfall destroying crops and catastrophic floods endangering human lives [21]. To overcome these obstacles, more accurate and reliable rainfall prediction techniques are needed. In this study, we propose a rainfall prediction system based on Internet of Things (IoT) and machine learning (ML) [22]. It is important to note that the model uses a modest amount of computer resources to predict rainfall, which is one of its strengths. In rare cases, a dam can break and release large amounts of water. As a result, some of the water seeps into the soil and "spills" out of the area. [23] The rivers weave along the banks of the station. In addition to the scarcity of goods and assets, rainwater from municipal buildings contains bacteria, and wastewater from garbage dumps can cause various diseases. The purpose of this study is to determine whether water is present on the river bed and to assess whether its condition is good [24]. The machine learning model mostly miss the feature dimension because of scaling factors are not analyzed properly to improve th perfroamne of the result [25].

The Internet of Things (IoT), an emerging technology, makes it easy and advantageous to share data with additional devices across wireless networks. However, due of their continual development and technological advancements, IoT systems are more vulnerable to cyberattacks, which could result in strong assaults [26].

Assaults like the location disclosure, neigh bour, and jellyfish assaults may be effectively countered with the use of the AIRS system. Three response schemes—Full isolation, Partial isolation, and No reaction—are provided by this computation of Degradation Performance (DP) and Trust of Attack. Everyone assess how well our suggested plan compares to the current Secure Routing Attacker Identification (SRAI) methodology. The performance of the response mechanism against neigh bour, jellyfish, and location disclosure assaults in a variety of settings is demonstrated by the results of the experiments [27].

3. Implementation of Proposed Method

Rainfall forecast Models are critical for risk assessment and management of extreme events. Reliable and accurate predictions will greatly contribute to water management strategies, policy advice and analysis, and further evacuation modeling. Therefore, the importance of advanced short- and long-term forecasting systems for rainfall and other hydrological phenomena is strongly emphasized to reduce losses. The effective implementation of rainfall monitoring and forecasting systems is challenging because it requires the availability and reliability of relevant information. Towards the development Linear Regression Rainfall Prediction Technique (LRRPT) for rainfall estimation to select the importance of features. Often there may be a range at the same time to analyze the occurrence of weather conditions with weather impact rate (WIR). The system performs a forecasting process based on historical weather information and produces Categories of rainfall, along with wind velocity and temperature. In keeping with the characteristic importance the ANFIS neural network is carried out to expect the rainfall forecasting depends on the climate record.

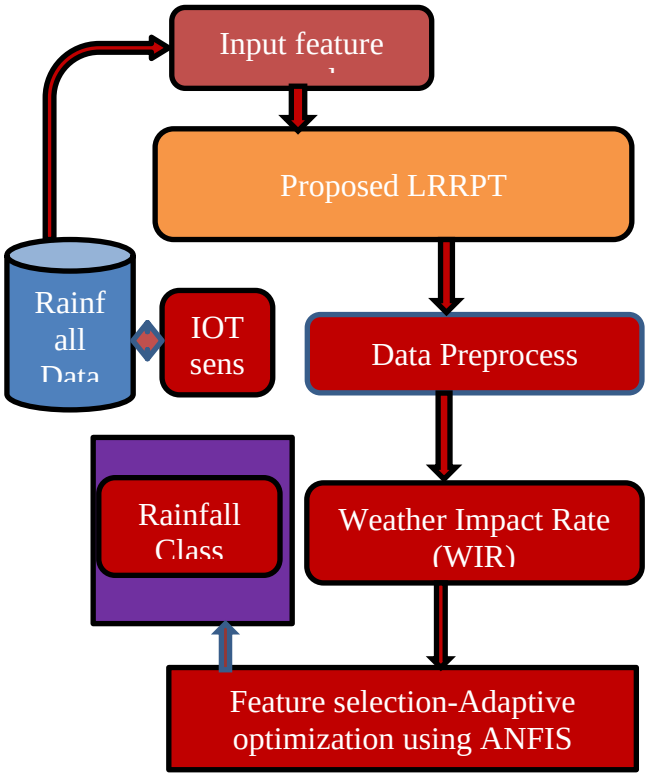

Fig. 1. Rainfall Prediction Proposed Diagram

Figure 1 show the proposed system rainfall data set is constructed based on rainfall scenarios and contains data such as average rainfall depth, maximum rainfall depth, rainfall frequency, grid average flow velocity, etc. for each rainfall event. The proposed machine learning-based LRRPT algorithm is able to predict rainfall and water resources phenomena accurately and efficiently. Rainfall input data are created using an input data construction method that predicts the expected rainfall area for the target watershed via a neural network.

3.1 Data Pre-processing

Initially the preprocessing was carried out to normalize the dataset. Several researches have been conducted on rainfall prediction based on the accumulation of water vapor. On the other hand, atmospheric marginal values and scaling factors

are verified depends on impact factor, mostly for the application in point positioning.

Algorithm: Pre-processing

Input: Rainfall Dataset

Output: Pre-processed dataset Rainfall

Step 1: Read all the weather report

Create Index file Indf ←Assign ID for all

Weather ←RF, form record set IOT

End For

Step 2: Collective record set observation of IOT sensors terms present in report

Perform a calculation for each Rs

For i=0 Indf from Rs=n

Create Attribute value V = the equalized data content extracted from Indf.

Verify Weather report → Rs

Report end if

Data order based on origin ID ←crds

Step 3: Process the rainfall datasets

Verify the presence of character terms related to weather

Count match case files (Cfs) =($\sum_{n=1}^{size(Ds)}$ Text€Di) × Non text char(.)

Return Cfs

Step 4: For All Cfs ← Rs (Indf)

Check the Count terms € symbols, char, numeric Except NLP meaning

Remove Equalized report and index IOT ← (Eqf)

End

Step 5 : Return RF ← weather

End

3.2 Weather Impact Rate (WIR)

Weather conditions are depends on various impact margins. A variety of sensor rain gauges are used to monitor weather conditions to get the average margins of data fall rate. However, its implementation is carried out by PCA to minimize the margin scaling error to ensure the variable the impact variations from feature are analysed depends on whether margins. However, predicting rainfall is a challenging task in meteorology. Most rainfall data have a high degree of irregularity and irregular patterns rarely seen in other time series data.

PCA Algorithm

First, I need to normalize my dataset to ensure that each variable has a mean of 0 and a standard deviation of 1. Let eqn (1),

Input dataset

$X_1 X_2 \ldots\ldots X_n$ (1) Standard deviation $Z = \frac{X-\mu}{\sigma}$ (2)

$$\mu = \{\mu_1, \mu_2 \ldots\ldots \mu_m\} \quad (3)$$

Here μ, $\mu = \{\mu_1, \mu_2 \ldots\ldots \mu_m\}$ (4) σ Is the standard deviation of independent features Let eqn (5),

$$\sigma = \{\sigma_1, \sigma_2 \ldots\ldots \sigma_m\} \quad (5)$$

Covariance Matrix Computation

Covariance, a variable of two or more joints, measures strength and indicates the degree of variation in those variables. Use the total variance of sub form': Let eqn (6),

$$cov(X_1 X_2) = \frac{\sum_{i=1}^{n}(X_{1i}-X_1)(X_{2i}-X_2)}{n-1} \quad (6)$$

The covariance price can be wonderful, negative or 0.

High quality numbers: As x1 max, x2 also min.

Bad: while x1 max, x2 min.

0: there is none mutual feature relation`

Let A be an nXn rectangular matrix and X be a nonzero vector. Call it Equation (7).

$$AX = \lambda X \quad (7)$$

$$y_{ab=1-\frac{x_{ab}-x_b^y}{Max\{Max\{x_{ab}, i=1;2;\ldots;m\}x_{ab}, \underset{N}{Min\{x_{ab}, i=1;2;\ldots;m\}}\}}} \quad (8)$$

For a =1,2,…….q, b = 1,2,…k

$$\gamma(y_{0b,y_{ab}}) = \frac{\Delta_{min+\zeta\Delta_{max}}}{\Delta_{ab+\zeta\Delta_{max}}} \quad for\ a = 1,2,\ldots q\ b \quad (9)$$
$$= 1,2,\ldots.k \quad \ldots\ldots\ldots\ldots$$

, he time factor is very important in such time series data because rainfall data changes significantly over time. Developing an effective predictive model requires a detailed analysis of the effect of time on predictive accuracy.

3.3 Adaptive Neuro - Fuzzy Inference Systems (ANFIS)

The fuzzy membership function creates the rule to predict the feature dependencies by considering the humidity, precipitation, and atmospheric pressure, but from a

climatological perspective, these weather phenomena and their fluctuations. If they remain consistent over long periods of time, they will have a major impact on habitat of rule are marginalize the identify the feature variation

Algorithm ANFIS

Step 1:

Where μ creates membership to each class variable in fuzzy sets Pi, Qi, Ri. this forms the feature class on defined fuzzy rule set to select the feature variation from rainfall rate accordingly forward the classification unit to ANFIS. Hence, the Gaussian function is the optimum choice. The formula for Gaussian function is

$$f(x) = a.\exp\{\frac{(x-b)^2}{2c^2}\} \qquad (10)$$

Step 2:

This creates non linera support fuinction and decision ststements for each clss to marginalize the data

$$o_i^2 = w\text{i} = \mu\text{Pi(x)}.\ \mu\text{Qi(x)}.\ \mu\text{Ri(x)}. \qquad (11)$$

μ using ANFIS algorithm rainfall data analysis weather

Step 3:

The normalized steps are carried out to create fuzzification unit to the neural hidden layers to forward the feature limits to set margins from Rainfall prediction management and IOT systems:

$$o_i^3 = w_i = \frac{\omega}{\sum \omega} \qquad (12)$$

Step 4:

The defeuzzification creates the adaptive node to the consequence parameters by evaluating the weather margins to categorize the threshold actual comparison.

$$o_i^4 = \text{wifi} = w_i.\ (\text{pix+ qiy+riz+si}) \quad (13)$$

Step 5:

The classification unit returns the actual margins f rainfall rate in class by reference

$$o_i^4 = f(x,y,z) = \sum_i w_i f_i = \frac{\sum_i w_i f_i}{\sum_i w_i} \qquad (14)$$

Classical ANFIS favors hybrid learning process, where parameters are updated through two passes and use two different optimization algorithms. The classification unit finalize the feature margins on prediction stage to categorize the result depends on high, low, modeate mediums rainfall rate .

3.4 Linear Regression Rainfall Prediction Technique

The methods produce predictions with different weather condition. Error analysis is needed to determine the best method of predicting rainfall with minimum error. Therefore, the focus of this study is to conduct numerical error analysis of rainfall prediction results using LRRTP. Forecasting rainfall can help prevent flooding and even aid the growth of crops.

$$y_{ab} = \frac{x_{ab} - \text{Min}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{n}\}}{\text{Max}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{n}\}\text{Min}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{n}\}} \; for\ a = 1,2, \ldots, q\ b = 1,2, \ldots, k \ldots\ldots\ldots \qquad (15)$$

$$= \frac{\text{Max}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{m}\} - x_{ab}}{\text{Max}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{n}\}\text{Min}\{x_{ab}, \text{i} = 1; 2; \ldots; \text{m}\}}$$

$$for\ a = 1,2, \ldots, q\ b = 1,2, \ldots, k \ldots\ldots\ldots\ldots \qquad (11)$$

Machine learning equation weather data to help predict rainfall. This weather data Max maximum record and Min minimum uses machine learning classification methods for rainfall prediction.

4. Result and Discussion

The results and performance of the proposed implementation effects will be adjusted and tested and trained cultivation data sets. Classification and reproduction for performance evaluation are conducted to test the accuracy, precision, recall, and time complexity measures obtained during the execution phase. The true and fake position calculates take a look at case dimension weather data processed.

Table 1 Simulation parameters

Parameters	**Values processed**
Simulation tool	Python
Number of data	5000
Dataset	Rainfall data set.

Table 2 describes the compile weather dataset that have been processed to test the functions of the proposed system.

4.1 Analysis of precision

Rainfall prediction analysis is done in terms of the proportion of precipitation that can be predicted. Will be notified in advance as the start of the weather prediction of IOT sensors. Therefore, a detailed fuzzy analysis of crop accuracy generates a forecast dataset.

Table 2 Analysis of Precision

No of Records	**LSTM in %**	**KNN in %**	**LRRPT in %**
500	5	11	16
1000	11	16	27
1500	16	27	32

2000	27	32	39
2500	32	39	46
3000	39	46	52
3500	46	52	57
4000	52	57	61
4500	57	61	75
5000	61	75	93

Show table 1 rainfall forecasts are made only when there is a possibility of rain. The primary goal of our system is to propose an IoT-based automatic weather system to give farmers an idea about whether cultivating or harvesting crops would have been profitable and to avoid and notify disasters. The system suggested in this paper analyze a way to track weather patterns in the input records.

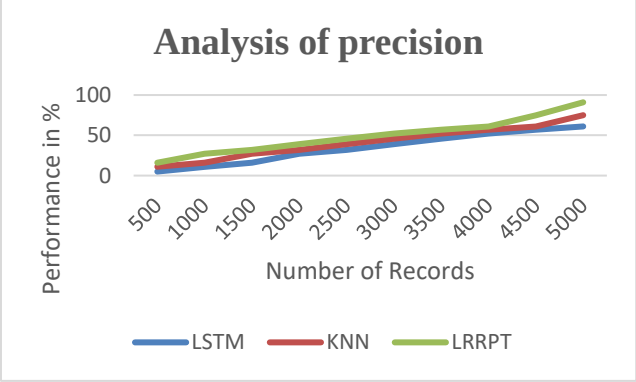

Fig 2. Analysis of precision

Figure 3 shows the true positive accuracy when calculating 60% of the LSTM. KNN is 78% more efficient than the non-implementation method proposed by LRRPT, and LRRPT's evaluation rate is 92%.

4.2 Analysis of Recall

Depending on the growing characteristics of different crops, inaccurate projection set sizes may arise. The different factors are represented as functions of a set size. The effect of object bias publicity intensity on consider mistakes.

Table 2 Analysis of Recall

No of Records	LSTM in %	KNN in %	LRRPT in %
500	5	13	16
1000	13	19	27
1500	19	25	32
2000	29	34	39
2500	32	39	40
3000	39	44	45
3500	46	56	54
4000	52	57	69
4500	57	63	78
5000	61	76	94

Shows table 2 specifically, rules are created by reading the IOT-based smart rainfall monitoring are suggested in this research. Based on rainfall tracked using IOT sensors in the catchment, implemented an LRRPT-based IoT Machine learning to simulate the rainfall-runoff process. Underneath special situations such as floods and droughts, noticeably correct rainfall prediction has excellent importance for agricultural management and disaster prevention and mitigation. Therefore, various calculation techniques had been proposed to be expecting rainfall correctly.

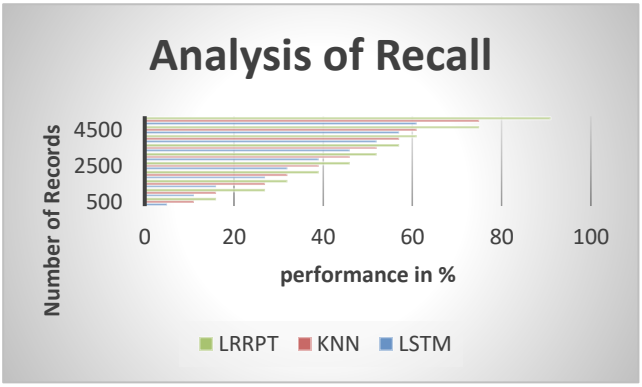

Fig. 3. Analysis of Recall

Recall evaluation utility the data above belongs to one of a kind datasets. Records blocks generate diverse check values in exceptional methods. LSTM has a ratio of 80% of the current method, and KNN has a ratio of 84% of the calculated ratio. The higher the LRRPT 90%, the more the proposed system reminds us of other methods.

4.3 Analysis of F-Measure

F-score also provides F1 score. This is called the F Measure, and it is a scale of experimental accuracy. The F-score reaches the best value of correct precision and recall value, and the worst F-concentration. This means a lower reel value which will result in less accuracy.

Table 3 Analysis of F-Measure

No of Records	LSTM in %	KNN in %	LRRPT in %
500	5	17	16

1000	11	19	27
1500	16	31	32
2000	27	44	39
2500	32	48	46
3000	39	53	52
3500	46	59	57
4000	52	67	61
4500	57	74	75
5000	61	86	92

Show table 3 the result is a rainfall forecasting rule that can provide Hidden however vital patterns and obvious causes. To validate the weather prediction report are LRRPT technique is finished, and its common F measure to predict the rainfall probability and hourly rainfall prediction, and the rules are analysis.

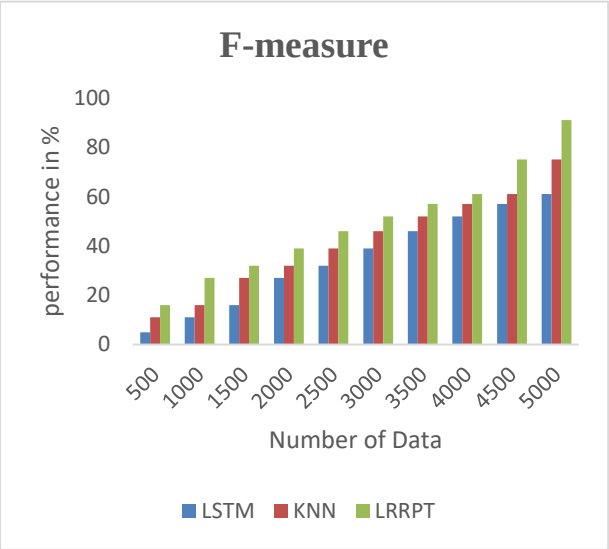

Fig. 4 Analysis of F-measure

4.4 Analysis of Predicting Accuracy

If LRRPT minimizes accurate detection results, analysis of seasonal changes in time could be a good way to predict rainfall weather condition. Complete task processing time according to the operation instructions.

No of Records	LSTM in %	KNN in %	LRRPT in %
500	5	11	16
1000	11	26	27
1500	16	32	32
2000	27	36	39
2500	32	47	46
3000	39	51	52
3500	46	53	57
4000	52	69	61
4500	57	74	75
5000	61	84	91

In rainfall prediction, it is important to clarify unknown critical factors, such a lot of rainfall prediction methods had been proposed to this point. Show table 4 However, most methods have performance limitations due to high data dispersion and limited data amount. In order to accurately neural networks have been proposed, and physical prediction models have been proposed that measure rainfall amounts using real-time flood prediction methods.

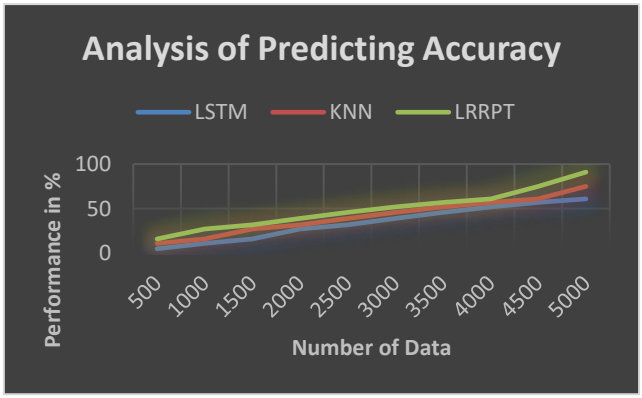

Fig 5: Analysis of Predicting Accuracy

Figure 6 describes the predicting accuracy Record count calculation seconds, minimum 500 records LSTM for calculation timeline evaluation is 61, KNN 76, LRRPT 91%. The time complexity of the proposed method is reduced.

5. Conclusion

In this paper an analysis of rainfall forecasting that is primarily based on machine learning has been built and features LRRPT protection, making it possible to the importance level of a rainfall forecast, in addition to evaluating the value of a rainfall forecast along with other influencing factors. This papers proves the prediction performance according to the actual prediction rate, This ANFIS support feature selection to reduce the dimensionality to improve the classification accuracy. Will be the system makes predictions based on ancient it collects Weather records and produces one in all five rainfall categories, consisting of wind velocity and temperature. This rainfall forecasting device operates based on the currently received Climate facts. The metropolis and assessments the forecast pattern. Assessments have proven that the machine has a rainfall prediction accuracy of up to 91%.

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