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Prediction of Disease for Banana using Wireless Sensor Network and Machine Learning

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***Abstract*—Weather plays major role in farm production. It influences growth of crop, total yield, pest and diseases occurrences, fertilizer and water need. Farming reliant on weather and its moody conditions nowadays. So, climate change results to unpredictable situation and beyond the human control. In this context wireless sensor network will sense real time information from the field. Our system will provide the temperature, relative humidity and rainfall information. It will give the alert about the disease favorable condition on farm to user for banana. Predicted and actual data is compared and it giving the 76% accuracy over the traditional followed method. We also developed the machine learning model here to predict the disease based on the past data. We used temperature, relative humidity and rainfall to train our machine learning model. Here prediction of disease on past data will import to make action plan to user. It gives us the accuracy of 58% for disease prediction. The average accuracy of the system for prediction of disease is 67%.**

***Keywords*— Precision Agriculture, Internet of Things, Machine learning.**

I. INTRODUCTION

Banana is the important fruit crop in India after mango. It is important and favorite due to through year availability, cost, nutritive and medicinal value. India is leading country in case of banana production. As Andhra Pradesh, Assam, Gujarat, Karnataka, Maharashtra and Tamil Nadu etc are the major banana production state in India. Banana is tropical crop, temperature range to grow 15ºC-35ºC with 75-85% relative humidity. Banana disease are Panama wilt, leaf spot (Sigatoka), anthracnose etc. and viral diseases. Panama wilt attack the root and its soil born disease. Sigatoka which causes the light-yellow spot and further grow in size and colour turned into brown. Sigatoka causes the small and unevenly ripened banana. Fig. 1 show the diseases and pest of banana.

Relative humidity and temperature often help to predict the various disease and pest. Based on weather monitoring farmers plans their activity like snowing, protection, harvesting and which results into avoiding the weather effect and yield loss. Weather monitoring having the number of measurement options which gives the information about the soil, crop etc. some of them are temperature, relative humidity, soil moisture, rainfall and wind speed/direction. These parameters can be used for field operation like irrigation, pest control and right time for fertilization. Now days agriculture activities based on weather information is crucial for successful farm management. Thus ensures the sustainable farming. In this context our wireless sensor network will collect the real time weather data and sent it remote server. Algorithms will run to check for the alert to be send to farmer regarding the disease favorable conditions or not on farm. Also, we created the machine learning model which is trained using captured historical data by same WSN system. When we give the current input of temperature, relative humidity and rainfall. It will predict the disease favorable conditions or not.

Fig. 1 Diseases and pest of banana

II. RELATED WORK

The author A. K. Tripathy [9] proposed Wireless sensor network and Data mining approach for identification of Leaf spot disease of groundnut crop. The data conducted from 4 consecutive seasons of Rabi and Kharif in low to medium rainfall region. WSN is used to capture the data from the field like temperature, humidity, leaf wetness etc. Then the data mining techniques like Naïve Bayes classification and multivariate regression mining has been applied to the data received by WSN. The author M. Bhange and H. A. Hingoliwala [8] developed a web-based system for pomegranate disease detection. In this system, the Image processing and data mining techniques has been used. When user upload the images, the system identifies the pomegranate fruit and leaf is infected by bacterial blight or not. Initially features are extracted from the uploaded image on basis of colour, CCV and morphology parameters, then clustering is performed using K-means algorithm. and then SVM is applied to classify the images as diseased or non-diseased. The author Ilaria Pertot [13] proposed a web-based system for identifying plant diseases for strawberry fruit. The intended users for these systems are generally non experts. This web-based tool allows user to user to upload picture from desktop as well as smart phone or short text description. The farmer in the field observes the symptomatic plant and compares the symptoms on the plant with the images provided by the web-based tool. This system responds to the user with identification of the most probable disease. The author T. Ojha [7] presented use of Wireless Sensor Networks in the agriculture domain. In this review paper the author presented challenges and issues associated with deployment of WSN for advanced and improved farming. Presenter discussed requirements, devices, sensors and communication techniques associated with WSN use in farming. The author B. Balaji Bhanu [6] proposed an agriculture monitoring system using WSN that will help to increase quality of farming and productivity. As well as the system will save a lot of time as there will not be need of manual observation of temperature, carbon dioxide and humidity. These parameters will be observed by WSN with more accuracy than manual method. By implementing this, the farmer can observe the environmental conditions that will helps to grow the good quality of crop. In the case of critical change in one of these parameters (humidity, carbon dioxide, temperature) the farmer will get email or text message from system.

III. SYSTEM ARCHITECTURE

Figure 2 depicts the overall architecture of the system. Here sensors are going the sense the real time data of relative humidity, temperature and rainfall. Those sensed data send to the remote server for further data analysis and prediction of disease. Sensor nodes are placed on the field in such manner that it will capture the data properly and in corrective way. Sensor nodes sense the data as per customized and set time interval. Interaction of end user farmer with the system using web application and android app. On mobile user will getting immediate access to current data of relative humidity, temperature and rainfall. Also, he will be getting the alert from the system related to disease severity

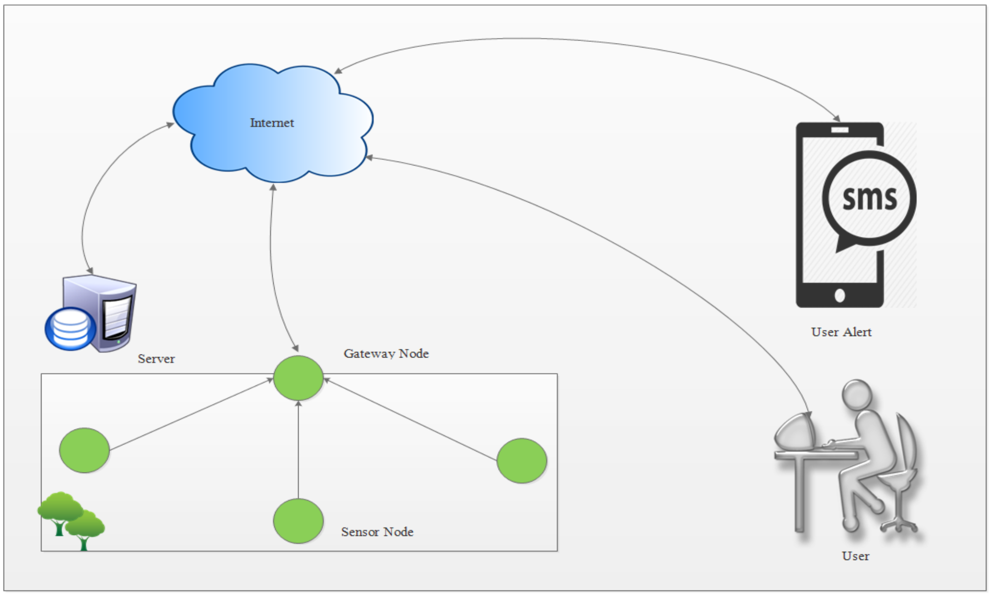

Fig. 1 Sensor nodes deployed on field

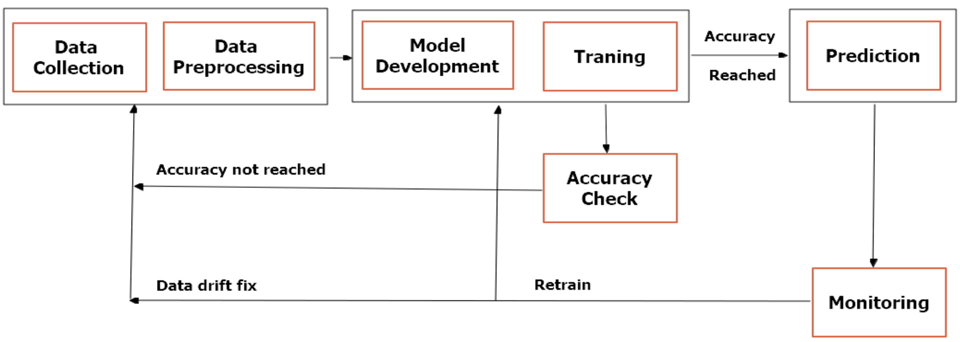

Fig. 3 Machine Learning workflow

Figure 3 shows the typical machine learning workflow. In first step it will require to collect the data that needed to train the machine learning model. Data required to train the machine learning model is captured by wireless sensor network which is deployed on farm. Then we done the data preprocessing to make the data ready for training purpose. It contains the missing data filling, make the scaling of the data, check of distribution of data, finding the outlier etc. we trained the model using the logistic regressing algorithm. Features used are temperature, relative humidity and rainfall to train the model. Also done the hyper parameter tuning to get the best testing accuracy. This training process is repeated till certain accuracy is achieved. Then deployed this model on real time environment. If we are not getting the as expected the results from the model on production so we need to do the retraining the model again with new data.

IV. ALGORITHMS

Algorithm to sense relative humidity, temperature and rainfall sensor data

1. Input: Relative humidity, temperature and rainfall of farm sensed at real time.
   Output: Sensed data send to server.

2 Read the sensed data from respective sensors and send it to server.

3.Go to sleep mode for 30 minutes.

4. Repeat steps 2 and 3 again.

5. End

To get relative humidity, temperature and rainfall sensor data of farm in real time above algorithm is used. Sensed data send to the remote server for further analysis. We are taking the reading of the data after the interval of 30 minutes, which is decided under the guidance of domain expert and requirement of particular crop.

Algorithm for disease alert

1. Input: Farm real time data of relative humidity, temperature and rainfall.
   Output: Disease favourable conditions (Yes/No) and Disease Severity.
1. Set the threshold values for relative humidity, temperature and rainfall.
2. Compare the input values with threshold values set in step 1.
3. Find the Cumulative count consecutively for 6 days.
4. If (Cumulative count > 36 && Day's count=2)
   {
   Disease Severity = VERY HIGH
   }
   else if (Cumulative count > 36 and Day's count=4)
   {
   Disease Severity = HIGH
   }
   else
   {
   Disease Severity = NORMAL
   }
5. Send the alert to the farmer based on the disease severity level in step 4.
   If (Disease Severity = VERY HIGH)
   {
   Disease favourable conditions=Yes;
   Alert Message= Disease severity is VERY HIGH at your farm, please take immediate action with the help of domain expert.
   }
   Else if (Disease Severity = HIGH)
   {
   Disease favourable conditions=Yes;
   Alert Message= Disease severity is HIGH at your farm, please take immediate action with the help of domain expert.
   }
   Else
   {
   Disease favourable conditions=No;
   Alert Message= Disease severity is normal at your farm; this alert is for your kind information.
   }
6. If (cumulative count > 36)
   {
   Cumulative count=0;
   Day's count=0;
   }
7. End.

As we are sending the alert about sigatoka disease to farmer by using the above algorithm. This algorithm continuously under execution after receiving the real time readings from the field. If the values of temperature, relative humidity and rain sensor are greater than threshold values the cumulative count is increased by one. Those count is maintained for 7 days duration. If the count is reached 36 within 2 days means for last two days there is favourable temperature, relative humidity and rain on the farm for sigatoka disease and also disease severity is very high or major.

V. RESULT DISCUSSION

The land selected for this experiment is from the Kolhapur district of Maharashtra state in which some areas are under the banana cultivation. We targeted especially the rainy season which is favourable for the disease spread on banana crop. In this season relative humidity, rainfall and sudden rise and fall in temperature are major cause of disease and pest attack. Disease alert algorithm running continuously and checking is threshold criteria is met and as per that sending the alert to the farmer. This algorithm gives the precise results as compare to the traditional open eye observation by farmer on field. The graph in figure 4 show the results recorded for the algorithm. As threshold of cumulative count is reaching fast as compare to traditional method. This is possible because this system is running 24*7 on field which is not possible to the farmer to be present physically and observe the same.

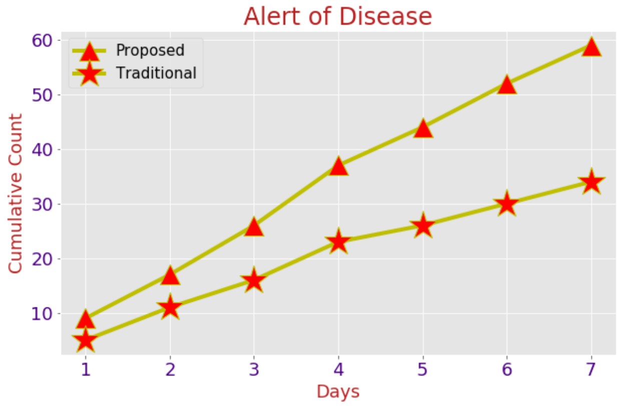

Fig. 4 Alert of Disease

Figure 5 show the bar graph for alerted vs detected. Here we observed the more alert are during the month of July, August and September in which the major rainfall occurs in the district.

Accuracy = (Actual Detected/Number of times alerted) *100
= (25/19) *100
=76%
We got the accuracy of the disease alert algorithm is 76%.

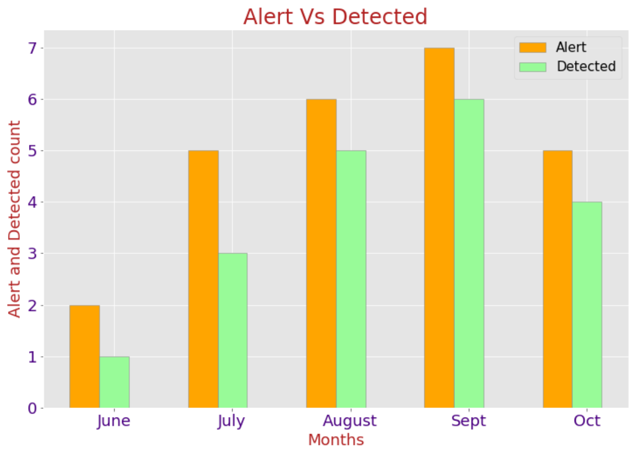

Fig. 5 Alerted Vs Detected

	A	B	C	D	E	F
1	Time	Temperature	Humidity	Rainfall	Date	DiseaseAttack
2	00:00	19.5	72	0	01-06-2019	0
3	01:00	19.6	72	0	01-06-2019	0
4	02:00	19.8	68	1	01-06-2019	0
5	03:00	19.5	71	1	01-06-2019	1
6	04:00	18.1	67	1	01-06-2019	1
7	05:00	18.5	67	0	01-06-2019	0
8	06:00	18.6	70	0	01-06-2019	0
9	07:00	24	71	0	01-06-2019	0
10	08:00	25.1	72	0	01-06-2019	0
11	09:00	24.2	70	0	01-06-2019	0
12	10:00	25.4	70	0	01-06-2019	0
13	11:00	35.3	68	0	01-06-2019	0
14	12:00	35.2	68	0	01-06-2019	0
15	13:00	31.9	67	0	01-06-2019	0

Fig. 6 Sample dataset to train Machine learning model

As historical data of weather is import for the prediction so we developed the machine learning model which is trained by using the captured data by wireless sensor network. Figure 6 shows the sample data which we used to train the model. This model is mainly trained by using the temperature, relative humidity, rainfall feature parameters. Here time and data parameters show the reading time and date respectively. This are also import because major disease attack is occurred during the month of June to October month i.e., in the rainy season.

Table 1 describe the summary of the dataset used to train the model. Total number of records were 5136. As low standard deviation represents the data is normally distributed. As we recorded this reading from June to December months. So mean temperature and relative humidity are 22.57 and 69.23 respectively. Low temperature and relative humidity are 13 and 51. Here 25%, 50% and 75% are the percentile values for the dataset. Which are 19, 21.1 and 22.2 for the temperature. We used to logistic regression to train to model. Model gives the result in binary form as 1 and 0 i.e., disease attack or not. We got the 58% accuracy of the model for disease prediction. As we are trained the model in incremental way means that as data captured increase by WSN we do the retraining the model once again. Initially we have very less size dataset. As accuracy is less for the model because of the less size of the dataset as more data it is expected the accuracy will increase accordingly. Also, other features need to be added for training like weather alert by government agencies. The overall accuracy of the system using both the disease prediction system is 67%.

	Temperature	**Relative Humidity**
Count	5136	5136
Mean	22.57	69.23
Std	4.49	10.44
25%	19	60
50%	22.1	70
75%	22.2	79
Min	13	51
Max	36	86

Table 1 Summary of the dataset

VI. CONCLUSIONS

Here we presented the wireless sensor network system to give the real time farm temperate, relative humidity and rainfall. Which are the major parameters for prediction of farm weather conditions. Historical data also crucial to make the future decision so our machine learning model will help to predict the future based on trained past data. As practical implementation of this technologies helps to farmers to avoid the crop loss and this also help to achieve the sustainable agriculture which is one of the challenges of modern India. As a future work we can conduct the same experiment for the number of years and for different seasons. So, we will get the deep understanding related to diseases. Also, machine learning accuracy depends on large number of dataset size to train the model which we get after conducting the experiment for number of years.

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