

# Early Detection of Pomegranate Disease Using Machine Learning and IoT

Dnyanesh Nawale <sup>1</sup>, Kunal Patil <sup>2</sup>, Rakesh Mahajan <sup>3</sup>, Sona Pawara <sup>4</sup>U.G. Student, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, India <sup>1,2,3</sup>Associate Professor, Department of Computer Engineering, Sinhgad Academy of Engineering, Pune, India <sup>4</sup>

**ABSTRACT:** Pomegranate is extremely established fruit in Asian country and earns high profit. But due to dynamical atmospheric condition like variations in temperature, precipitation additionally as relative humidity pomegranate plants are infected by numerous diseases which ends in reduction of the assembly. Crop diseases will be uncovered in its early stages with the assistance of projected system by using Hidden Markov Model and sensor network, which is able to offer alerts to the farmer and therefore the professional. The Pomegranate fruit and leaves are laid low with numerous diseases aggravated by plant life, microorganism and therefore the atmospheric condition. These diseases include bacterial Blight, Fruit Spot, Fruit rot and Leaf spot. Air temperature, Air humidness, leaf wetness amount and soil wetness are the aspects that have severe impact on the disease development in pomegranate. The system uses numerous parameters together with temperature, humidity and uses gsm module for wireless digital communication.

**KEYWORDS:** IoT, Bacterial Blight, GSM, Hidden Markov Model.

## I. INTRODUCTION

India is an agricultural country. Pomegranate is one of the key crop that is cultivated on massive scale in Asian country. The country has registered sizeable increase in cultivation and production, over the last one decade. Asian country has been manufacturing pomegranate at larger extent. Export of pomegranate is increasing year by year. Over a past few years agriculture has seen numerous swings and is changing into a supply of financial gain generation.

Pomegranate is a domestic plant of Iran and is additionally grow well in Himalaya Mountains in northern Asian country since earlier period. It ordinarily grows below 1000m in altitude and cultivates well in arid and semi-arid climates. A temperature between 25-38 degree is well matched for pomegranate plant. In India, the assembly regarding 11.0 lakh tons of pomegranate is dispensed on a locality of 1.5 lakh hectares with a production about. Maharashtra is that the largest producer of pomegranate in India contributive 2/3 rd of total production.

Over the previous couple of years the standard of pomegranate has degraded thanks to several reasons. Dynamical environmental conditions end up in generation of microorganism, plant life and viruses on leaves and fruits. the key diseases occurring on pomegranate are bacterial Blight, Fruit Spot, Fruit Rot and Leaf Spots. bacterial blight is the most evident illness damaging the pomegranate crop small to larger proportion, thereby inflicting major losses in production.

To prevent diseases farmers spray large quantity of pesticides that end in increasing the price of production. The diseases are known solely after the infection, however its takes up lots of time and have adverse effects.

In the current scenario Indian farmers lack information regarding the utilization of pesticides, hence precision agriculture helps farmers with management of crops. Using some high technology an intelligent decision system befittingly detects additionally as diagnose the diseases on plant for their prevention and to restrict their growth.

### A. Internet of Things (IoT)

An system of connected physical objects that are accessible through web is thought as internet of Things (IoT). The factor in IoT may well be something with inbuilt sensors, with assigned information science address and skill to gather and transfer the information over network. Devices embedded in numerous systems connected to internet by IOT.

# International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 7, Issue 6, June 2018

## B. Machine Learning

An application of artificial intelligence within which system has the power to find out automatically and while not being explicitly programmed improves itself from experience. The first aim of machine learning is to permit the computers to find out automatically without human intervention or consistence and alter actions consequently.

In projected system we tend to use numerous sensors to gather the real time info of assorted agro meteoric parameters like temperature, leaf wetness, humidity, moisture. the information collected from device is going to be gathered at central node and can be send to base station.

## II. LITERATURE SURVEY

Hidden Markov Model is introduced in [1] for developing a observance system which is able to determine diseases on grapes crop in its early stages. Numerous environmental conditions like temperature, humidity, leaf condition amount, etc. are examined by Hidden Markov Model to predict the disease on Grape plant.

M Dhakate [2] projected a pomegranate disease detection system using image processing and neural network. numerous pomegranate diseases are mentioned together with bacterial Blight, Fruit Spot, Fruit rot and Leaf spot. Grey level co-occurrence matrix (GLCM) is developed to get statistical texture options.

In [3] using machine learning approach, 2 image sensing strategies that modify an automatic observation to capture flowers and seedpods of soybeans in real fields is conferred. numerous environmental conditions like weather, temperature, humidity, radiation, soil condition, etc. are analyzed.

Precision Agriculture has been employed in [4] for pomegranate plant farming. Author has mentioned regarding best usage of water in irrigation, correct nutrient management to plant and avoid crop losses because of diseases and pests with correct planning of sprays.

Author in [5] discussed regarding e-AGROBOT, a agricultural robot, that is ground based mostly accustomed solve challenges existing in massive and complicated solutions that are based on satellite and help desk type of solutions out there as m-Services.

[6] presents an summary of existing reportable techniques helpful in detection of diseases of agricultural merchandise. A comparative study of various strategies based on the type of agricultural product, methodology and its potency together with the benefits and downsides is additionally mentioned.

In [7] author has projected plan of precision farming using ideas of wireless sensor network with an IOT cloud . Author has mentioned regarding attainable uses of Wireless sensor Network (WSN) and IoT Cloud in Agriculture.

[8] proposes a novel approach for Alzheimer's disease progression modeling. Assessment of disease progression is done with the help of Hidden Markov Model.

## III. MOTIVATION

India is an agricultural country. Agriculture plays a big role in socio-economic material of Asian country. In Asian country agriculture is contributive regarding sixteen percent (16%) of total gross domestic product and ten percent of total exports. Agriculture is named because the backbone of Indian Economy. Our Farmers work day and night attempting to feed our population that counts over 1.21 billion.

But today, quality and amount of agricultural products are decreasing. This can be because of the environmental factors, pests, diseases and additional spraying of chemical pesticides etc. With evolving technologies, new construct of precision agriculture is additionally evolving. Several farmers are able to implement and lots of are implementing this idea. These our efforts are simply very little addition to the precision farming. So the farmer can detect the diseases on pomegranate plant in its early stages and take the required measures to avoid the disease. These are our honest efforts to save our "Food Donor" and facilitate him to extend the standard and quantity of fruit plants and indirectly serving the nation.

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## IV. SYSTEM ARCHITECTURE

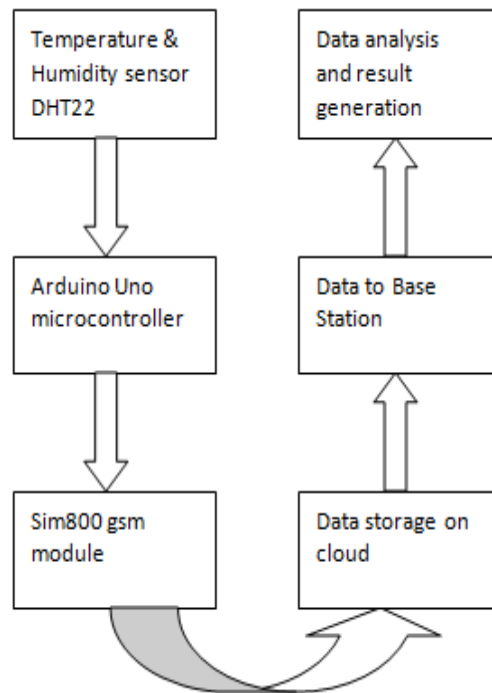


Figure1. System Architecture

Temperature and Humidity sensor DHT22 will send readings of temperature and humidity to Arduino which will act as an interface between sensor and gsm module. Then Arduino will send data to Sim800c gsm module which will get upload on ThingSpeak cloud. Once the data get uploaded on cloud , the base station will retrieve data from cloud . Base station consists of a system with Hidden Markov Model and previously existing datasets will analyze data retrieved and generates output.

## V. SYSTEM SPECIFICATION

### A. Generic DHT22 Digital Temperature and Humidity Sensor Module AM2302



Figure2. DHT22

It is low cost sensor module. It needs 3-5 V power supply. It is sensible for 0-100% humidness readings with 2-5% accuracy. It measures the temperature in range of -40 to 80 degree Celsius.

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### B. Arduino Uno microcontroller



Figure3.Arduino Uno

Arduino Uno microcontroller is based on ATmega328P. It has fourteen digital input/output pins, six analog inputs, a sixteen MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. In proposed system it is accustomed as interface between sensor and gsm module.

### C. SIM800 Quad band GSM / GPRS MODULE WITH SMA ANTENNA for Arduino



Figure4.GSM 800 Module

SIM800 is a serial Quad Band GSM/GPRS modem that is a complete Quad-band GSM/GPRS solution. Quad-band supported by sim 800 is 850/900/1800/1900MHz. Sim800 is beneficial for transmission of voice, sms and data information with low power consumption.

## VI. METHODOLOGY

Hidden Markov model is based on Markov model but the basic difference between HMM and Markov model is that in Markov model states are visible to the user whereas in hidden Markov model states are invisible or hidden from the user. In Markov model, we have to predict the state sequence or find the state by using the observations generated by that sequence. There are different orders of hidden Markov model such as first order, second order. But here in this project, we have used first-order hidden Markov model in which the probability of next state depends only on the previous one state.

There are two different states in hidden Markov model:

- 1) Hidden state: States which is not observable or hidden to a user

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2) Observable States: States which are observable to us these are also known as observations or symbols.  
A. Proposed Hidden Markov model

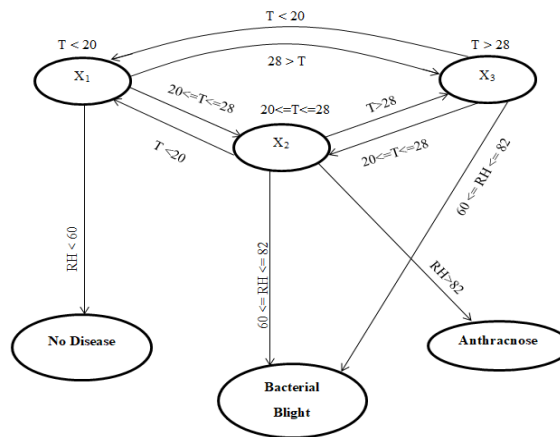


Figure4.Proposed Hidden Markov Model

In our project, we use first-order hidden Markov model. We have real-time readings of to meteorological factors: temperature and humidity. We use these factors to model the hidden Markov model. There are namely 3 hidden States which are x1: when the temperature is less than 20 degree Celsius, x2: when the temperature is in the range of 20 degree Celsius to 28 degree Celsius, x3: temperature is above 28 degree Celsius. We have three observing States namely: no disease, bacterial blight, anthracnose. Observing states are the diseases we want to predict.

hidden States: {x1,x2,x3}

observing States: {no disease, anthracnose, bacterial bright }

we have training data of temperature and relative humidity and We trained a model on this data. We calculated different probabilities for a model by considering below points: in the project, we used relative humidity has a key factor, to calculate the emission probabilities. Following are the formula that we used to calculate different probabilities.

1) Starting probability(pi) :

Starting probability of state  $x_i$  is given as

$$P_i(x_i) = \frac{\text{No of samples with state } x_i}{\text{Total No of samples}}$$

where  $1 \leq i \leq N$

2) Transition Probability (A):

Transition probability from state  $x_i$  to  $x_{i+1}$  is given as

$$A(x_i, x_{i+1}) = \frac{\text{No of samples with state } x_i \text{ having next state as } x_{i+1}}{\text{Total No of samples with state } x_i}$$

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### 3) Emission Probability (B):

Emission Probability from state  $x_i$  to  $O_j$  is given as

$$B(x_i, O_j) = \frac{\text{No of samples with state } x_i \text{ having observations as } O_j}{\text{Total No of samples with state } x_i}$$

where  $1 \leq i \leq N$   
and  $1 \leq j \leq m$

Our project works as follows :

- 1) Take an input of temperature and relative humidity from DHT 22 sensor.
  - 2) Pass the reading to Arduino and from Arduino to GSM sim 800c module which will send the reading to ThingSpeak IoT cloud platform.
  - 3) Read the reading from ThingSpeak IoT platform to base station. After reading the readings, store them in the database.
  - 4) Use the formulas given above to calculate the starting probability, transition Probability, and emission probability.
  - 5) Build three different models for three different diseases that is model for anthracnose, a model for bacterial blight and model for no disease.
  - 6) After building the three models Bayes rule to obtain the model with the highest probability.
- Consider  $m = \{m_1, m_2, m_3\}$  and  
 $D = \{\text{anthracnose, bacterial blight, no disease}\}$  be a set of diseases.  
 According to the point given above Bayes rule for a project can be formulated as:

$$P(m_i | O) = \frac{P(O | m_i) \cdot P(m_i)}{P(D_i)}$$

where  $1 < i < 3$

All three parameters on the right side are calculated as below:

- Observation sequence we have a temperature(T) and relative humidity(RH) so we will use these factors to calculate above parameters. Using temperature we can decide the state 'X' to be considered while calculations. Similarly using relative humidity we can decide the state 'r' to be considered while calculations.
  - Here 'r' belongs to different humidity levels.
  - $P(m_i | O) = P(m_i | x_i, r_i)$  is nothing but the emission probability of that observation sequence or disease in state x and calculated using r.
  - $P(m_i | O) = P(m_i | x_i, r_i) = B(x_i, D_i)$
  - P(O) is nothing but the starting probability of State X and R which we calculated from training data.
  - $P(O) = \pi(x) \cdot \pi(r)$
  - $P(D_i)$  is nothing but the maximum probability of most probable part taken by model to generate observation as a disease  $D_i$ . This probability can be calculated by using a viterbi algorithm.
  - $P(D_i) = \text{Vit}(D_i)$
  - where  $\text{Vit}(D_i)$  is the viterbic probability of disease  $= D_i$ .
- 7) The model with the highest probability of  $P(O | M_i)$  is selected as the final result.
  - 8) If the disease is detected then the SMS alert is sent to the farmer and professional.

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## VII. RESULT

Confusion Matrix		Target			
		Positive	Negative		
Model	Positive	64	146	Positive Predictive Value	0.65
	Negative	33	17	Negative Predictive Value	0.89
		Sensitivity	Specificity	Accuracy = 0.807	
		0.79	0.89		

Figure5.Confusion Matrix

Given above is the confusion matrix which depicts about results of output generated by proposed HMM . According to obtained results , accuracy of proposed model is 0.807 and in percentage it would be 80.7%.

## VIII. CONCLUSION

Generally India is dominated by small-holder farmers who work in variable and unpredictable environments. To cater to their needs, there is a need of scoped services. Cost effective solutions which have potential to aid the farmers in real time as well as complex solutions that can have a rich content of information are needed.

In this work we presented the system for detection of pomegranate plant disease and sending alerts to farmers and experts using IoT Technology. The system built above provides farmers with real time detection of disease along with specific use of pesticide. Bacterial Blight which is one of the major diseases occurring on pomegranate can be diagnosed with help of above system.

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