

# A Novel Plant Specimen Detection Technique using IoT

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## Abstract

Ayurveda is a traditional Indian medical system that aims to maintain health and wellness by balancing the mind, body, and spirit and preventing disease rather than treating it. According to the World Health Organization, traditional medicine, primarily in the form of plant drugs, is used by the majority of the population in developing countries to meet their healthcare needs. From ancient times to the present, medicinal herbs have played an important role in Ayurvedic treatment. The essence of Ayurveda and Ayurvedic treatments is medicinal plants that are locally available in various parts of our country. Many diseases can be cured by using natural herbs found in various parts of the country. However, the blooming season and location of availability of these herbs are not known. The primary goal is to create a prototype that determines the evolution of various rare available herbs that can be used to treat diseases in our country. A Node is placed on a specific plant in an area where the species is present, and all growth details are sensed. All sensed values are updated in the cloud accordingly, The user can view the data collected regarding the stage of growth and blossoming of the flower at any time and from any location easily and comfortably. The following data are analyzed that includes determining the angle of the leaf, which predicts the growth of a specific species. The results support the species' blossoming period

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## I. INTRODUCTION

The primary goal is to locate and predict when various rare available plant specimens will bloom. In this paper, the camera module is connected by Raspberry Pi to capture images in real-time. As shown below, the Matlab software is used to load the captured image and calculate the angles of the leaves (petiole, base, apex, vein, and margin angles). The camera records and analyses the changes that occur in a plant. The data collected by the Raspberry Pi camera module and MATLAB is then stored in the cloud. The cloud data is displayed on the web page (or) app. This system allows the user to determine the specimen's growth status.

### 1.1 Motivation

The science of life, the world's oldest medical system, employs medicinal plants, also known as medicinal herbs, in traditional medicinal practices. It approaches health and disease holistically, focusing on preventing and promoting good health and disease prevention.

### *1.2 Introduction to the Internet of Things*

The Internet of Things (IoT) is simply a network of interconnected things/devices that are equipped with sensors, software, network connectivity, and the necessary electronics to collect and exchange data, allowing them to be responsive. The Internet of Things is more than just a concept; it is an architectural framework that allows for integration and data exchange between the physical world and computer systems via existing network infrastructure

### *1.3. Important to IoT components*

Many people mistakenly believe that IoT is a separate technology. Surprisingly, the presence of other independent technologies that are critical components of IoT allows the internet of things to function. The following are the basic elements that make the internet of things a reality: Making physical objects responsive and allowing them to retrieve data and respond to commands is what hardware is all about. The Software allows for data collection, storage, processing, manipulation and instruction. Communication Infrastructure-Themostimportantof all is the communication infrastructure, which consists of protocols and technologies that allow two physical objects to exchange data.

### *1.4 Introduction to Image processing*

Image processing is the process of modifying or extracting useful information from an image. It is a type of signal processing in which an image on input and an image or image characteristics/features are output the three basic steps in image processing are as follows: Importing the image using image acquisition software; Analyzing and manipulating the image; and Output, which can be an altered image or a report based on image analysis. There are two types of image processing methods: analog image processing and digital image processing. Hard copies, such as printouts and photographs, can benefit from analog image processing. When using these visual techniques image analysts employ a variety of interpretation fundamentals. Digital image processing techniques aid in the manipulation of digital images through the use of computers.

### *1.5 OPEN CV:*

Open CV is a free and open-source library with pre-built functions for computer vision projects. The functions were originally written in C and C++, but they have been adapted for use in Python, Java, and MATLAB. The library includes functions useful not only for basic image processing techniques, but also for a variety of gesture detection algorithms. The following are a few Open CV library applications.

- Augmented Reality • Motion Tracking • Gesture Recognition

Open CV is a cross-platform library that can be used on both desktop and mobile platforms such as Windows, Linux, and macOS.

## **II. LITERATURE REVIEW**

K. Lakshmi and S. Gayathri proposed combining Image Processing and IoT to monitor the plant and collect environmental factors like humidity and temperature. In image processing, a recognition system capable of identifying plants by using images of their leaves has been developed, and pesticide use can be controlled using the images. The system applies pre-processing and feature extraction techniques to the image before a pattern matcher compares the information in the image to the information in the database to find potential matches. The color, texture, and shape of the leaf are among the characteristics extracted and compared. leaf can be classified as healthy, or dead based on pattern recognition. I have captured an image from the field and am currently pre-

processing it. Then it was sent to the server. By capturing images alternatively, determine the shape, height, and width of the leaf, as well as its health conditions by taking alternative images.

Nadine JaanD.Caldito, Eusebelle B. Dagdagan, Mark G. Estanislao, Kim Leonard b. Jutic, Mary Regina B. Apsay, Marissa G. Chua, Jeffery F. Calim, Floracito S Camata Plant recognition is a critical issue, particularly for biologists, agricultural researchers, and environmentalists. There is programming that can create a system and recognise an image and match it with information in a database simply by having an image. Plant recognition can be done manually by human experts, but it is a time-consuming and inefficient process. Plant recognition automation is an important process for those who work with plants. The image is converted from RGB to grayscale before proceeding to the extraction and method.

J Suk, S Kim, and I Ryoosensors use real-time non-contact methods to measure plant growth parameters such as stem radius and generate diameter, cross-sectional, and thickening forms of plant stems using measured data. Non-contact sensors were used to avoid causing any damage to the plants while measuring growth parameters. The plant growth measurement system was designed and implemented using infrared sensor-based measurement methods and devices of fixed and rotary types. The system performance is compared and validated using measurement data obtained from practical field parameters.

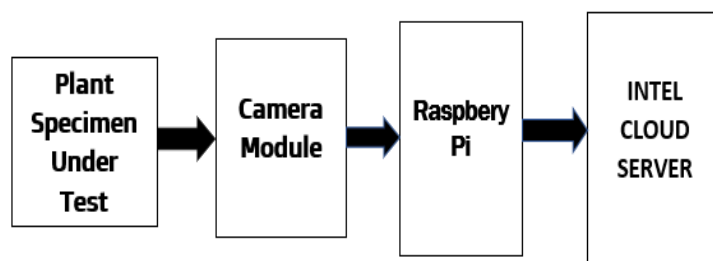
Smithsonian Institution, 1999. Manual of leaf architecture: Morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms. The leaf shape, size, and organisation are described. And how to calculate the angles of the leaf, such as the petiole, base, margin, apex, and veins [5]. Here, I discovered the angles for the leaf, such as the petiole, base, apex, and margin. Also, compare the angles of two leaves, as well as the shapes, height, and width of the leaf.

WiGig networks as well as Machine learning models that are cognitive radio networks are used to extract data from me field [9] [10] [11] [12]

### III. PROPOSED SYSTEM

#### 3.1 Block Diagram:

##### Transmitting End:

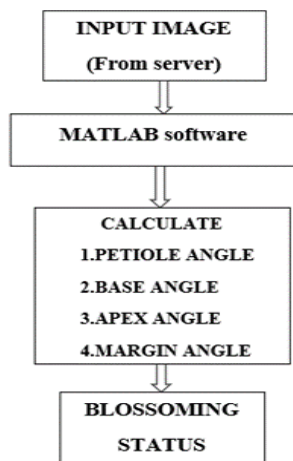


**Figure 1. Transmitting end**

##### Description:

The camera module is used to capture the plant image, and it is connected to the raspberry pi to calculate the values, which are then sent to the cloud server, where user can see the growth stage of the plant leaf angles.

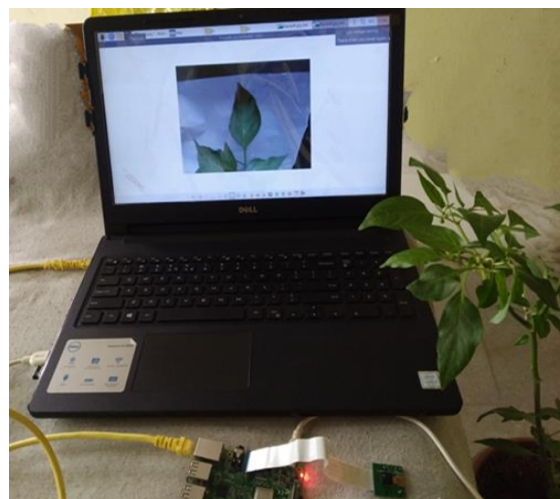
*Processing End:*



The leaf image was collected from the field and loaded into the MATLAB workspace. The input image is then resized and pre-processed, with conversions from RGB to GRAY and GRAY to BINARY. The extraction of features is accomplished through the use of canny edge detection. As a result, it detects the image boundary and determines the angles for the input image, such as the petiole, base, apex, and margin. The WiFi module sends input values to the server (NodeMCU). The information is obtained by the end user via the server. The leaf growth stages are determined by collecting input images for ten days and comparing the specimen from Day 1 to Day 10, as well as the leaf blossoming stages and plant health status.

#### IV. HARDWARE IMPLEMENTATION

##### 4.1 System model:



**Figure. 2 Hardware Image**

With the help of the below flow chat data is analysed from the plant leaf's growth stage.

4.2 Flow Chart:

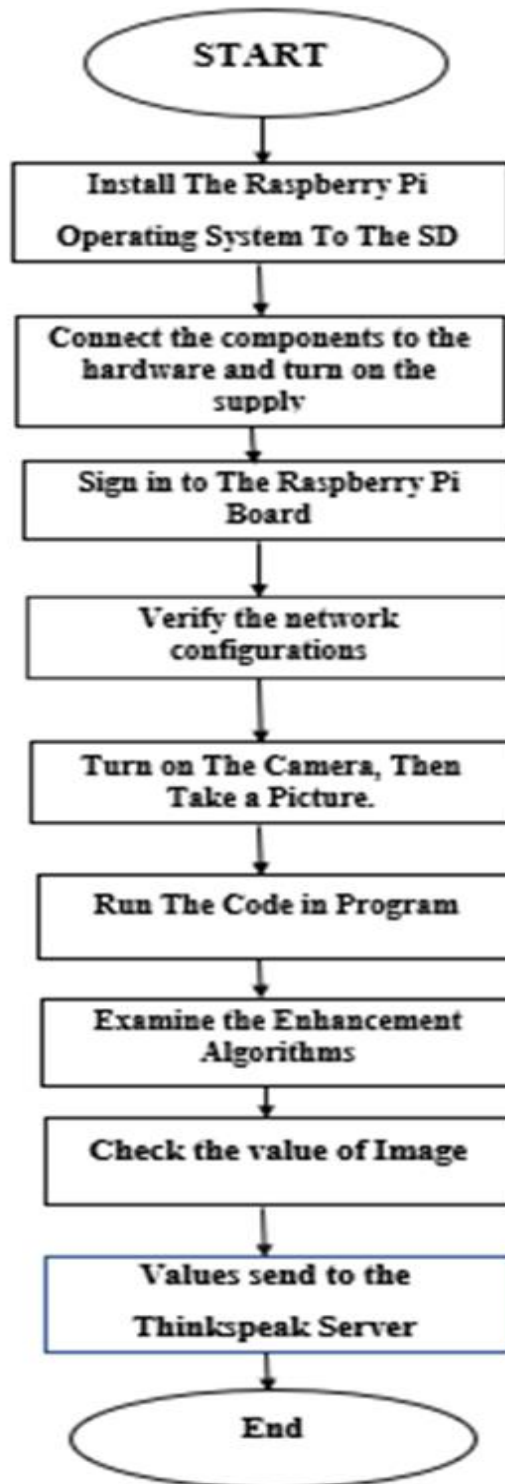


Figure 3. Flow chart

1.3 Algorithm: [Matlab]

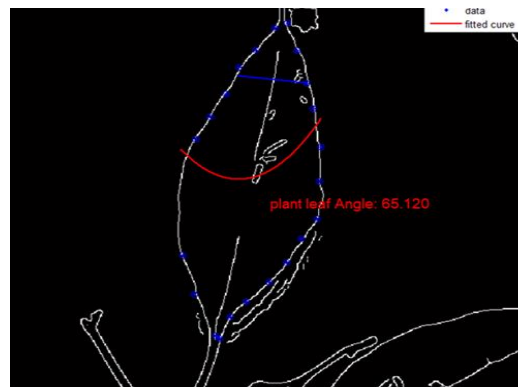
- 1) Find: Determine plant height and leaf angle
- Connect the components to the raspberry and switch on the supply.

- Execute the code in python [ Capture image and sent to the server].
- 2) Check the process of enhancement algorithms.
- 3) Verify the height and width of the input image.
- 4) Image values are sent to the Intelcloud server.

#### 4.4 Computing:

##### 4.A.1 Base angle

The vertex of the base angle is located in the center of the petiole, where the basal most laminar tissue touches the petiole. the angle formed by the vertex and the points at 0.25lm from the base where a line perpendicular to the midvein intersects the margin When measuring the base angle of a leaf with a basal extension ( $lb>0$ ), the angle should be measured from the same vertex point on each side to the leaf's basal most points. The base angle is always measured on the apical side of the rays in leaves with angles greater than  $180^\circ$ . The peltate leaf's circular angle is defined.

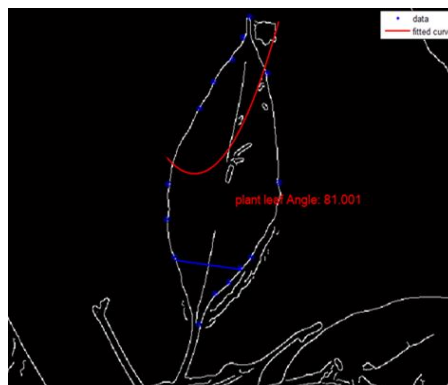


**Figure.4 A1 Base angle**

The input image is captured and loaded into Matlab to determine the leaf's base angle. The plant's leaf angle is 81.001.

##### 4.A.2 Apex angle:

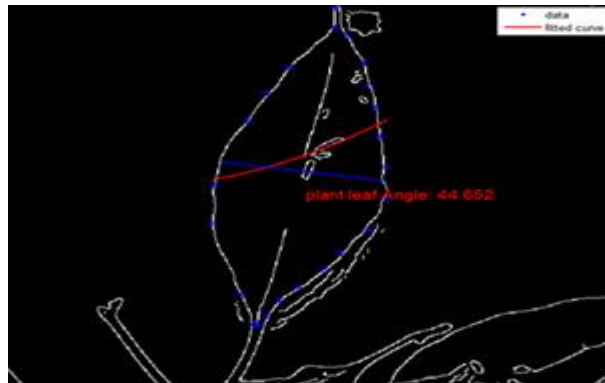
The Angle is formed by a line perpendicular to the midvein and 0.75lm from the base intersecting the margin. The apex angle of leaves with an apical extension ( $la>0$ ) should be measured with the midvein termination as the vertex and the apices of the lobes on each side as the vertex. The apical angle is always measured on the basal side of the rays in leaves with angles greater than  $180^\circ$ .



**Figure.4 A.2 Apex angle**

#### 4.A.3 Margin angle:

TEETH are marginal projections with sinuses indented less than a quarter of the way to the leaf's midvein or long axis. Dentate, serrate, and create teeth are the three types of teeth



**Figure.4 A3 Margin angle**

#### 4.A.4 Petiole angle:

Take note of the petiole's distinguishing features (e.g., width, length, base swollen, base inflated, sessile or other). The leaf angle of the petiole is 61.82 degrees.



**Figure.4 A4 Petiole angle**

*Flow Chart:*

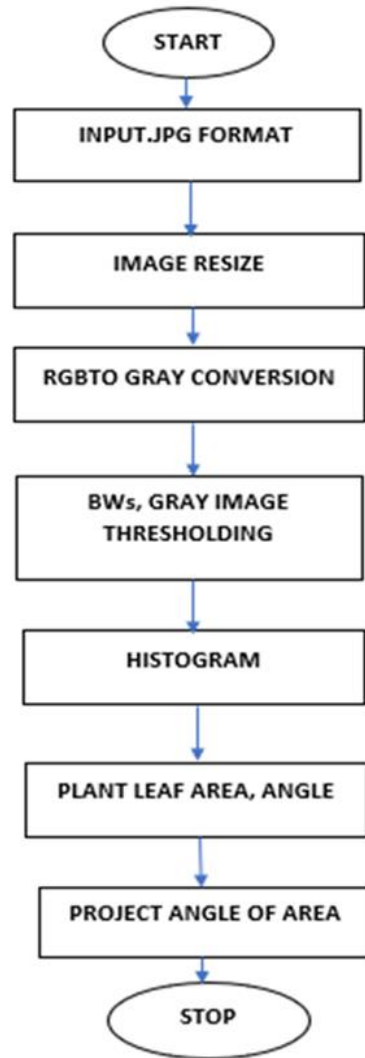


Figure 4. Flow chart

## V. RESULTS AND DISCUSSIONS



Fig:5 A1 Day 1 Input image



Day 1 Leaf Image taken from a field and loaded in a Matlab workspace to find the angle for the leaf. Plant Leaf angles for Petiole: 38.98, Base: 81.51, Apex:70.9, M84.05.



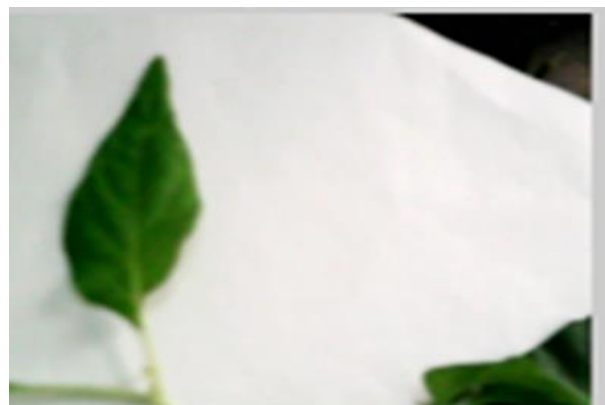
**Figure. 5 A2 Day 2 Input image**

Day 2 Leaf Image taken from a field and loaded in a MATLAB workspace to find the angle for the leaf. Plant Leaf angles for Petiole: 87.73, Base: 85.56, Apex: 89.76, Margin: 88.12.



**Figure.5 A3 Day 3 Input image**

Day 3 Leaf Image taken from a field and loaded in a MATLAB workspace to find the angle for the leaf. Plant Leaf angles for Petiole: 80.54, Base: 89.85, Apex: 61.66, Margin: 78.32.



**Figure.5 A4 Day 4 Input image**

Day 4 Leaf Image taken from a field and loaded in a Matlab workspace to find the angle for the leaf. Plant Leaf angles for Petiole: 87.28.2, Base: 49.35, Apex: 57.88, Margin: 80.01.



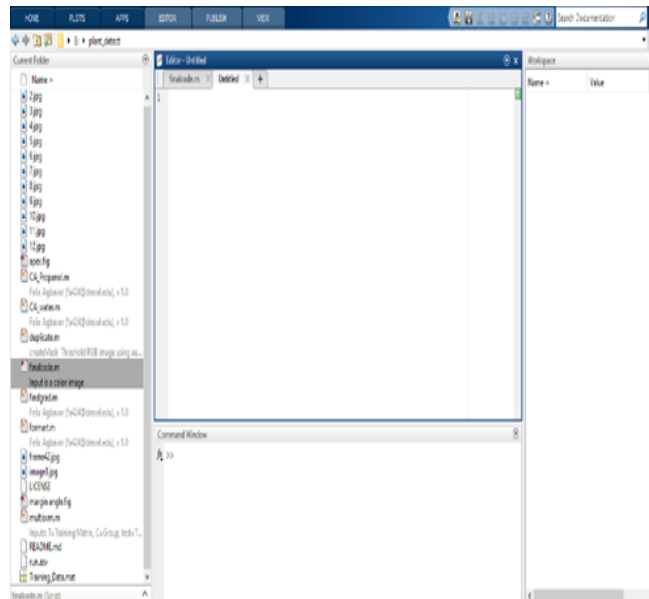
**Figure.5 A5 Day 5 Input image**

Day 5 Leaf Image taken from a field and loaded in a MATLAB workspace to find the angle for the leaf. Plant Leaf angles for Petiole: 82.09, Base: 89.39, Apex: 88.32, Margin: 89.46.

The above 5 days' image angles are found in MATLAB and sent to the server by using Node MCU.

### 5.B. Estimation of Leaf angles

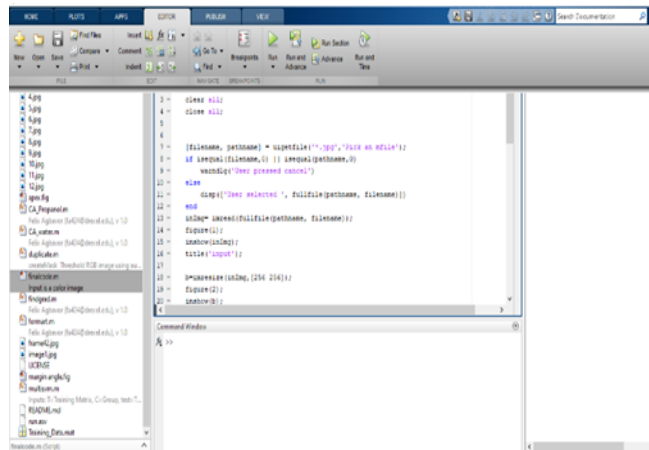
MATLAB window is used to write a code



**Figure.5 B1 MATLAB Window**

To find the angles for the input leaf, a code was written in MATLAB.

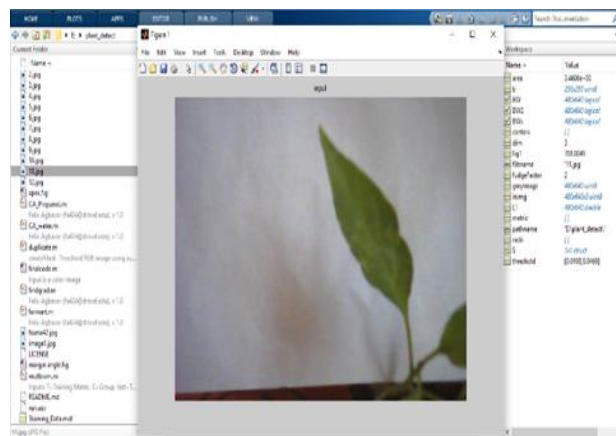
*MATLAB code to run*



**Figure.5 B2 Matlab code**

Load a leaf image into MATLAB, save it as a jpg file, and resize it. Then, with the help of thresholding, convert it from RGB to grey and then from grey to binary. Determine the angles for both the input and output leaves.

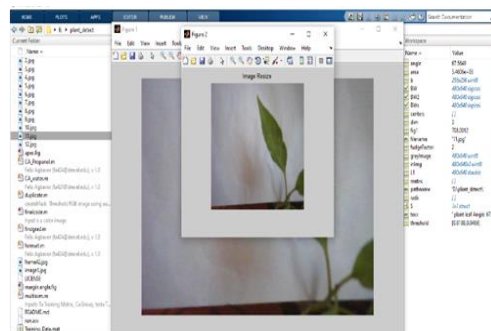
*input image*



**Figure.5 B3 input image in MATLAB**

First, The User obtains the input image before running the code in MATLAB to find the angles.

*Resize image*



**Figure.5 B4 Input resize an image**

After a color image is an input, it is resized to [256x256]

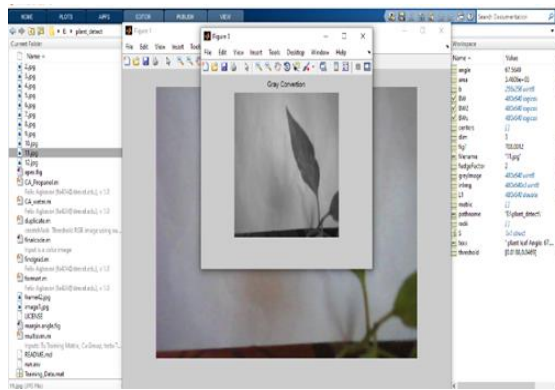


Figure.5 B5 gray image

*Gray image*

The input image is converted to a grayscale image

*Canny edge image*

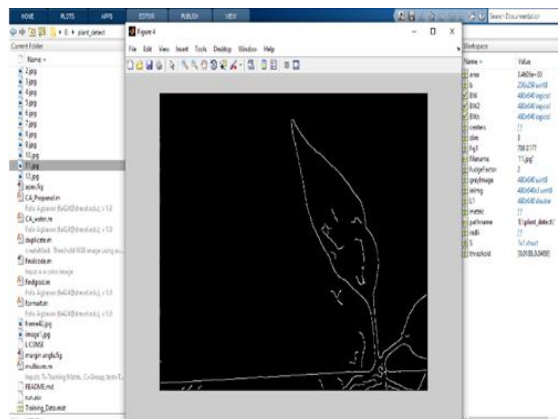


Figure.5 B6 Canny edge detection

The input image is converted from RGB to grey and grey to binary using thresholding and canny edge detection.

*Click and drag to draw a horizontal line to display the angle*

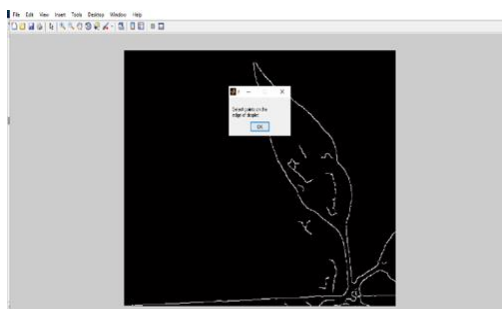
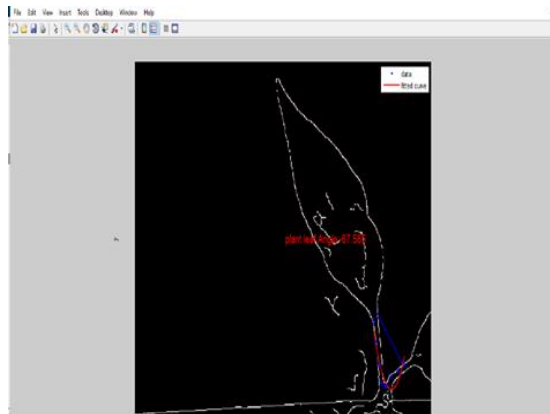


Figure.5 B7 select the droplets

To determine the angle of the leaf, the y-axis for the midvein and stem and the x-axis at horizontal are manually selected.

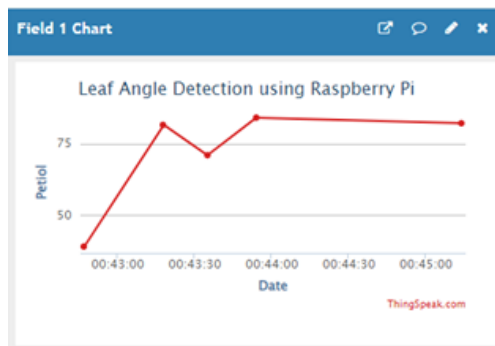
Example: user calculates the petiole angle for the input leaf image. The Plant leaf angle is 67.5.



**Figure.5 B8 Plant leaf angle**

### 5. C: Analysis of leaf angles

#### 5.C1 Petiole Angle:

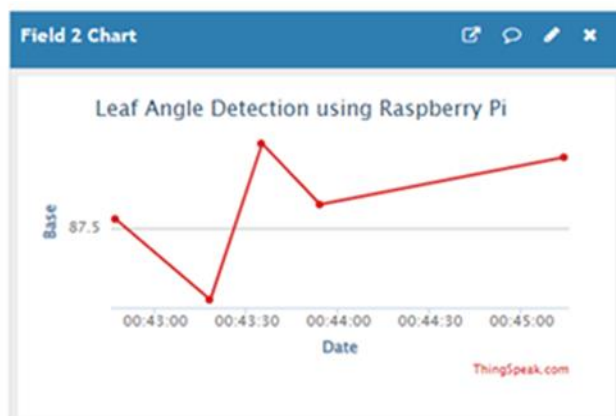


**Figure. 5 C1 Petiole Angle**

The graph shows the input leaf of the petiole angles from Day 1 to Day 5.

Petiole angles: Day1:38.98, Day2:87.73, Day3:80.54, Day4:87.28, Day5:82.09

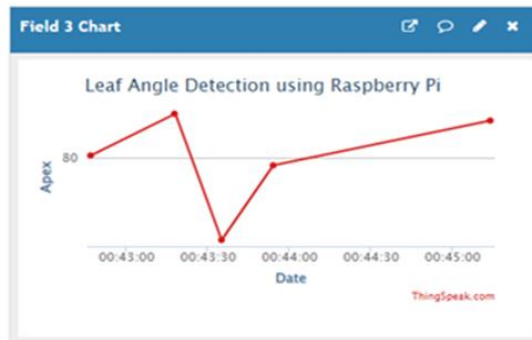
#### 5.C2 Base Angle



**Figure:5 C2 Base Angle**

The graph shows the input leaf of the petiole angles from Day 1 to Day 5.  
 Base Angle: Day1:81.51, Day2: 85.56, Day3: 89.85, Day4: 49.35, Day5: 89.39

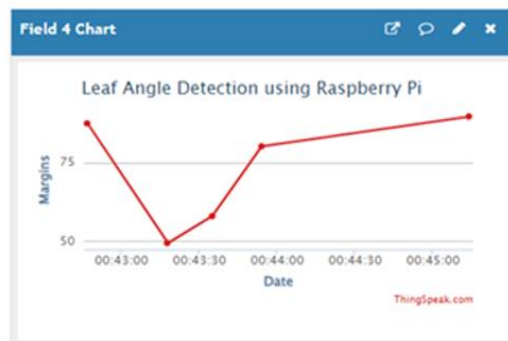
5.C3 Apex Angle:



**Figure:5 C3 Apex Angle**

The graph shows the input leaf of the petiole angles from Day 1 to Day 5  
 Apex Angle: Day1: 70.93, Day2: 89.76, Day3: 61.66, Day4: 57.88, Day5: 88.32

5.C4 Margin Angle:



**Figure:5 C4 Margin Angle**

The graph shows the input leaf of the petiole angles from Day 1 to Day 5  
 Margin Angle: Day1: 84.05, Day2: 88.12, Day3:78.32, Day4: 80.01, Day5: 89.46.

**VI. RESULTS**

Days	Leaf Angles			
	Petiole	Base	Apex	Margins
1	38.98	81.51	70.93	84.05
2	87.73	85.56	89.76	88.12
3	80.54	89.85	61.66	78.32
4	87.28	49.35	57.88	80.01
5	82.09	89.39	88.32	89.46

## 6.2 Conclusion

In the proposed work, the system examines each stage of the plant leaf and predicts the desired day of leaf blossoming. The species' latitude and longitude are also identified. The website is properly designed to locate plant stages.

## VII. FUTURE SCOPE

Directly updating the cloud with the current status of the plant can improve the system. The images captured by the Raspberry Pi are sent directly to the server, while the MATLAB data is sent via WiFi. It is possible to build a wireless sensor network that detects blossoming time and sends the information to the cloud. In real-time working conditions, more research and appropriate funding are required.

## REFERENCES

- [1] K. Singh, I. Gupta, and S. Gupta, "SVM-button and fourier moment technique for classification of leaf shape," *International journal of signal processing, image processing, and pattern recognition*, pp.67-78,2010.
- [2] *Manual of leaf architecture: Morphological description and categorization of dicotyledonous and net-veined monocotyledonous angiosperms.*
- [3] Gary Bradski and Adrian Kaehler, "Learning OpenCV: Computer Vision with the OpenCVLibrary", O'Reilly Publications.
- [4] The OpenCV Tutorials, Release 3.4.6
- [5] J Suk, S Kim, I Ryoo-sensors "non-contact plant growth measurement method and system based on ubiquitous sensor network technologies".
- [6] K. Lakshmi, S. Gayathri" Implementation of IoT with image processing in plant growth monitoring system".
- [7] Nadine jaanD.Caldito, Eusebelle B. Dagdagan, Mark G. Estanislao, Kim Leonard b. Jutic, Mary Regina B. Apsay, Marissa G. Chua, Jeffrey F. Calim, Floracito S Camata "A leaf recognition of vegetables using Matlab".
- [8] The OpenCV Tutorials, Release 3.4.6.0.
- [9] S. Praveen Chakkravarthy, V. Arthi, Leeban Moses "Performance Analysis of 60 GHz Wireless Communications for Wigig Networks" Vol.8, Issue 10, *International Journal of Innovative Technology and Exploring Engineering*, pp. 4213 – 4216, August 2019.
- [10] S. Praveen Chakkravarthy, V. Arthi, Leeban Moses "A machine learning perspective to foster the next generation 5g networks" Vol.8, Issue 11, pp 3598-3603, November 2019.
- [11] V.Arthi, S. Praveen Chakkravarthy ,2017 'Performance analysis of Multicarrier CDMA Transceiver system using a novel dynamic decoding and scheduling procedure' *CVR Journal of Science and Technology*, pp.21-24
- [12] Dr.V. Arthi, Dr. S. Praveen Chakkravarthy, Ms.R. Ramya, 2016, 'Threshold optimization based on Energy detection in Cognitive Radio Networks', *Australian Journal of Basic and Applied Sciences*, vol.10, no.1, pp.586-591.