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Research Article

Fruit Maturity Identification System

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Abstract*:* In India most of population is dependent on agriculture, so we can integrate Internet of Things (IoT) and Image processing Technology with our agriculture to increase the growth of agriculture which in turn strengthens economy of our country.

This paper aims to combine IoT and Image processing Technology for developing smart agriculture based System. The Farmers must take actions like Irrigation control and remote monitoring of farm to save natural water resources and to improve the growth of plant. Classification of fruits based on their maturity can be done by taking into consideration these two important features: color and size. Traditional methods of irrigation and manually evaluating the maturity of fruit by visual detection are prone to human error.

The goal of system is to collect real time data of agriculture domains using cameras and sensors and send the data via Android app to farmers. The use of Internet technology to send collected information to farmers and controlling field remotely via Android app is the purpose of proposed system. The aim of smart farming system is to makes automatic irrigation possible. This reduces the manpower involved.

Keywords: Smart agriculture, IoT, Sensor, Image processing, Water irrigation, Cloud computing, Wi-Fi, OpenCV-Python, Fruit maturity, Raspberry Pi

INTRODUCTION

The primary occupation in India is agriculture. India is gifted with a huge amount of cultivable land, but the output produced by cultivating crops does not do satisfy the need of country. The land under cultivation in India is 60 %. The use of recent technology in agriculture has increased, but a large portion of agriculture, which includes irrigation, sowing, use of pesticides, fertilizers remains a manual exercise. The availability of sufficient quantity of water is a rising issue due to shortage of natural water resources. The existing system cannot update the status of cultivated crop online and cannot easily identify whether the fruit is mature enough to harvest. This was the driving factor behind choosing automated irrigation and fruit maturity identification as topic for our project. The following sensors that have been used are: Temperature and Humidity sensor, Soil moisture sensor. Soil moisture helps to find out soil moisture content that is if water content of the soil gets reduced it turns ON the water motor automatically. The temperature of farm house is detected by temperature and humidity sensor. If temperature rises beyond threshold it drives the water motor automatically.

The visual selection to harvest fruit is time-consuming and laborious. Sorting process in fruit industry is increasing rapidly by the use of image processing technique. With the innovation of Raspberry pi, Aurdino and open source software and free libraries the use of image processing techniques is increasing than before. In this paper, images of mangoes are obtained from FAMA's website. The method includes OpenCV-Python installed on Raspberry Pi to perform further image processing on obtain images.

So, by the means of sensors that collects information is updated on android app via internet connectivity that helps farmer to remotely monitor their plant and make automatic irrigation possible.

LITERATURE REVIEW

Various environmental factors are responsible for decreasing water resources, rivers and tanks getting dry, drought in cultivated areas presents need to make efficient water utilization. The system that we need to develop needs first to collect data ,analyze data and carry information over network to remote location and intensify it by combining it with new technology. In order to increase the production and reduce the man power there is a need of smart farming technology to perform smart irrigation and reduce the use of pesticides fertilizer.

Root level of plants contains soil moisture sensor and temperature sensor connected in distributed wireless network. WSN gateway fetches sensor information, activates actuators and sends data on web. Here algorithm is set with margin value of sensor that is program on microcontroller to ensure water quantity. [1]

Python programming language is used to process user commands on raspberry pi. ON/OFF commands from Raspberry pi are received on Aurdino microcontroller using zigbee protocol. The communication between raspberry pi and end device is done by star zigbee topology. Center co- coordinator is Raspberry pi and routers are end devices. [2]

The system contains WSN units aka nodes or motes placed in the field to gather the real time information, a cluster head receives and transmit acquired information to the control section which controls the drips for watering. Zigbee helps in transmission of collected data by sensor from each node to the master node or cluster head. The received data from the cluster head is stored on Cloud and cloud server compares sensed values and predefined threshold values and make decision on basis of this comparisons. [3]

This system collects soil humidity and temperature with the help of different sensors. A threshold value for soil moisture and temperature is fixed, depending on soil type or crop type. When the moisture or temperature of soil defers from fixed range the smart watering system turns motor ON/OFF. The irrigation system activates the pumping water for dry soil and high soil temperature. [4]

This project is mainly based on developing a mobile app and controlled through it which acts as a replacement for the GSM method. [5]

Author Izadora Binti uses K-means clustering algorithm to find dominant color of the image. Each stage of maturity index is different for dominate color. In these paper dominant colors is used to make a comparison for maturity of mango fruit. Comparison between the reference image and the captured image is done to find the maturity of mango. K- Means clustering to find dominant color in image is checked against range of RGB values of referenced mango images to plot actual maturity stage of mango fruit. [6]

Author Apeksha Thorat used K-Means algorithm of Image Processing to identify leaf disease. This paper describes the method for identification of healthy and disease leaf. After applying K-Means algorithm green pixels has been masked and decision for identification of healthy or unhealthy leaf is done basis of total unmasked pixels. If unmasked pixel is more than 30% then leaf has disease otherwise leaf is healthy. [7]

Author Sudhir Rao Rupanagudi presents algorithm to identify the six important stages of tomato ripening. Using MATLAB, algorithms were designed and developed. With respect to maturity grade detection 98% accuracy was achieved and an execution speed of algorithm was greater than 7.6 times. [8]

This system is designed to identify and classify the date fruit according to their categories. This classification is done according to date fruit color, size and skin texture. This system gives count and label the total number of harvested fruits. Dates fruit are categorized by system by fetching the objects color and comparing its size. [9]

5

This paper used camera sensor for getting information as input and image processing is used for identifying RBG parameter that used for classifying oranges. The orange image is processed by applying filter to control lightening and shadows because they may affect image analysis. [10]

Table No. 1: Literature Survey

Sr no.	Author	Objectives	Algorithm/Technology	H/W Tools, S/w and Sensors	Implementation
1	Joaquin Gutierrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Angel Porta Gándara	WSN based Automated Irrigation System	Wireless Sensor network ,GPRS module	Electronic Component PCB, Temperature ,Moisture	Configuration of WSU and WIU with Zigbee and GPRS
2	Nikhil Agrawal, Smita Singhal	Smart Drip Irrigation System with Zigbee	Wireless Sensor network , zigbee Module	Raspberry Pi ,Aurdino , Ultrasound distance Sensor	SMTP ,IMAP ,Library to send email and email pooling ,Zigbee ,Sensor ,Relay
3	Shweta B. Saraf , Dhanashri H. Gawali	CC based Smart Irrigation Monitoring and Controlling	Wireless Sensor Network, Cloud Computing ,Zigbee Module	Microcontroller at mega 328 ,Temperature ,Humidity , Soil Moisture ,Water level Sensor	server with App interfacing
4 6	M. Newlin Rajkumar, S. Abinaya , V. Venkatesa Kumar	Intelligent Irrigation System-GSM	Aurdino Application ,GSM Module	Aurdino ,Temperature ,Soil Moisture	Remote control of Farm with Android app using Wi-Fi
	N Seenu, Manju Mohan, Jeevanath V S	Android Based Intelligent Irrigation System	WI-FI Module	Microcontroller ,Aurdino ,Moisture ,DHT 11	Mobile App Wi-Fi module to interface API with Aurdino
	Izadora Binti Mustaffa , Syawal Fikri Bin Mohd Khairul	Fruit Size and Maturity Identification of Mango Fruit	Image Processing	Open-CV, Python	K-Means Clustering using Python Open-CV Libraries numpy ,sklearn ,matplotlib
7	Thorat , A., Kumari, S., & Valakunde, N. D.	An IoT based smart solution for leaf disease detection	Image Processing	Open-CV, Python	K-Means, RBG to HSV, Masking, Comparison between Masked pixels
8	Sudhir Rao Rupanagudi, B S Ranjani, Prathik Nagaraj, Varsha G Bhat	Tomato Maturity Grading System	Image Processing	Matlab	Color conversion ,segmentation ,erosion ,dilation ,classification
9	Tasneem Najee	Dates Maturity Status	Image Processing	Matlab	Image enhancement,

c)

	b, Mayth am Safar	and Classific ation			color space, conversion,segmentation ,thresholding ,labeling, morphological feature
10	Caro Prieto Diana Carolina, Nieto Tapias Deivis David	Classification of Orange by Maturity	Image Processing	Matlab	Binarization ,border intensity , erosion , dilation , RGB Histogram

SOIL MOISTURE SENSOR

Soil moisture sensor is used to identify moisture of the soil that is water content of soil. If the soil has lack of water content it will notify the system. This sensor helps user to remind to water their plants and monitor water content of soil. We simply need to insert this sensor into soil and it will report moisture content. It has been used in agriculture domain, land irrigation and botanical gardening.

I. METHODOLOGY / EXPERIMENTAL/COMPUTATIONAL

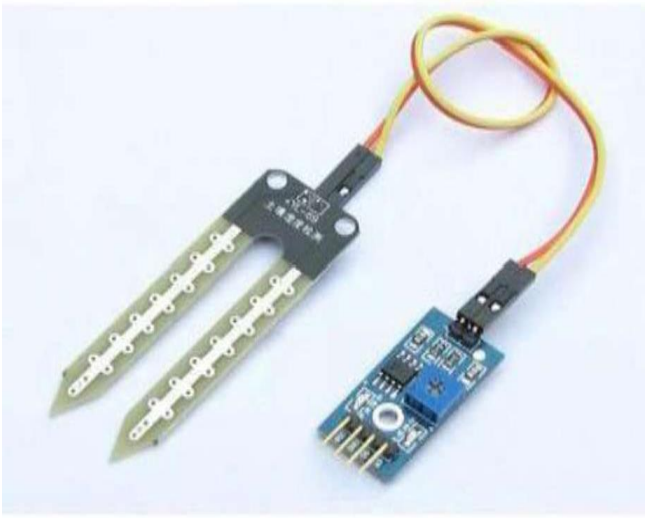


Fig. 3: Soil Moisture Sensor

HARDWARE COMPONENTS:

a) RASPBERRY PI

Raspberry pi is very small sized computer or board computer. This processor does everything you'd except a computer to do. It has many versions with better features than previous one. It is a open hardware, card sized computer and contained on single board. It uses the rasberian or noobs operating system. Also it has different modules like Wi-Fi, Bluetooth etc.

Fig. 1: Raspberry Pi

b) DHT 11 SENSOR

The DHT11 measures the humidity and temperature of the environment. It is simple to use, low cost sensor and easy to set it up. This sensor is easy to interface with different micro controllers. It can work for 0-50 °C temperature range and humidity 20-90%. It has excellent quality, low power and good response time and better performance.

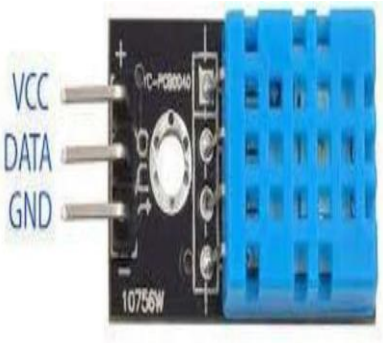


Fig. 2: DHT 11 Sensors

d) DC MOTOR

DC motor is a electric machine that converts electrical energy into mechanical energy. There are two basic types of motor: AC or Alternate Current motor and DC or Direct Current motor. It has a stator, an armature, rotor and commutator with brushes. We can speed of DC motor to a wide range. DC motor is very simple to setup and use.

Fig. 4: DC Motor

SOFTWARE USED:

a) RASPBIAN OS

Raspbian is a Linux based "official " operating system for Raspberry pi. It has compatibility with different versions of Raspberry pi. It comes with inbuilt software installed into it. This operating system has good security features and capabilities. Raspbian desktop environment is also called as "Lightweight X11 Desktop Environment".

b) OPENCV-PYTHON

OpenCV stands for Open Source Computer Vision Library is an open source software library for computer vision and machine learning. It is originally developed by Intel and released under BSD license hence we can have it for free for both commercial and academic use. The languages it can support are C++, Android SDK, Java, Python, C etc. and it can be used with various platforms like Windows, Linux, OS X, Android, iOS etc.

IMPLEMENTATION:

Many sensors are connected to Raspberry pi and their values are read by them and these values are sent to cloud server. The threshold values are already stored at cloud so it will compare sensor values with it. According to that DC motor will get controlled using mobile application. If soil moisture sensor value is less than threshold value then DC motor should turn ON through mobile application otherwise it remains OFF. Thus app user can continuously fetch updated values to turn motor ON/OFF. This makes automatic irrigation possible. The connections of the experiment are shown below.

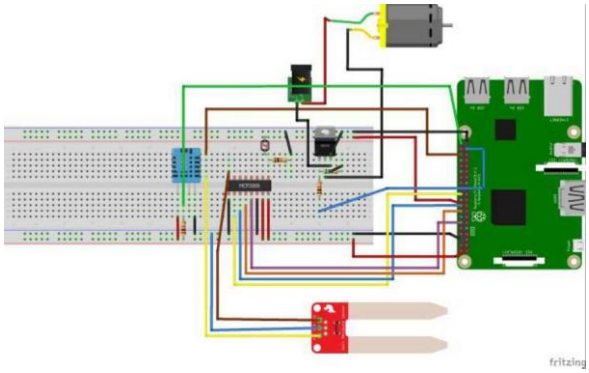
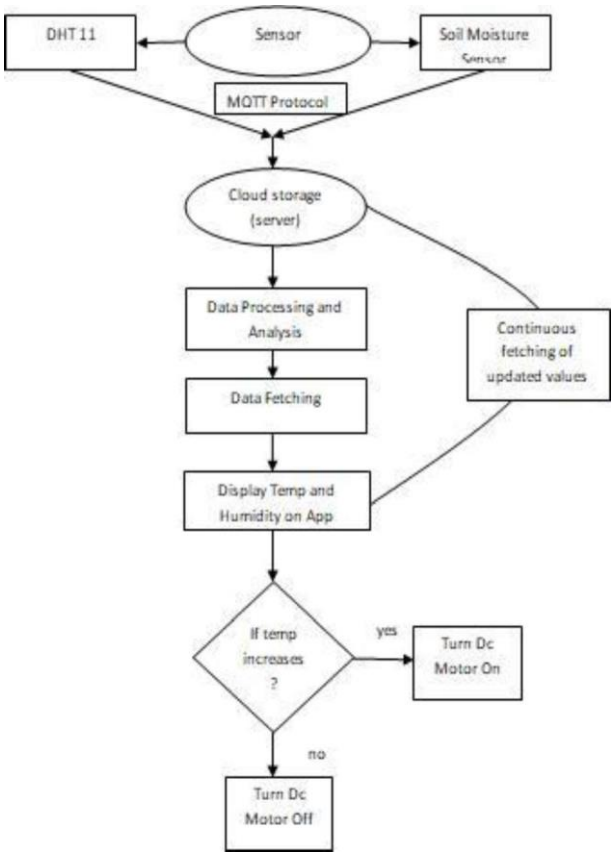


Fig. 5: Configuration of Sensors with Raspberry Pi

FLOW OF DATA STORAGE AND FETCHING DATA FROM CLOUD:



K-means clustering algorithm is used in this project for finding most dominant color. Each maturity range has its own different dominant color. So, this mechanism is used for differentiation of

maturity. Black is used for background and foreground color represent itself a fruit. Comparison is done between the set of RGB values from reference image of mango and the actual RGB value of image provided to the algorithm, maturity stage of the mango is identified. Color histogram is used to plot the most dominant color generated by providing the number of clusters user wish to generate. In this way this system makes the comparison and checks the maturity of a fruit using OpenCV python and then plots the histogram of fruit image.

ALGORITHM TO IDENTIFY FRUIT MATURITY:

1) To perform K-means clustering import packages like Scikit-learn, Matplotlib, numpy, cv2, argparse and helper package utils that contain two helper functions one that creates histogram and second that plot colors on bar chart
2) Load image
3) Convert image from BGR to RGB
4) Show the original image
5) Reshape the image to be a list of pixels
6) Cluster the pixel intensities
7) Perform following steps in utils package

a) Supply the number of clusters we wish to generate
b) Grab the number of different clusters
c) Create a histogram based on the number of pixels assigned to each cluster
d) Normalize the histogram such that it sums to one
e) Return histogram
f) Initialize the bar chart representing the relative frequency of each of the color
g) Loop over the percentage of each cluster and color of each cluster
h) Plot the relative percentage of each cluster return the bar chart

8) Build the histogram of each cluster and create a figure representing the number of pixels labeled to each color
9) Show the color bar of dominant color
10) Display RGB values of dominant color on terminal
11) Loop through six ranges of RGB values provided to identify fruit maturity stages
12) Display the identified fruit maturity stages

II. RESULTS AND DISCUSSION

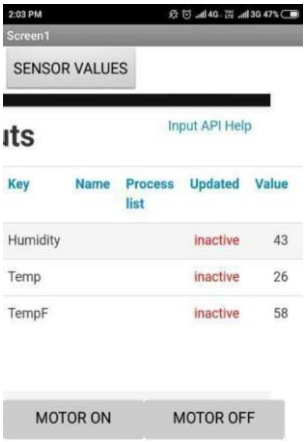


Fig. 6: DHT 11 sensor value fetched on App

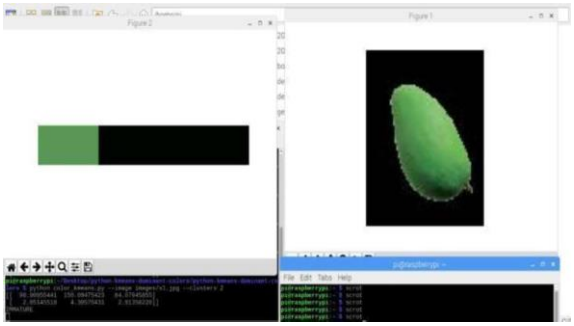


Fig. 7: Immature Stage

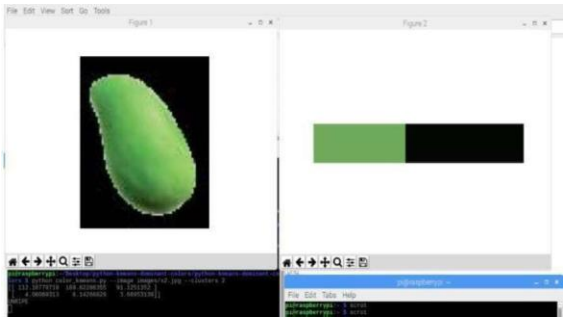


Fig. 8: Unripe Stage

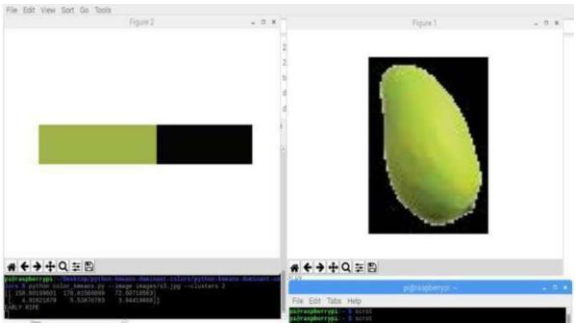


Fig. 9: Early Ripe Stage

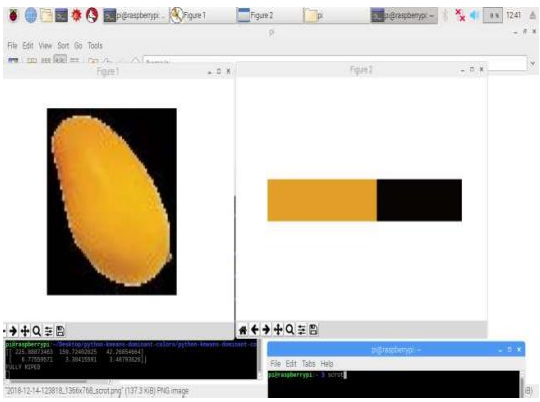


Fig. 10: Partially Ripe Stage

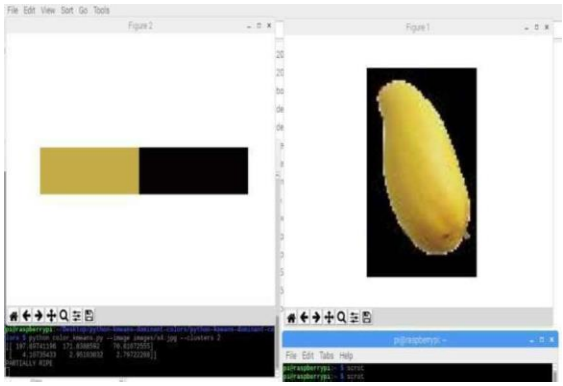


Fig. 11: Ripe Stage

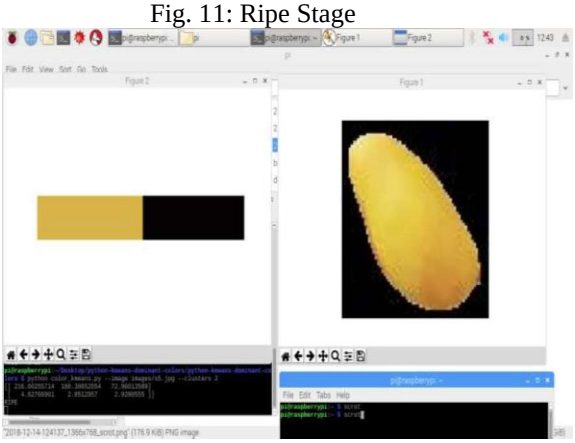


Fig. 12: Fully Ripe Stage

Sr No.	Maturity Stage	RGB Value	Threshold
1	Immature(Fig.7)	(90,150,85)	101
2	Unripe(Fig.8)	(112,169,91)	135
3	Early Ripe(Fig.9)	(158,178,72)	178
4	Partially Ripe(Fig.10)	(197,171,70)	207
5	Ripe(Fig.11)	(216,180,72)	221
6	Fully Ripe(Fig.12)	(225,159,42)	255

Table No. 2: Threshold decided by considering Red values

The above algorithm efficiently predicts the actual stage of mango for various input images thereby achieving 85% of accuracy.

III. CONCLUSION

This proposed system helps to remotely control and monitor farm. This avoids traditional manual method of plant health monitoring. This makes plant irrigation possible at right time to avoid shortage of water and supplying excess water. It also maintains moisture level of soil to avoid excess supply of water to the crops. This system helps in harvesting mango crop at right time to avoid it from getting damaged. For growth of our agriculture we need to combine the IoT, cloud computing, and image processing etc.

APPLICATION

1) It is useful for farmers to control and monitor their farm remotely.
2) The sensors give information about environment (temperature, humidity, soil moisture) is useful for plant health monitoring.
3) This system is applicable for people who stay at remote location from their farm.
4) Fruit Industry can use fruit maturity prediction to classify fruits based on maturity index.

ADVANTAGES

1) This system reduces manpower, proper water utilization helps to increase productivity and thereby increasing profit.
2) Using sensors (dht11, soil moisture) plant health is monitored and whenever the values seem abnormal the respective motor turns on.
3) This system helps in early detection of maturity of mango which helps in harvest mangoes at right time to avoid manual

method of ripening mangoes.

4) Water application efficiency is high if managed correctly.
5) Moisture at the root level can be maintained at field capacity.
6) Avoid early harvesting that may cause decaying of fruits.
7) Avoid preservative majors like use of chemicals.

8) Prevents problems like cancers caused due to use of chemicals.

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