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Real Time Tomato Ripening Stage Identification System

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Abstract: Tomatoes are the best-known grown fruit in greenhouses. Tomato is a plant which its fruit does not ripe simultaneously, therefore it is necessary to develop an algorithm to distinguish between green, pink, light red and red tomatoes. This experimental work aimed to develop an efficient approach for identifying the ripening stages of tomato. Using the acquired image, the RGB values of the tomato were processed by the MATLAB and used to identify the stage of the tomato. The MATLAB processing will be done by the AVR Microcontroller. The stage of captured image is communicated with the processor and finally the farmer is informed via massage through GSM technology as well as the captured image will be sent to the specific mail-id.

Keywords: MATLAB, USB camera, AVR Microcontroller, GSM module.

I. INTRODUCTION

There are around 7,500 tomato varieties grown for various purposes. Tomato varieties are roughly divided on the basis of their shape and size. Heirloom tomatoes are becoming increasingly popular, particularly among home gardeners and organic producers, since they tend to produce more interesting and flavorful crops at the cost of disease resistance and productivity.[1] In 1973, Israeli scientists developed the world's first long shelf-life commercial tomato varieties.[2].

To facilitate transportation and storage, tomatoes are often picked unripe (green) and ripened in storage with ethylene.[9] Unripe tomatoes are firm. As they ripen they soften until reaching the ripe state where they are red or orange in color and slightly soft to the touch. About 161.8 million tones of tomatoes were produced in the world in 2012. China is the largest producer, accounted for about one quarter of the global output, followed by India and the United States. For one variety, plum or processing tomatoes, California accounts for 90% of U.S. production and 35% of world production [4]. In 2012, tomato production was valued at 58 billion dollars and tomatoes were the eighth most valuable agricultural product worldwide.

Tomato is a plant which its fruit does not ripe simultaneously, therefore it is necessary to develop an algorithm to distinguish green, pink, orange and red tomatoes. In the current study, a new segmentation algorithm based on masking is designed in MATLAB which separate out the color band and after masking the algorithm will take the decision of particular stage of tomato.

Tomato maturity is closely related to its surface color feature, so evaluating their levels of maturity by visual analysis of the tomato's surface color features is a feasible mean. Generally, tomato maturity is divided into six stages: Green stage, breakers stage, turning stage, pink stage, light red stage and red stage. Color in tomato is the most important visible characteristic used to assess ripeness and

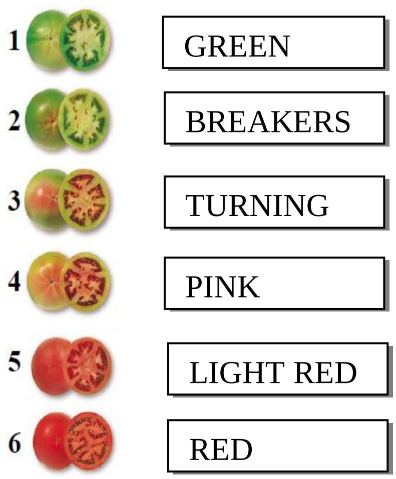

Figure 1: Tomato Ripening Stages

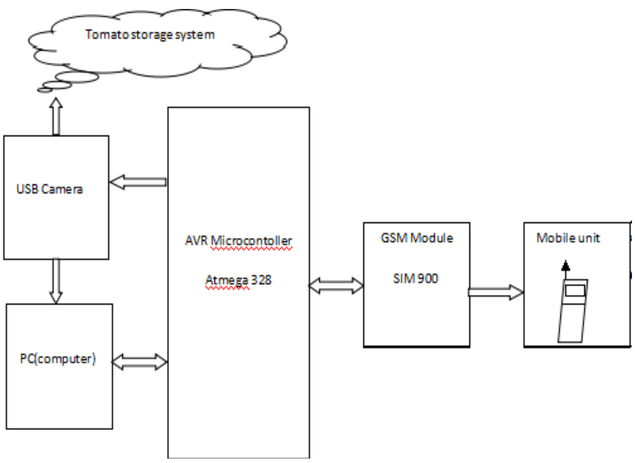

Figure 2: General Block Diagram of the system

post-harvest life, and it is a major factor in the consumer's purchase decision. The degree of ripeness is usually estimated visually by human graders who compare the tomato color to a classification chart. This manual practice of tomato maturity classification often results in errors due to human subjectivity, visual stress and fatigue. Human identification of color is complex because sensations such as brightness, intensity, lightness and vividness modify the perception of primary colors (red, blue and yellow) and their combinations (e.g., orange, green and purple).

II. METHODOLOGY

Concept works on basically two modules, which are computer and AVR controller. Whenever the farmer wants to check his crop stored he will send a keyword as an SMS to the GSM Module. This keyword will be verified by the controller, and if the keywords are verified correctly then it will initiate the AVR controller for further processing else it will discard the SMS and will take no action.

Hence, after initiating the AVR controller, it will command camera to take the snapshot of the field. This snapshot taken will be stored in the memory of the computer. Then the computer will perform the MATLAB processing on the image and derive the results.

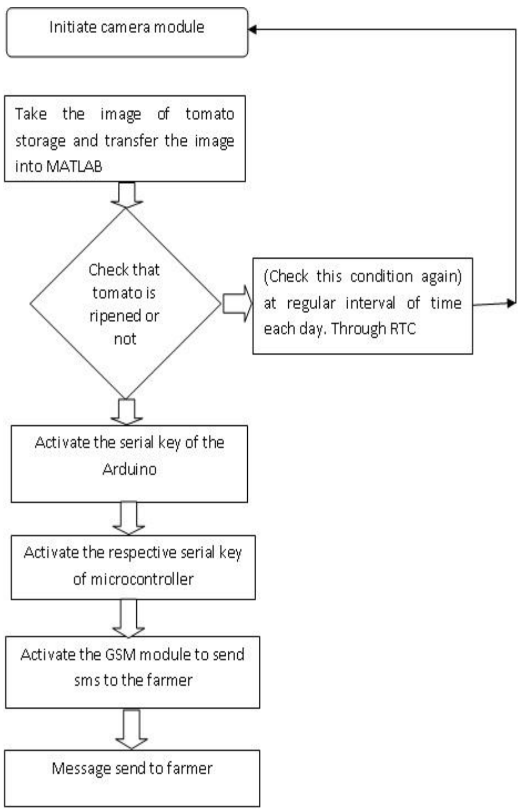

Figure 3: Flowchart of the system

The output of MATLAB will be given to AVR controller through COM port, that will activated the AVR Microcontroller depending on the condition of the crop detected. Similarly, it will initiate that same controller so as to understand which SMS is to be send on farmer's mobile. Hence, the AVR controller will detect the SMS to be sent and initiate the GSM Module to send that particular message.

Also, while we are processing the image (snapshot) taken from camera to detect the ripening stage of the crop, we will also send that image on farmer's mobile via Gmail using MATLAB Gmail service. This will benefit the farmer to analysis the minute details of the crop which may not be detected by the MATLAB processing.

This whole setup will be mounted on the field (greenhouse) where the crops are stored for further growth. As the size of setup is moderate, it cannot work on flexible field. Thus, long trays of tomato are assumed to be there in greenhouse. For smaller fields, we can omit computer and use other any embedded platform which will support MATLAB processing. The algorithm describes the working of the whole Experimental work.

Algorithm for MATLAB processing:

1) Read the image from the folder where the images are stored.
2) Maximize the figure.
3) Split the original image into colour bands.
4) Display them.
5) Threshold each colour band and create mask to detect particular colour in the image and display them.
6) Combine all three masks to find where all 3 condition are true for 'RED' colour detection.
7) Similarly, change the thresholding values to detect Orange, Yellow and Green colour in the image.
8) Compare all 4 images so as which image has more coloured pixel, and display it as detected stage of the crop.
9) Also, send the original image using Gmail through MATLAB Gmail service.

In this paper we have proposed masking method for detection of 4 various colour stages of the tomato crop. Masking is the method used for extracting particular parameter of the image such as edge, sharpness, colour etc. A mask is a filter matrix which convolves with the input image to filter the required information from the image. An matrix is created according to the user's requirement so as to what parameter is to be extracted.

Every image is made up of three components i.e. Red, Blue and Green. These are called as primary colours and combination of these three colour can create any other colour Threshold values of the gray levels are used to create colour bands. These colour bands are mixed in various proportions to create mask for particular colour to be detected in the image.

Thresholding method is the easiest way to divide complete image into set of pixels in such a way that each set have

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common characteristics, out of which one set is the information extracted from the image which is required by the user.

III.RESULTS

The experimental results of the project are shown below. This Experimental work uses thresholding method and creates various mask for every colour(according to maturity of tomato crop) to detect in the image. Also, embedded platform is used to send the result remotely using GSM module.

This approach is beneficial to monitor not only the tomato crop but also any other crop farmer wish to monitor.

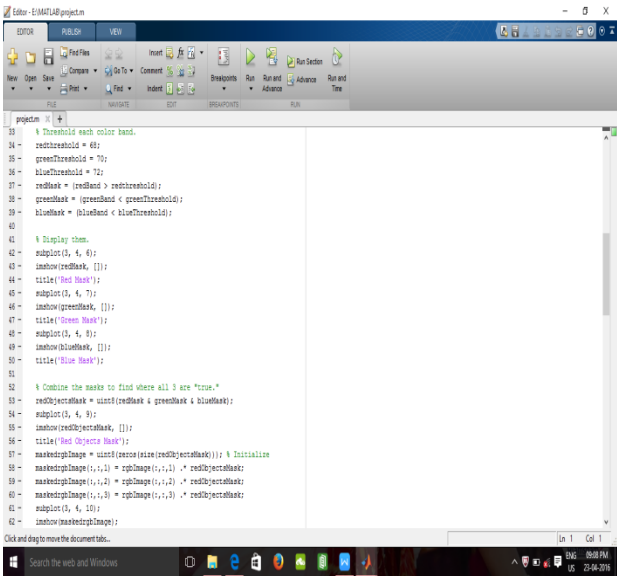

Figure 4. Snap Shot of the MATLAB code

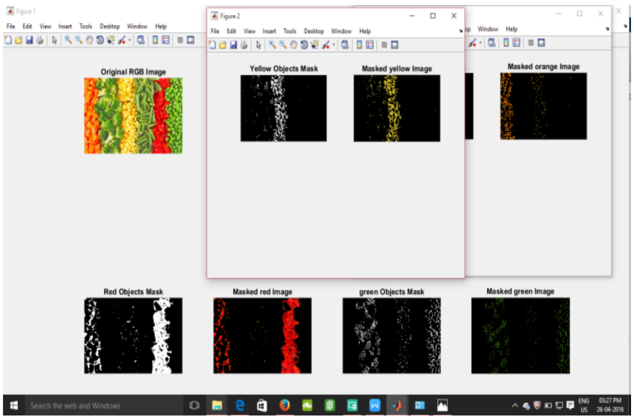

Figure 5 Snap Shot of the MATLAB output.

Here, the image taken in the MATLAB is for reference purpose so as to verify whether all the conditions can be detected or not. In the above result, we can see that all the four proposed stages of ripening of the tomato fruit can be detected. Also, it can count the total number of maximum pixels in the image and verify which colour is maximum.

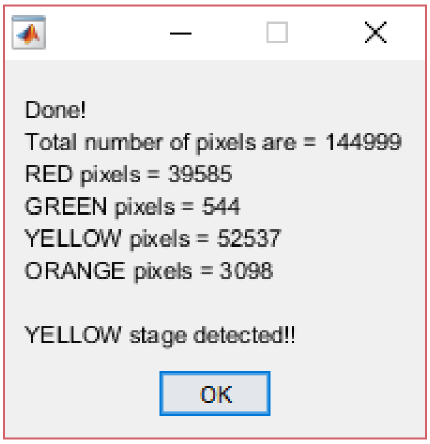

Figure 6. Result of MATLAB verifying the maximum colour detected in the image

Using the above analysis, we can verify the working of code correctly. For practical application, it is assumed that crops stored in the greenhouse are all in same condition. Hence, at a time only one stage will be detected.

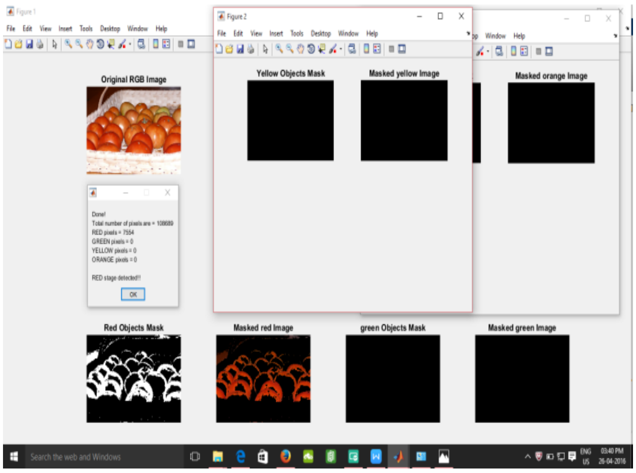

Figure 7. Snap Shot of MATLAB output for Real Time application

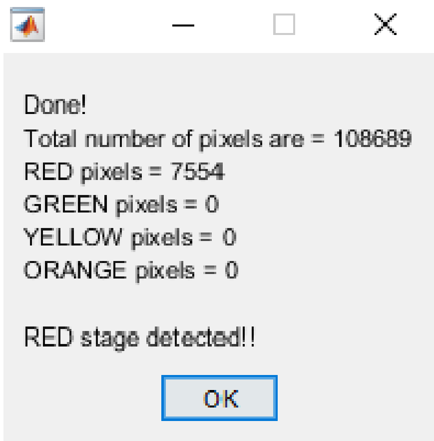

Figure 8. Result of MATLAB verifying the maximum colour detected for Real Time application

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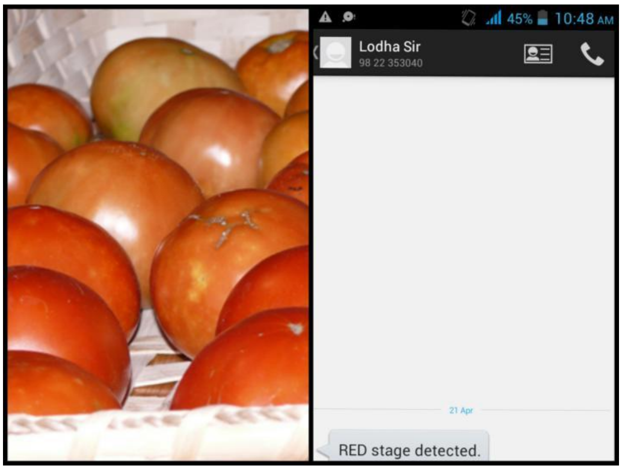

Figure 9. Snap Shot of the message received by the farmer

The output of the MATLAB will be sent to AVR microcontroller through serial communication and further processing will be done by controller to send the SMS.

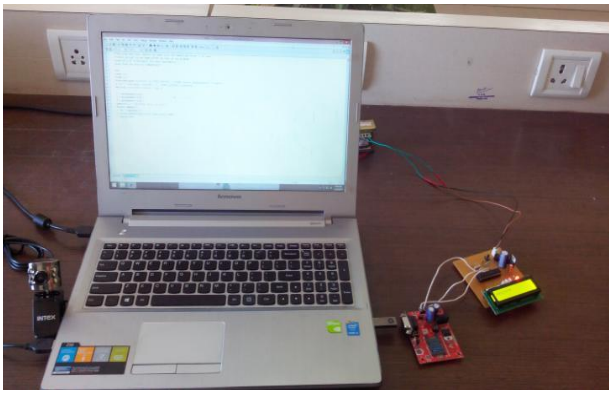

Figure 10. Experimental setup of the Project.

IV. CONCLUSION

This Experimental work is intelligent assistant for farmer to monitor their crop remotely and take advantage of technology in the field of agriculture. The future scope of this Experimental work can be that we can add temperature sensor to monitor the humidity of the atmosphere where the crops are stored and according to it humidity information can also be sent to farmers. Also, we can add another embedded platform to remove the computer, which will be beneficial to apply this Experimental work on any other field as required by the user.

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BIOGRAPHIES

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