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Arduino Based Tomato Ripening Stages Monitoring System

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ABSTRACT: Tomatoes are the best-known fruit in green-houses. The ripening process of the tomato comprise of varies stages in which tomato mature. There is the particular pattern in which process of ripening of tomato take place. In this paper, we are proposing the algorithm for monitoring varies ripening stages of the tomato using simple Arduino based system which will predict and display the complete process according to the color changes in tomato. Using the acquired image, the mean of L*a*b color space values of tomato w processed by the MATLAB and information send to the Arduino microcontroller serially, which tells the color of tomato and the message informing color of the tomato to farmer using GSM module as well as to specific mail-id.

KEYWORDS: USB Camera, MATLAB, L*a*b color space, Arduino microcontroller, GSM module, tomato ripening stages

I. INTRODUCTION

Maximum contribution to Indian economy is from the agriculture and the base of agriculture is farmer. So, we should help the farmer by using the latest technologies to improve their crop production. We are contributing a method to monitor various stages of ripening of the tomato by using an Arduino microcontroller system with MATLAB tool so that food should not be wasted. As tomato is the world's largest vegetable crop in the list of canned vegetables. The total global area under tomato is 46.16 lakh ha and the global production is to the tune of 1279.93 lakh tons [1]. The perfect ripening process of the tomato, is comprise in varies stages. It begins with, tomato in their primary stage is completely green and they turn completely red at the final stage. We have divided this complete process into six different stages. Tomato maturity is closely related to its surface color feature, so evaluating their levels of maturity by L*a*b color space values of the image pixel processed in the MATLAB and this information send to the Arduino microcontroller, which detect the condition of tomato and it send message which tells the color of tomato and the repining stage of the tomato to farmer using GSM module as well as to specific mail-id.

II. RELATED WORK

Use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the man power efforts. Research for improving agricultural production by utilizing wireless sensor network technologies is still in progress. Brijesh, Describe the system for monitoring the ripening stages of banana by using RGB color space value process in MATLAB [2]. Shen et al. developed a remote real-time data analysing and processing system based on GSM SMS module [3]. Stipanicev describes a networked embedded greenhouse monitoring and control based on simple embedded web servers and connecting sensors and actuators using 1-wire protocol [4]. Gill et al. proposed Zigbee based home automation system that can control and monitor various home appliances. The proposed system consists of four devices, a safety sensor; light switch, radiator valve and Zigbee remote control have been integrated and evaluated with the home automation system [5]. M. Haefke et al. designed and developed a Zigbee based smart sensing platform for monitoring environmental parameters such as relative humidity, pressure, temperature and sunlight. These units collectively send the sensor data wirelessly to a central station, which collects the data, stores and displays them into a database. Also, the facility of adding few more sensors and a few more stations has been provided in the proposed system [6].

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III. PROPOSED WORK

In this work, we use the L^*a^*b color space for the masking of the image of its great advantage over a RGB color space. L^*a^*b color space is designed to approximate human vision. It aspires to perceptual uniformity, and its L component closely matches human perception of lightness. Thus, it can be used to make accurate color balance corrections by modifying output curves in the a and b components, or to adjust the lightness contrast using the L component. In RGB or CMYK spaces, which model the output of physical devices rather than human visual perception, these transformations can be done only with the help of appropriate blend modes in the editing application [7].

IV. RIPENING STAGES OF TOMATO

The overall ripening process is divided into six stages. It begins with the primary color green to final color red via orange. In each stage have different color so it has different L^*a^*b color space values and different mean. This complete process is shown by figure 1 below.

- 1) STAGE – I: In first stage of maturity, the color tomato is natural green.
- 2) STAGE – II: In this stage, tomato changes its color from complete green to light green with yellow.
- 3) STAGE – III: In this stage, the change in the color of tomato can be clearly observed. In this stage the color of tomato change to light orange.
- 4) STAGE – IV: The next stage consists of much orange tomato. If the tomato in this stage, then it is ready to go in market in hot weather.
- 5) STAGE – V: In this stage tomato mature 90% having light red color.
- 6) STAGE – VI: In the last stage of ripening process, the tomato turns into red.

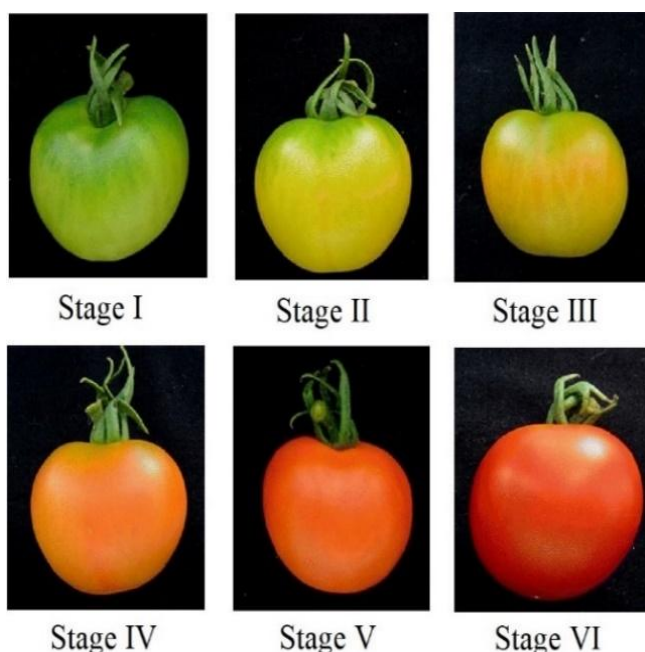


Figure 1: Ripening stages of tomato

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V. SYSTEM BLOCK DIAGRAM

This system consists of the camera which is used for the image acquisition of tomato crop from agriculture field. With the help MATLAB R 2016a the filtering and masking of image is done. After the analysis, the L*a*b color space value of acquired images are being obtained and this value are compared with the stored database. By comparing images, we get an information about ripening stage of tomato. This data will send to Arduino microcontroller and it communicate with farmer via GSM module. The block diagram of the scheme is shown in figure 2.

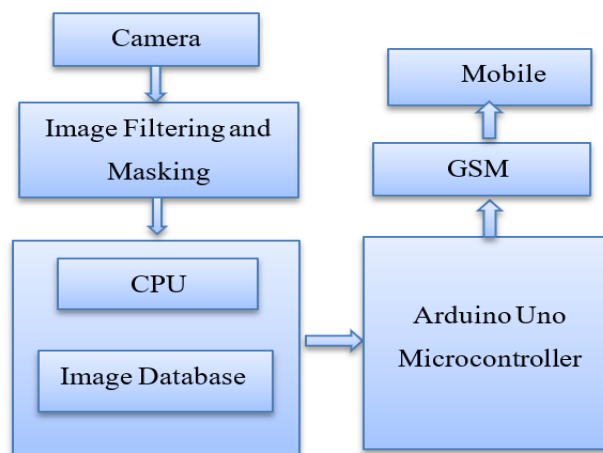


Figure 2: Block diagram of tomato ripening monitoring system

VI. HARDWARE AND SOFTWARE IMPLEMENTATION

We divide this system into two sections, monitoring section and transmitting section. Monitoring system include camera which take an image from the crop field and then it is send to the CPU(MATLAB). MATLAB process this image by finding RGB value and compare with the prestored database. Depending on the algorithm, it sends the information to the transmitting section. In transmitting section Arduino receive this information and send message to farmer about the present stage of the tomato by GSM module. The figure 3 shows the hardware implementation.



Figure 3: Hardware implementation of peripheral devices

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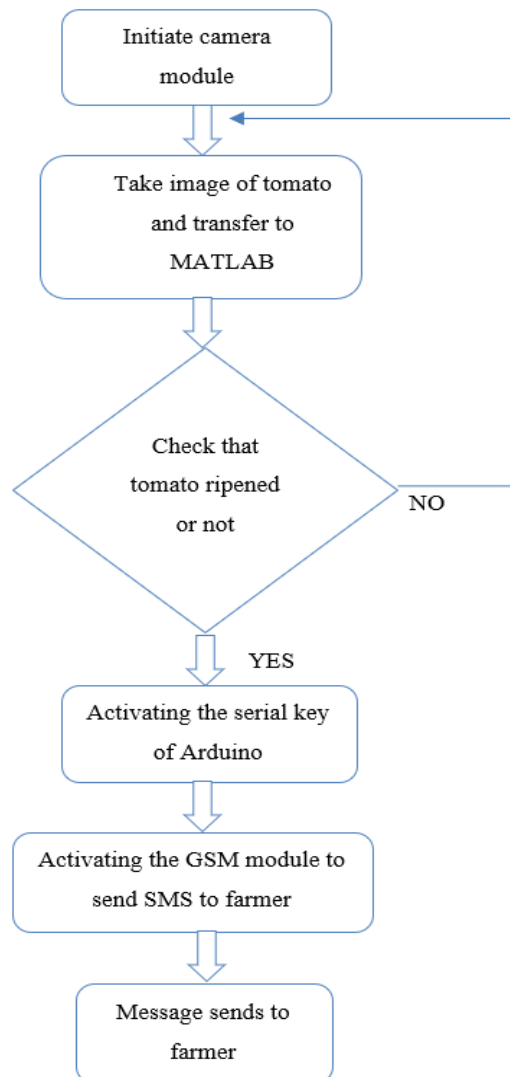


Figure 4: Flow chart of the system

The figure 4 shows the flow chart of whole system. The Table 1 shows the different serial codes, pin and information of message communicating among MATLAB, Arduino and GSM module and finally mobile according to the ripening stages of tomato.

In this paper, we have used masking method for the detection of 6 different color stages of tomato. Masking is the method which is used for extracting particular pattern of image such as edge, sharpness, color, etc. For masking we used L*a*b color space. A mask is a filter matrix which convolves with the input image to filter the required information from the image. A matrix is created according to user requirement.

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Table 1: Different stages, Serial code and message

Stages	Serial code to Arduino	Message to farmer
Stage I	A	Color of tomato is green.
Stage II	B	Color of tomato is light green with yellow.
Stage III	C	Color of tomato is light orange.
Stage IV	D	Color of tomato is orange.
Stage V	E	Color of tomato is light red
Stage VI	F	Color of tomato is red. It is ready for market.

VII.EXPERIMENTAL RESULTS

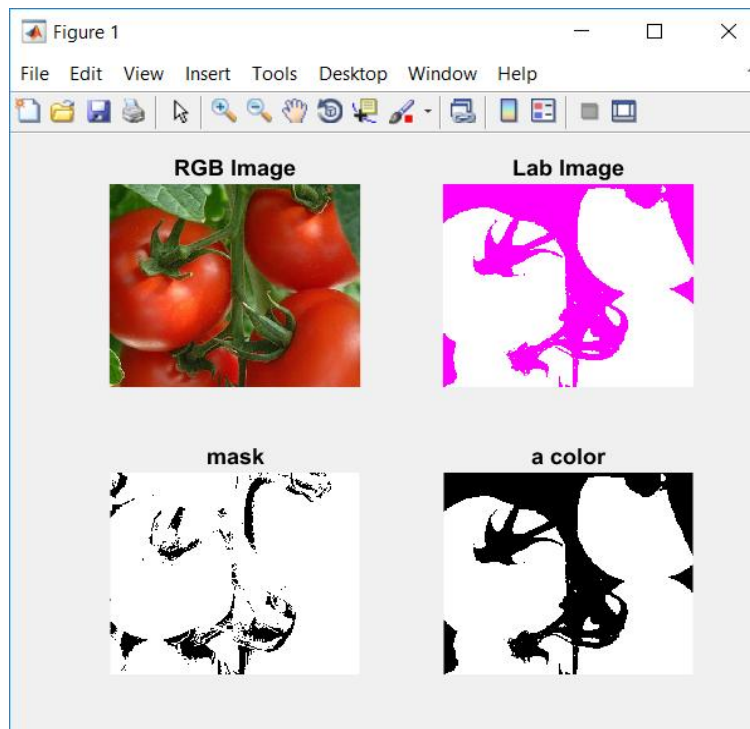


Figure 5: Snap shot of thresholding and masking of image.

Using this system, we have tested approximately 500 sample and out of which 488 samples are accurately identified. The experimental results of the project are shown below. This Experimental work uses thresholding method and creates various mask for every color (according to maturity of tomato crop) to detect in the image. Also, embedded

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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 wishes to monitor.

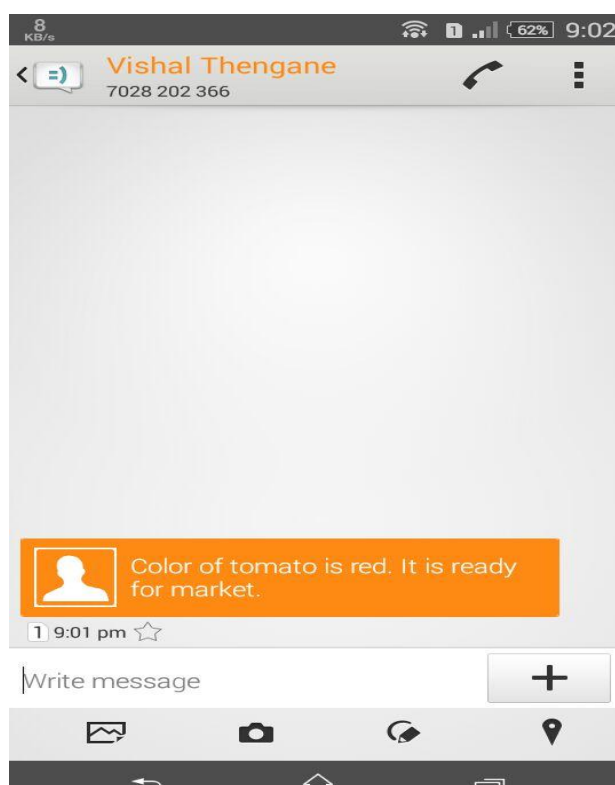


Figure 6: Message obtained at the receiver end.

The images which acquired from field which is converted into L^*a^*b color space to create the mask according to the RGB values. Then L^*a^*b image divide into L, a and b colors to identify the ripening stage of tomato. The Figure 5 show the thresholding and masking operation on images. Here, the image taken in the MATLAB is for reference purpose to verify whether all the conditions can be detected or not. In the below result, we can see that all six 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 color is maximum. Then this data serially sends to the Arduino microcontroller then inform to farmer as shown in figure 6.

VIII. CONCLUSION

This paper presents the design of an intelligent system used to monitor the condition of ripening of tomato based on color index at different ripening stages. It is a low cost, and real-time system which aims in helping the farmer to take the advantage of technology in the field of agriculture. Using the similar concept, the ripening stages of other fruits and vegetables can also be detected and informed to farmer. The future scope of this paper is to use the LAN controller which will enable us to send the .html file for the ripening condition data to the farmer as email through internet.

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