Design of fruits and vegetables online inspection system based on vision

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Abstract. This paper proposes a vision-based online fruit and vegetable inspection system. This system consists of two parts: the online detection of fruits and vegetables and the online weighing measurement of fruits and vegetables. Online detection system can detect the species of fruits and vegetables, and through the database to get the unit price of fruits and vegetables. The image processing includes image pre-processing, filtering, background removal, noise filtering and hole filling for recognition, and analysis of blocks. The weight of the fruits and vegetables is obtained by gravity sensor. Prices of fruits and vegetables can be displayed in real time in order to achieve the goal of unattended retail. This study built an online fruits and vegetables detection system which may be accelerated in the future for commercial uses.

1. Introduction

Fruits and vegetables online inspection system can quickly identify the types of fruits and vegetables, which will play an irreplaceable role in the unmanned fruits and vegetables supermarket [1-2]. Vision-based fruits and vegetables online inspection system, not only provide consumers with quality service, but also bring tremendous benefits for vendors.

In recent years, with the continuous improvement of people's living standards, they are increasingly yearning for healthy living. The need for accurate, fast and objective quality determination of these characteristics in fruits and vegetables continues to increase [3]. This growing demand is the driving force behind the development of markets and services. With the introduction of the concept of new retail, unmanned supermarkets are emerging. Inspection of fruits and vegetables online system will be more to meet this situation [4].

The development of embedded technology is closely related to the emerging popularity of artificial intelligence. Embedded technology in fruits and vegetables online inspection is a trend. It is conducive to real-time detection of fruits and vegetables online. The effect of real-time online inspection is obvious.

In this paper, vision-based online fruits and vegetables detection system was developed. The system consists of MCU, sensor module, visual module and other components. It has the high feasibility and the wide range of application.
2. System Structure
This article is based on embedded technology to solve the problem of on-line detection of fruits and vegetables in the current vending unmanned environment. Based on the vision of fruits and vegetables online inspection system consists of two parts, fruits and vegetables detection, fruits and vegetables online display. The system structure is shown in figure 1.

![Figure 1. The fruits and vegetables online inspection system structure.](image1)

Customer will place the product on the scale pan, click the transaction button on the terminal device. The camera will capture the product image into the processor for the appropriate pretreatment, feature extraction and classification identification, identify the type of product. Inquire the corresponding product information in the database. At the same time, Customer will read the weight of the product measured by the weighing sensor from the serial port and get the transaction result on the screen. The transaction data will be recorded in the database after the customer confirmed and the transaction is completed.

3. Design of the hardware system
Real-time weight of fruits and vegetables will be collected by the relevant sensors and the collected data is uploaded to the host in real time through the serial port. At the same time, the HD camera collects fruits and vegetables images. After a series of operations such as grayscale and threshold segmentation, the Processor detects the fruit category. By calling the database of fruit prices, the price of fruit will be posted on the Terminal Device. Online detection system design is illustrated in figure 2.

![Figure 2. Structure of the hardware system.](image2)
4. Image processing algorithm

4.1. Image preprocessing
This system is used in supermarkets under unmanned environment, so the image acquisition environment changes little. However, uneven brightness, shadows, and changes in the position of the camera will affect the recognition of fruits and vegetables. In order to increase the recognition rate, it is necessary to preprocess the images of fruits and vegetables.

Due to the influence of the camera shooting angle and the height of the camera from the weighing platform, when we photographed fruits and vegetables, we would shoot outside the weighing platform. The images outside the weighing platform will affect the recognition of fruits and vegetables. Therefore, we need to cut the captured image. In this article, the image size is set to 640*480. Through the image cutting, a relatively clean and complete image of the same size is obtained for subsequent processing.

Filtering, that is to suppress the noise of the target image under the condition of preserving the original feature details of the image as much as possible [4]. The position of the camera in the system is fixed, and the image background is single, so the noise in the original image is not much. In this paper, the median filtering method is chosen. The classical median filtering method sorts the gray values of all the pixels in the window, and then uses the median value instead of the gray value of the specified point. Different window sizes will affect the results of the median filter [4-5]. The larger the window, the longer the filtering time. Considering the filtering effect and the operating speed, the system uses a 5*5 window for filtering.

4.2. Image segmentation and morphology processing
Image segmentation is the main technology of image processing and machine vision system, which is the prerequisite of image analysis and pattern recognition. The purpose of image segmentation is to divide the image into meaningful connected components to extract the features of the object [5]. These similarity features include grayscale, color, texture. We can distinguish the types of fruits and vegetables through its shape, color and other features [6].

Colors are usually described by a set of attribute values (usually three or four color components). The combination of different independent variables naturally constitutes a set of spatial coordinates. This is the color space. There are three types of cones in human eyes that are most sensitive to red, green and blue light, so the three primary colors of light are divided into red, green, and blue. Three kinds of light overlap to form white light. This is the origin of RGB color space. Since the RGB color space is an uneven color space, it is not suitable for image segmentation [7]. The HSV color space is consistent with human visual color perception, and the hue, as known as H channel has nothing to do with the level of brightness or darkness of the shadow. The hue is very effective for differentiating objects of different colors. The research on fruits and vegetables recognition algorithms proposed in this paper will make use of this important feature of HSV. Fruits and vegetables image processing module algorithm flow chart is shown in figure 3.

4.3. Fruits and vegetables recognition based on color texture feature
In this paper, I use OpenCV-Python for image processing. An algorithm based on hue and morphology is proposed. In order to distinguish between apples and bananas, we can detect the fruit by apple’s and banana’s minimum circumscribed circle. It is very obvious that the apple’s minimum circumscribed radius is greater than the banana’s. The key is to first study the fruit samples to obtain the apple’s and
banana’s minimum circumcircle radius. Then I calculate the radius mean value and average the two radius mean again as the threshold. In this experiment, the threshold was taken as 250.

The RGB color space is transformed into the HSV color space. Distinguish color by extracting the value of the hue [7]. For example, the hues of yellow color are 26°- 34°. The hues of red are 156°- 180° and 0- 10°. Because of the different colors of bananas and apples, I distinguish apple and banana based on hue.

Choose 6 bananas, 4 apples and 2 oranges for random testing. I use oranges as distracters. The test results are shown in table 1.

| number | radius | hue | result |
|--------|--------|-----|--------|
| 1      | 450    | 29  | banana |
| 2      | 465    | 30  | banana |
| 3      | 110    | 54  | apple  |
| 4      | 186    | 176 | banana |
| 5      | 430    | 29  | apple  |
| 6      | 170    | 1   | apple  |
| 7      | 445    | 1   | banana |
| 8      | 195    | 178 | apple  |

As shown in table 1, according to the hue of the image and the minimum radius of the circumscribed circle, apples and bananas which have the same quality can be well identified, the third group is an orange in the experiment, because the hue and the radius of the minimum circumscribed circle do not meet the classification criteria of apples and bananas, so its classification does not belong to apples and bananas. This algorithm can distinguish apples and bananas well.

5. Summary
In this paper, I use OpenCV-Python for image processing. An algorithm based on hue and morphology is proposed to distinguish apples and bananas. The result of test shows that the two classifications have remarkable effect. Fruits and Vegetables Online Detection System Based on Vision obtains real-time pictures through HD cameras, identify the types of fruits and vegetables through specific algorithms and invoke the unit prices of fruits entered in the database. When the camera gets real-time images, the weight of fruits and vegetables can be collected through the weight. Ultimately real-time detection of fruits and vegetables species and prices will be displayed on the terminal device. The system is suitable for the new unmanned retail supermarket. In the future, unmanned and intelligent background will be shine.

Acknowledgements
This research work is supported by National Natural Science Foundation of China (Grant No. 51504228), 2016 postdoctoral research projects of Zhejiang Province of China and the Public Welfare Technology Application Research Project of Zhejiang Province Science and Technology Department (LGG18F030010).

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