Image Processing on Orange Industry, a Brief Review

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Keywords: Image processing, Orange classification, Classification with neural network.

Abstract. The huge expectation of population for food products, mainly fruits require quality products. The need for accurate, fast and objective determination of these characteristics on food products continues to grow. Normally, classification of the oranges industrially produced is made visually and manually, considering the color pattern, which requires a lot of labor and can be inappropriate and has an elevate cost. Machine vision provides one alternative for an automated, non-destructive and cost-effective technique to accomplish these requirements. Researches focused on the development of this task has been tried to find ways to automatize this process. However, part of this development happens in many areas, commercially and industrially. This work aims to present the progress of image processing on industry and mainly on classification of oranges.

Introduction

The increased population and the sophistication of costumers created an expectation for improved food products, this has increased the need for enhanced quality monitoring. External quality is considered of paramount importance in the marketing and sale fruits. The appearance, size, shape, color and presence of blemishes influences consumer perceptions and determines the level of acceptability to purchase [1].

The package process (who involve screening and classify) its manual, the manual job is susceptible to error and adds human extra costs to product. The traditional method to classify at production system is based at visual inspection made by a man [2]. The paper from Simões and Costa do the classify according the fruit color. This paper methodology purposes a classification by color, quality and size. According to market quality parameters, non-destructive classify systems were developed by sensors and electronic advices.

Computer vision systems have been used increasingly in the food and agricultural industry for inspection and evaluation purposes as they provide suitably rapid, economic, consistent and objective assessment [3].

Automatic inspection systems, mainly based on camera-computer have been used for the sensory analysis of agriculture and food products [1]. Recent advances in hardware and software have aided in this expansion by providing low cost powerful solutions, leading to more studies on the development of computer vision systems in the food industry.

Citric Fruits, like oranges and lemons has a peak of production on winter. The different types of fruit are easily hybridized one each other. Among these fruits the oranges are most common because the huge different varieties around the world. Brazil is the third big world producer, with a production of 25 million of tone by year [2]. Automatic new methods, with precision and fast to classify fruits its desirable.

Computational Methods

Usually the studied techniques are based in academic works about image processing and has a color parameters, size, form and others [4]. To capture images the system has some components: light, camera, scanning, computational advices and software [5]. This system usually called “visual computation” has a differential, because uses integrated systems without fruit contact, so the capture
and analysis in real time is automatic [6]. These facts, we can classify oranges with images processing and histogram to analyses the color level and provide a classification bases on size and color [7]. Figure 1 show the processing image system.

![Image processing system diagram](image)

Figure 1. Steps of image processing [8].

Image processing and image analysis are recognized as being the core of computer vision [9]. Image processing involves a series of image operations that enhance the quality of an image in order to remove defects such as geometric distortion, improper focus, repetitive noise, non-uniform lighting and camera motion. Image analysis is the process of distinguishing the objects (regions of interest) from the background and producing quantitative information, which is used in the subsequent control systems for decision making.

Vidal [11] works proposes de development of a mobile equipment able to classify in real time oranges according the color. This equipment was developed to operate on the farm and do an orange pre-classification during the harvest. The performance was analyzed by a spectrophotometer and the results presents a great trust based in the fruit color index.

Lefebre [12] developed an automated system to classify fruits, the system is based on external and physical parameters by machine vision.

Sapirstain [13] showed that digital image techniques can generate precise images and contribute by analysis quality.

Aleixos et al. [14] the new hardware components make possible the implantation in real time processing images.

Table 1 show the applications of image processing in different areas. Singh [8].

| Area                        | Purpose                                                                 |
|-----------------------------|-------------------------------------------------------------------------|
| Industrial Automation and image processing | Process control  
Barcode and package label  
Parts identification on assembly lines, defect and fault inspection  
Inspect of printed circuit boards and integrated circuits |
| Medical image analysis      | Tumor detection, measurement of size and shapes of internal organs, cell count.  
X-ray inspection |
| Robotics                    | Obstacle avoidance by recognition and interpretation of objects in a scene collision collision avoidance, match monitoring. |
| Radar Imaging               | Target detection and identification, guidance of remote piloted vehicles, guiding missiles and satellites from visual cues |
| Food Industry               | Sorting of vegetables and fruits, location of defects, location of dark contaminants and insets in cereals. |
| Document Analysis           | Handwritten character recognition, layout recognition, graphics recognition. |
**Image Processing Analysis**

The basic machine vision and image processing algorithms can be divided into five groups: segmentation and algorithm development, edge detection techniques, digital morphology, texture and thinning and skeletonization algorithms. Russ [15].

| Table 2. Processing images algorithms. |
|---------------------------------------|
| **Segmentation and algorithm development** | Typical process to locate objects and boundary, assigning a label to every pixel in image, examples: neural networks, manual selection, isodata algorithm, objective function, histogram clustering. |
| **Edge detection techniques** | The process of separate the edges (boundary object and background), the process identifies the shape, size object. |
| **Digital morphology** | Images are processed as topographical surface, and the elevation of each point is assigned as the intensity value of the corresponding pixel. |
| **Texture and thinning** | The repetition of a pattern over a region is called texture. Texture describes the properties of objects surface, but there is not an ideal method for measuring the texture, the existent methods use capture the texture by variation across pixels and their neighboring pixels. |
| **Skeletonization** | Is a process to describe the global properties of an object and reduce the original into a more compact representation. |

**Image Processing Analysis on Oranges**

Computer vision has been applied to the classification of oranges by reference to their visual characteristics. Ruiz [16] studied three image analysis methods to solve the problem of long stems attached to mechanically harvested oranges. The techniques include color segmentation based on linear discriminant analysis, contour curvature analysis and a thinning process which involves iterating until the stem becomes a skeleton. It was found that these techniques were able to determine the presence or absence of a stem with certainty, however, stem location was correctly estimated in 93, 90 and 98% for the different techniques, respectively, in the samples tested.

The work of Kondo [17] studied the relation of appearance with sweetness of oranges using image processing and had a positive result about it was positive, the method could successfully predict the sweetness by the orange format.

Suphamitmongkol [18] using near infrared spectroscopy (NIRS) for on-destructive discriminating Thai orange varieties were studied. Short-wavelength near infrared (SWNIR) spectra in region of 643 to 970 nm were collected from 100 orange sample of each varieties. A total of 300 spectra were used to develop an accurate classification model by diversity of classifiers. The result showed that Logistic Regression (LGR) model was achieved 100% classification accuracy while Multi-Criteria Quadratic Programming (MCQP) and Support Vector Machine (SVM) ones also demonstrated satisfying result (95%).

Simões and Costa [2] used pixels classification and RGB decomposition followed by a patterns creation and by last the patter compared by a RNA algorithm, the results were good, but the RNA algorithm was no able to accept or reject the oranges, just a fuzzy algorithm is able to this.

Jawar [19] did experiments with 160 oranges, the images were made in a controlled environment with white background, the images had the background removed, the pixels were segmented in a RGB scale. The vectors created were submitted do linear regression algorithm, the vectors length determine the orange size, and a relation between the statistics analysis were obtained.

**Conclusion**

This review presents the recent developments and applications of image analysis in the food industry, the concepts and technologies associated with computer vision. Computer vision systems have been used increasingly in industry for inspection and evaluation purposes as they can provide rapid, economic, hygienic, consistent and objective assessment.
Image processing is recognized as being the core of computer vision with the development of more efficient algorithms assisting in the greater implementation of this technique. Even though adequately efficient and accurate algorithms have been produced, processing speeds still fail to meet modern manufacturing requirements.

The flexibility and non-destructive nature of this technique also help to maintain its attractiveness for application in the food industry.

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