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Citrus Fruit Feature Extraction using Colpromatix Color Code Model

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Keywords: *citrus, texture, shape, texture, features.*

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Abstract- Classification of citrus fruit more precisely and economically under natural illumination circumstances. The aim of this paper was to develop a robust and feature extraction techniques to discover citrus fruit features with different dimensions and under different illumination conditions. To identify object residing in image, the image has to be described or represented by certain features. In this paper, proposed a citrus fruit feature extraction process for deriving the classification. The proposed system present two tasks namely, 1) Image pre-processing: it is carried out using Hybrid Noise filter to remove the noise; ii) Citrus fruit features extraction: Feature extraction using new Colpromatix color space model, Size, Texture, Shape, and Coarseness. The Image Shape is an important visual feature of an image. Difference features representation and description techniques are discuss in this review paper. Feature extraction techniques play an important role in systems for object recognition, matching, extracting, and analysis. It also presents comparison between various techniques.

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1. INTRODUCTION

Image processing is one of the mostly increasing areas in computer science. As technology advances, the analog imaging is switched to the digital system now-a-days. Every day capture huge amount of images which are very difficult to maintain manually within a certain period of time. So the concept and application of the digital imaging grows rapidly. Digital image processing is used to extract various features from images [1] [13]. This is done by computers automatically without or with little human intervention.

(Post-harvest) process of fruits and vegetables is concluded in several steps: washing, sorting, grading, packing, transporting and storage [12]. The fruits sorting and grading are considered the most important steps of handling. Fruit grading: involves the inspection, assessment and sorting of various fruits regarding quality, freshness, legal conformity and market value. Fruit grading often occurs by hand, in which fruits are assessed and sorted. Machinery is also used to grade fruits, and may involve sorting products by size, shape and quality. For example, machinery can be used to remove spoiled fruits from fresh product.

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Categorization is a several process of assembling items analytically, and has two general, until now distinct meanings:

- 1) *Ordering*: organizing items in a sequence ordered by some condition;
- 2) *Categorizing*: clustering items with similar properties.

Categorization of agricultural products is accomplished based on appearance (color and absence defects), texture, shape and sizes. Manual sorting is based on traditional visual quality inspection performed by human operators, which is tedious, time-consuming, slow and non-consistent. It has become increasingly difficult to hire personnel who are adequately trained and willing to undertake the tedious task of inspection. A cost effective, consistent, superior speed and accurate sorting can be achieved with automated sorting.

Color and size are the most important features for accurate classification and sorting of citrus. Because of the ever-growing need to supply high quality fruits and vegetable products within a short time, automated grading of agricultural products is getting special priority among many farmer associations. The impetus for these trends can be attributed to increased awareness by consumers about their better health well-being and a response by producers on the need to provide quality guaranteed products with consistency. It is in this context that the field of automatic inspection and machine vision comes in to play the important role of Quality control for agricultural products. Fruit size estimation is also helpful in Planning, packaging, transportation and marketing operations. Among the physical attributes of agricultural materials, volume, mass and projected areas are the most important.

The feature can be described as a behavior of one or more estimations, where each of estimation determines some significant property of an object [10]. Moreover, features characterized some significant aspects of an object. Researchers arrange the numerous features as follows:

Ordinary features: These features include the features that are independent of applications such as *color*, *texture* [11] and *shape*. According to the conceptual level, they can be further split into:

- *Pixel-level features:* those features that can be measures at each pixel, e.g. color and location.

- *Local features*: it includes the features that can be computed on the results of the division of image into three planes i.e. red, green and blue plane by image segmentation
- *Global features*: these feature are determined over the whole image.

Domain-specific features: it includes the features that are specific to a particular application such as human faces, fingerprints and conceptual features. These are often specific to a particular domain.

The aim of this work is to develop a citrus fruit feature extraction process is to effectively partitioning objects in images to facilitate fruit defect detection. In this paper, we present citrus fruit image Feature extraction process in a segmentation scheme using Colpromatix Color, Size, Shape, Texture and Coarseness is used to over-segment the original image because it is known to give a good feature extraction result and time efficiency.

The rest of the paper is organized as follows: Literature Review is detailed in Sect. 2. In Sect. 3, Research methodologies acquire orange fruit images and conclusion is in Sect. 4.

II. LITERATURE REVIEW

Rapid color grading for fruit quality evaluation using direct color mapping [2] presented an effective and user-friendly color mapping concept for automated color grading that is well suited for commercial production. User friendliness is often viewed by the industry as a very important factor to the acceptance and success of automation equipment. This color mapping method uses preselected colors of interest specific to a given application to calculate a unique set of coefficients for color space conversion. The three-dimensional RGB color space is converted into a small set of color indices unique to the application. In contrast with more complex color grading techniques, the proposed method makes it easy for a human operator to specify and adjust color-preference settings Tomato and date maturity evaluation and date surface defect detection are used to demonstrate the performance of this novel color mapping concept.

In [3] authors introduced an intelligent system which tackles the most difficult instance of this problem, where two-dimensional irregular shapes [9] have to be packed on a regularly or irregularly shaped surface. The proposed system utilizes techniques not previously applied to packing, drawn from computer vision and artificial intelligence, and achieves high-quality solutions with short computational times. In addition, the system deals with complex shapes and constraints that occur in industrial applications, such as defective regions and irregularly shaped sheets.

Image Texture Feature Extraction Using GLCM Approach [4] has discussed a feature Extraction is a

method of capturing visual content of images for indexing & retrieval. Primitive or low level image features can be either general features, such as extraction of color, texture and shape or domain specific features. In this paper authors presented an application of gray level co-occurrence matrix (GLCM) to extract second order statistical texture features for motion estimation of images. The Four features namely, Angular Second Moment, Correlation, Inverse Difference Moment, and Entropy are computed using Xilinx FPGA. The results show that these texture features have high discrimination accuracy, requires less computation time and hence efficiently used for real time Pattern recognition applications.

Contrast enhancement and intensity preservation for gray-level images using multi-objective particle swarm optimization [5] proposed the contrast enhancement is achieved by maximizing the information content carried in the image via a continuous intensity transform function. The preservation of image intensity is obtained by applying gamma-correction on the images. Since there is always a trade-off between the requirements for the enhancement of contrast and preservation of intensity, an improved multi-objective particle swarm optimization procedure is proposed to resolve this contradiction, making use of its flexible algorithmic structure. The effectiveness of the proposed approach is illustrated by a number of images including the benchmarks and an image sequence captured from a mobile robot in an indoor environment.

In [6] authors considered regularity analysis for patterned texture material inspection. Patterned texture-like fabric is built on a repetitive unit of a pattern. Regularity is one of the most important features in many textures. In this paper, presented a new patterned texture inspection approach called the regular bands (RB) method is described. First, the properties of textures and the meaning of regularity measurements are presented. Next, traditional regularity analysis for patterned textures is introduced. Many traditional approaches such as co-occurrence matrices, autocorrelation, traditional image subtraction and hash function are based on the concept of periodicity. These approaches have been applied for image retrieval, image synthesis, and defect detection of patterned textures. In this paper, a new measure of periodicity for patterned textures is described. The Regular Bands method is based on the idea of periodicity. A detailed description of the RB method with definitions, procedures, and explanations is given. There is also a detailed evaluation using the Regular Bands of some patterned textures.

In [7] authors illustrated a comprehensive survey of 48 filters for impulsive noise removal from color images is presented. The filters are formulated using a uniform notation and categorized into 8 families. The performance of these filters is compared on a large set

of images that cover a variety of domains using three effectiveness and one efficiency criteria. In order to ensure a fair efficiency comparison, a fast and accurate approximation for the inverse cosine function is introduced. In addition, commonly used distance measures (Minkowski, angular, and directional-distance) are analyzed and evaluated. Finally, suggestions are provided on how to choose a filter given certain requirements.

Measurement of Color of Citrus Fruits using an Automatic Computer Vision System [8] authors presented a key aspect for the consumer to decide on a particular product is the color. In order to provide as soon as possible fruit available to consumers, citrus begin to be collected before they reach their typical orange and therefore are subject to certain degreasing treatments, depending on their initial coloration. Recently, there has been developed a mobile platform that is capable of performing this process in the field while the fruit is harvested. However, due to the restrictions of working in field conditions, the computer vision system equipped in this machine is limited in its technology and processing capacity compared to conventional systems. This work evaluates this automatic inspection system of citrus color and compares it with two other devices; a characterized computer vision system and a spectrophotometer used as reference in the analysis of color on food.

III. RESEARCH METHODOLOGY

The research methodology considers the Citrus fruit classification process of Feature Extraction process is derived in this part. We introduce a tractable feature extraction process of Colpromatix color code for Gray and RGB color space, Size, Shape, Texture and Coarseness which is a natural extension of image feature extraction process. The overall feature extraction process flow diagram is described in figure 1.

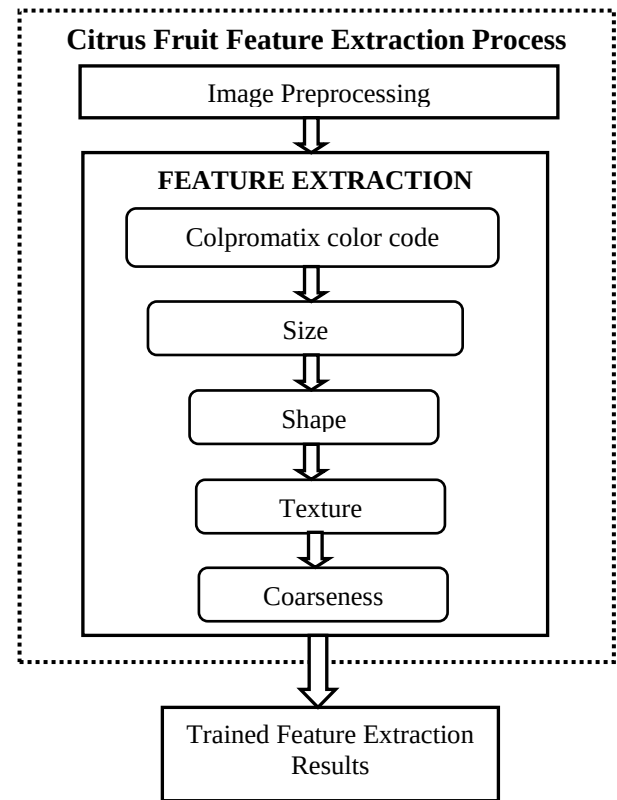


Fig. 1: Proposed Flow Diagram

a) Image Preprocessing

Image preprocessing is a mining technique that performs transforming raw image data into a reasonable format. In this process, original images pixels size (1027 x 768 x 3) is resized into (256 x 256 x 3) dimensions without pixel loss using 'bicubic' method. After that, images must be of the same size and are supposed to be associated with indexed images on a common color map. In preprocessing, we introduced Hybrid Noise filter (HNF) to remove noise in a citrus image. The HNF is a new method enhanced version from Gaussian and Wiener filter. The noise is evenly distributed over the pixels. This means that each pixel in the noisy image is the sum of the true pixel value and a random Gaussian distributed noise value. For this noise removal, the maximum likelihood de-noised answer would just be a local mean, which can do with convolution (conv2) method. The peak signal noise ratio (PSNR) and Mean square error (MSE) ratios are compared to the Gaussian and HNF is described in table 1 and 2.

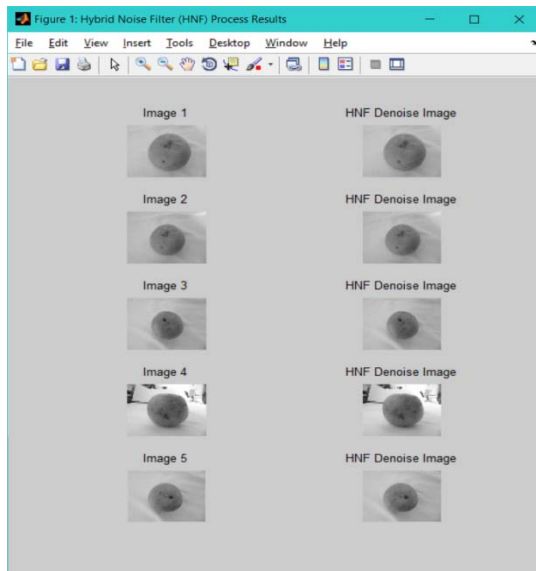
Table 1: Comparison of MSE ratio with Gaussian and HNF method

Images	Gaussian	HNF method
Image 1	97.5055	68.0320
Image 2	98.1133	68.4084
Image 3	98.0081	68.1074
Image 4	98.2375	64.7535
Image 5	98.0727	68.3908

Table 2: Comparison of PSNR ratio with Gaussian and HNF method

Images	Gaussian	HNF method
Image 1	28.2745	29.8377
Image 2	28.2475	29.8137
Image 3	28.2522	29.8329
Image 4	28.2420	30.0522
Image 5	28.2493	29.8148

In table 1 and 2, the *HNF* method outperforms MSE and PSNR ratio than Gaussian filter. The *HNF* denoised results are shown in figure 1.

**Fig. 1:** Hybrid Noise Filter (HNF) Process Results

b) Image Feature Extraction

Image feature extraction is done without local decision making; the result is often referred to as a feature image. Consequently, a feature image can be seen as an image in the sense that it is a function of the same spatial (or temporal) variables as the original image, but where the pixel values hold information about image features instead of intensity or color. Feature extraction is a mining technique that involves transforming raw data into a comprehensible format. Feature extraction is a proven method of resolving Colpromatix Color code, Texture Shape, and Coarseness.

c) Color Feature Extraction

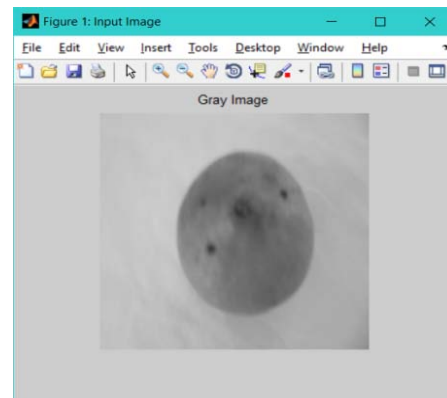
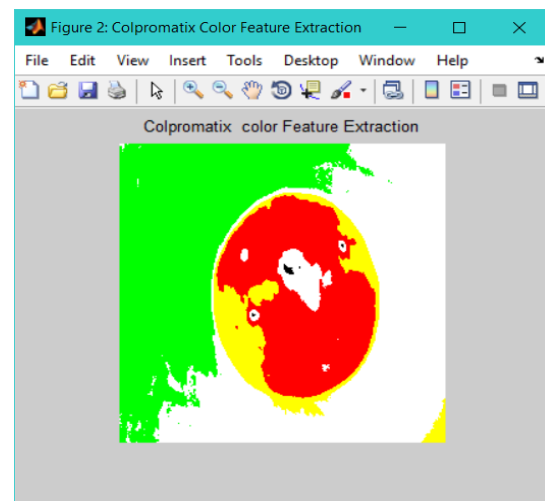
The feature extraction process starts with the Color Space model. The color descriptors, RGB colormap features are extracted using color descriptors (i.e., mean and standard deviations of R, G and B). We introduce a tractable Colpromatix color space code for Gray and RGB color space models. A Colpromatix image (sometimes styled Colpromatix color or Colpromatix color) is derived from a grayscale image by mapping each intensity values (0 to 255) to a color according to a

table or function. The intensity values of citrus images described in table 3.

Table 3: Gray Intensity values ranges for color space model

Colors	Intensity Vales
Yellowish Gray	0 to 63
Yellow	64 to 95
Orange	96 to 127
Red	128 to 59
Purple	160 to 191
Light Blue	192 to 223
Green	224 to 255

Colpromatix color is typically used when a single channel of data is available (e.g. temperature, elevation, soil composition, tissue type, and so on), in contrast to false color which is commonly used to display three channels of data. The results of Colpromatix Feature extraction is described in figure 2 and 3. In figure 2 represents an input Gray model image. The gray model image is converted into Colpromatix color format intensity changes according to table 1. The Color feature extraction result finds the disease portions 90% located clearly in black color represents in figure 3.

**Fig. 2:** Input Citrus Gray Image**Fig. 3:** Result of Colpromatix Color Feature Extraction

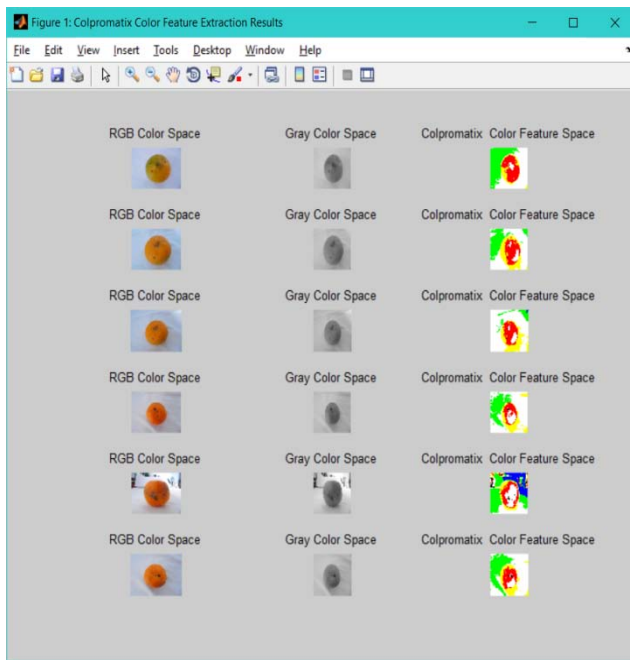


Fig. 4: Result of Colpromatix Color Feature Extraction; First column shows input RGG Color space mode; Second column shows Gray Color Space; Third column shows the Colpromatix Color space result model.

d) Texture Feature Extraction

The texture feature refers to surface characteristics and appearance of an object given by the dimension, shape, density, display, proportion of its elementary parts. After Colpromatix color descriptors stage to collect such features through texture analysis process is called as texture feature extraction. Due to the signification of texture information, texture feature extraction is a key function in citrus image segmentation functions in 9 levels described in figure 5 and 6.

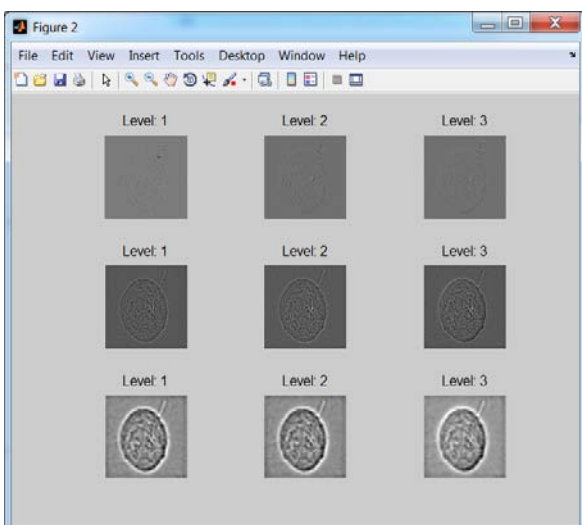


Fig. 5: Texture Feature extraction result of image 1

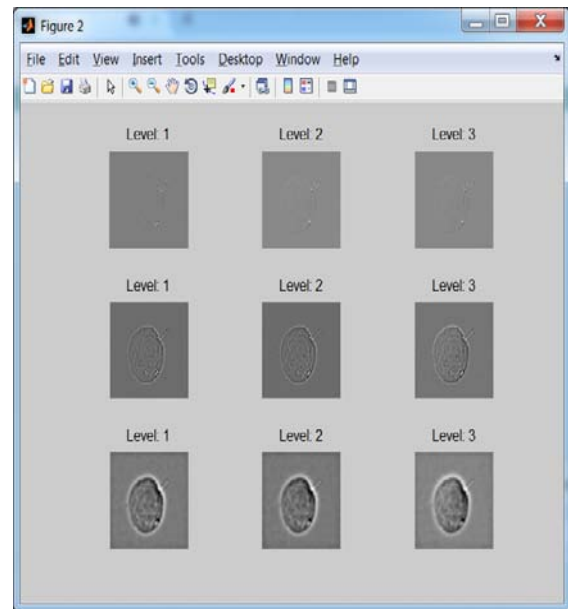


Fig. 6: Texture Feature extraction result of Image 2.

e) Shape Feature Extraction

For shape feature extraction, Citrus object is a significant and essential feature for describing image content, and can be thought of as an outline of the object [14], invariant to rotation, scale and translation [15]. Shape features are frequently used for finding and identical shapes, classifying objects measurement of shapes. Moment, perimeter, region and direction are some of the important characteristics used for shape feature extraction technique. The shape of an object is determined by its outside boundary abstracting from other properties such as color, content and texture composition, as well as from the object's other spatial properties.

It performs simple geometrical calculation such as shape formula. In here, it detect the edge location of "1" from the image, it perform the computation and verify the circular objects. To detect it, the radius level of the object must be given in order to detect the required round objects size. It detects 75% of it. In this step, some unrelated object are find out using padarray method detected due to it has the similar shape region because of the object base on the edge of each object.

The equation of the a shape is,

$$r^2 = (x - a)^2 + (y - b)^2 \quad \text{eqn. (1)}$$

Here a and b represent the coordinates for the centered, and r is the radius of the circle. The shape feature results displayed in figure. 7 & 8.

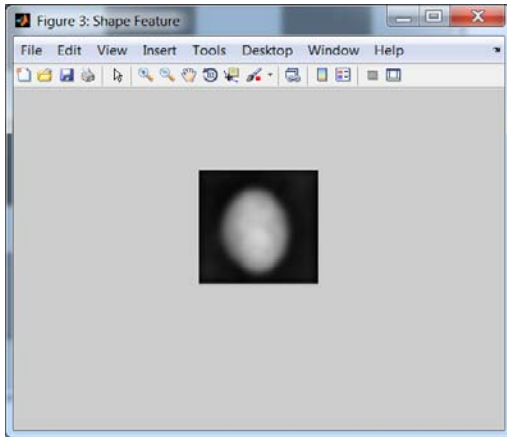


Fig. 7: Shape Feature extraction result image of A.jpg

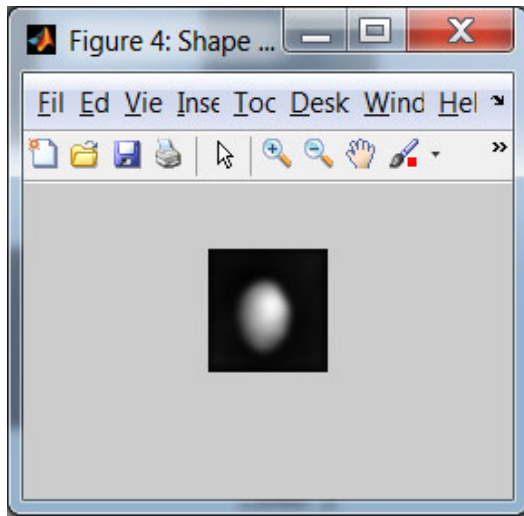


Fig. 8: Shape Feature extraction result image of B.jpg

f) Coarseness Feature Extraction

Coarseness relates to distances of prominent spatial variations of intensity-levels. It implicitly refers to the dimensions of the primitive elements forming the texture. The computational process accounts for differences between the average pixels for the non-overlapping blocks of different sizes in the following procedure:

Algorithm 1: Coarseness Feature Extraction

Step 1: At each pixel (x, y) , compute 6 averages for the blocks of size $2^k \times 2^k$, $k=0,1,\dots,5$, around the pixel.

Step 2: At each pixel, calculate absolute differences $A_k(x, y)$ between the pairs of non-overlapping averages in the horizontal and vertical orientations.

Step 3: At each pixel, find the value of k that maximizes the difference $A_k(x, y)$ in either direction and set the best dimension $D_{best}(x, y)=2^k$.

Step 4: Calculate the coarseness feature $F_{Coarseness}$ by averaging $D_{best}(x, y)$ over the entire image.

$$F_{Coarseness} = \frac{1}{mn} \sum_x^m \sum_y^n D_{best}(x, y) \quad \text{eqn. (2)}$$

where $m \times n$ are the image total pixels, and D_{best} is the best demission that gives the highest difference of averages between non overlapped neighborhoods on opposite sides in both horizontal and vertical orientations for every pixel (i, j) .

IV. CONCLUSION

In this paper reviewed the advancement of the information and communication technology in the field of citrus image preprocessing and feature extraction. Citrus fruit image processing approaches used in the field of agriculture and food industry for fruit classification of two processes is explored in this paper. Most of the work in this image processing is composed of the mainly two main steps (1) Image preprocessing and (2) feature extraction for training. In the first step image preprocessing is carried out using Noise removal method, in the second step Citrus fruit feature extraction process are extracted from the preprocessed image region, of fruit diseases. The proposed feature extraction method of Colpromatix color space model process and analyze the disease locations effectively. Texture feature extraction gives the efficient values when compared to the other methods. These methods can be applied to citrus fruit classification for grading.

The further work is to do graph based recursive process segmentation and Post processing of Naive Bayesian classification algorithms.

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