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Research paper

# Analysis of content based image retrieval for plant leaf diseases using color, shape and texture features

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ABSTRACT

This research paper is an attempt to present Content Based Image Retrieval (CBIR) system developed for retrieving diseased leaves of soybean. It uses color, shape and texture features of leaf. Color features are extracted using HSV color histogram. Scale Invariant Feature Transform (SIFT) provides shape features in the form of matching key points. Local Binary Pattern (LBP) and Gabor filter are widely used texture features. Novel texture feature named Local Gray Gabor Pattern (LGGP) is proposed by combining LBP and Gabor. Performance of all these features with respect to retrieval precision is tested for three soybean leaf diseases. Further color, shape and texture features are combined to increase performance. It is found that when LGGP is combined with color histogram and SIFT retrieval precision is improved. Retrieval efficiency of about 96%, 68% and 76% is achieved for soybean leaves affected by mosaic virus, septoria brown spot and pod mottle disease respectively. Average retrieval efficiency of 80% (for the top 5 retrieval) and 72% (for the top 10 retrieval) is obtained by combined features. This retrieval precision is database dependent and varies with size of the database and quality of images.



## 1. Introduction

In last few decades, vast revolution in the world of computer vision is observed because of cheaper storage devices, fast computers, novel communication technologies and multimedia. This has increased collection of images from various application areas. Image has become now an integral part of human life including commerce, government, academics, hospitals, crime prevention, surveillance, engineering, architecture, journalism, fashion and graphic design and historical research. Retrieval of required image from such a large collection is a challenging task.

Traditional methods of retrieving image are text or keyword based which retrieve the image according to name or describing text provided by user. It may be possible that same object is recognized by different name in different region which limits the retrieval accuracy. Describing ability of user is also one of the factors affecting text based retrieval. In this context Content Based Image Retrieval (CBIR) is more reliable and efficient method which retrieves the image based on their visual contents like color, shape, texture etc. CBIR found its use in many computer vision and image information systems which include medical imagery, criminology, satellite imagery etc. Agriculture is one of the domain in which researcher has a scope for applying CBIR for identification of leaf, stem and fruit diseases.

The economy of agriculture countries has major share from agricultural production which is affected by crop diseases. Preventive and predictive measures at appropriate stages of crop cultivation can improve productivity by handling disease management.

Experts like, experienced farmer and agricultural adviser recognize the disease. Prolonged cultivation experience can bring enhanced ability in farmers as their visual sense gets developed so as to catch changes in the crop caused by disease. But it is difficult for them to transmit this visual sense to future generation. An agricultural advisor can be better expert if he/she is available in time and is able to provide expertization with the available information. Again the role of these two experts is limited by subjectivity and inconsistency (Patil and Kumar, 2014).

Computer based systems can overcome these limitations. These systems can be developed as mobile application or special disease detection device which any farmer or agricultural expert can use.

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Computer based systems are intelligent computer programs designed to work excellently both in a way and at a level of farmers and agricultural experts. Compared with human experts these systems require less information for processing and also reduces man power and increases throughput. It consists of an image acquisition device and computer with appropriate software as shown in Fig. 1. The image acquisition device may be digital camera which will take image of the diseased part of the plant/crop. The farmer may send the image by email or using mobile multimedia message. Computer with software like MATLAB, SciLAB are used to process the acquired image so as to detect the disease for further treatment.

Computer based systems can be implemented using various methods like genetic algorithms, artificial neural networks, image processing techniques etc. This paper presents implementation of computer based system using Content Based Image Retrieval (CBIR) for detecting the leaf diseases of the plant.

It is developed with objective of providing assistance to farmers as well as agricultural experts. In future it can be developed as mobile application or small handy pocket device. It will avoid farmers to visit in person to seek advice of an expert. Along with the disease detection, system can be enhanced to provide disease severity. This leads to in time treatment of plant/crop diseases.

Number of researchers has developed CBIR system for different applications using image features like color, shape, texture and combinations of these. CBIR systems are developed by using color features like RGB color histogram (Chakravarti and Meng, 2009), color histogram using GLCM and color histogram using K-Means (Rasli et al., 2012), Color Moments (Redi et al., 2011; Shukla, 2013; Weng et al., 2013). Image texture features like Local Binary Pattern (LBP) and LBP variance (Doshi and Schaefer, 2013) are used to develop CBIR systems. Shape-Adaptive Discrete Cosine Transform (SA-DCT) (Belloulata et al., 2014) and Scale Invariant Feature Transform (SIFT) with Canny Edge Detection (CED) (Bandaru and Naik, 2014) are used by researchers as shape features in designing CBIR systems. CBIR systems using combination of color, shape and texture features are very efficient. Few examples are combination of color moments and Gabor filter (Hiremath and Pujari, 2007), auto-correlogram, BDIP and BVLC moments (Chun et al., 2008), color moments and Gabor texture descriptors (Huang et al., 2010), wavelets and color histogram moments (Selvarajah and Kodithuwakku, 2011), color and geometric moments (Bhagat and Meghe, 2012), gray co-occurrence matrix and Zernike moments (Kang and Zhang, 2012), HSV color moments and Ranklet Transform (Afifi and Ashour, 2012), color histogram, color correlogram, gray level co-occurrence matrix and Tamura-Hu moments (Wenfei et al., 2014), color moment and LBP (Choudhary et al., 2014), HSV color histogram and co-occurrence matrix (Ganar et al., 2014).

The Proposed system is implemented using color, texture and shape features of the leaf. A new texture feature named Local Gray Gabber Pattern (LGGP) which is combination of Gabor filter and LBP is proposed. To increase retrieval precision color, shape and texture features are combined.

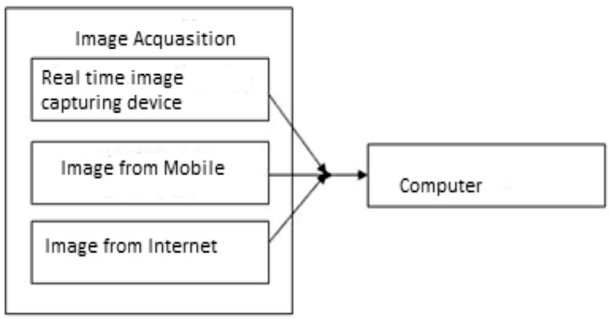


**Fig. 1.** Computer based systems.

Outline of paper is as follows: Section 2 gives a short overview of related work by other researcher in context of disease identification, classification and retrieval. Section 3 gives proposed CBIR systems and features used for it. Section 4 reveals experimental results and finally Section 5 presents conclusion.

## 2. Related work

During survey of related work in field of agriculture; it is found that earlier research has been carried using image processing and computer vision technologies for detection and classification of plant diseases (leaf, flowers, fruit etc.). Very little research is found in domain of CBIR specifically developed for plant disease identification.

Meunkaewjinda et al. (2008). proposed automatic plant disease diagnosis system which uses multiple artificial intelligent techniques for grape leaf diseases. Self-organizing feature map and back propagation neural network is used to recognize the colors of grape leaf. Further a modified Self-organizing feature map is used for segmentation and support vector machine for classification. The average percentage of diagnosis achieved with this method is 86.03%. Self-organizing feature map is also used to detect disease of cotton leaves (Gulhane and Gurjar, 2011).

Kebapci et al. (2011). developed CBIR system for plant image retrieval using color, shape and texture features. Color histogram, color co-occurrence matrix and modified Gabor method based on patch based approach is proposed. SIFT is used to captures local characteristics of the plant and global shape descriptor is used to capture global characteristics of the plant. The experiment is carried for identification of house plants with the accuracy of 73%.

The method of automatic identification of wheat diseases is proposed in (Li et al., 2010). Otsu algorithm is used to extract the lesion area from the image. Fourteen different morphological characteristics are obtained from segmented region are filtered by using principal component analysis. Around 85% disease detection rate is reported.

The plant image retrieval method based on plant leaf images is proposed in (SathyaBama et al., 2011). Color, shape and texture features of leaf are used for retrieval. SIFT is used for shape feature extraction, SIFT in saturation band of HSV color space is used for color feature extraction and log Gabor wavelet in SIFT is used to extract texture features. These features are combined to retrieve the leaf images. The retrieval efficiency of about 97.9% is achieved.

Plant disease detection technique is developed by Anand and Ashwini (Kulkarni and Patil, 2012). The technique uses Gabor filter and artificial neural network. 91% performance is achieved through this technique. An automatic plant disease detection techniques based on histogram matching is proposed in (Kailey and Sahdra, 2012).

## 3. Proposed system

The study of related work encouraged to propose CBIR based system for retrieving diseased leaves of plant. Fig. 2 shows general architecture of proposed system. CBIR based system involves execution of two steps i.e. Feature Extraction and Feature Matching. In feature extraction, feature vectors from images are extracted and stored in Feature Database. Single or multiple features can be used. When query image is given; its feature vector is extracted and compared with the feature vectors in database during Feature Matching step. If distance between feature vector of query image

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