2009 Third International Symposium on Intelligent Information Technology Application

Mobile-Based Flower Recognition System

Jung-Hyun Kim, Rong-Guo Huang, Sang-Hyeon Jin and Kwang-Seok Hong
School of Information and Communication Engineering
Sungkyunkwan University
Suwon, 440-746, Republic of Korea
{kjh0328, hrg316, jinjinsh}@skku.edu and kshong@skku.ac.kr

***Abstract*—Conventional flower or leaf recognition studies have some restrictions and limitations. These include a sharp drop in recognition rate due to the varying positions and number of relevant objects in the original object image. Hence, this paper suggests and implements a mobile-based flower recognition system using Difference Image Entropy (DIE) and contour features of the flower from the original image with multi-flower objects. In system framework includes 1) WiBro Net.-based transmission and designation module of the relevant flower object by drawing the flower region of the user's interest, 2) contour feature extraction module, and 3) DIE-based flower recognition module. The system was evaluated using ten species of flowers with each ten samples. Experimental results achieved an optimum average recognition rate of 95% and average response run-time of 9,033ms, for a set of ten images per species.**

Keywords- flower recognition; difference image entropy; contour feature

I. INTRODUCTION

People have sought ways to cultivate, buy, wear, or otherwise be around flowers and blooming plants, partly due to their agreeable appearance and smell. Although flower species abound in most environments co-inhabited by humans, most species are still unknown to them. Recognition technology is necessary but a difficult task to achieve such that it provides humans with the knowledge of the flowers and leaves they encounter. In recent studies related to flower or leaf object recognition, Takeshi Saitoh et al. described an automatic method for recognizing a blooming flower based on a photograph taken with a digital camera of a natural scene [1]. Jie Zou and George Nagy evaluated model-based interactive systems to recognize natural objects, such as a flower or a leaf, in the Computer Assisted Visual InterActive Recognition (CAVIAR) [2]. Zhenjiang Miao et al. introduced a rose variety recognition program [3] using a Modified Fourier Descriptor-based angle measurement for image shape analysis. Stephan R. Harmsen et al. introduced a multi-target tracking algorithm that can be used to solve many similar quality assessment issues for agricultural objects [4]. Miao Zhenjiang et al. describe a rose analysis and recognition system using the mathematical description methods for rose features, such as shape, size and color of the flower, petal, and leaf, and an object-oriented pattern recognition approach [5]. Ji-Xiang Du et al. proposed a new classification method, referred to as move median centers (MMC) hypersphere classifier, for leaf recognition using a database based on digital morphological features [6]. Das et al. similarly presented an interactive extraction system for flower recognition based on color. Nakamura et al. proposed a content-based retrieval system for flowers based on the color distribution of the flowers. Im et al. and Sekita et al. worked on the recognition of maple trees from the leaf shape alone [1].

However, these conventional studies or algorithms are usually of low computational complexity, but require many subsequent images to ensure that changes between targets from image to image are sufficiently small. They experience restrictions and limitations, such as a sharp drop of recognition rate due to varying the positions of the objects and number of objects in the original image. In summary, due to the lack of proper models, automatic flower recognition from color images is a difficult pattern recognition task. The large range of biological variations of a flower and image preprocessing errors of the flower images contribute to some of the difficulties, since they refer to an input image with only a single flower or petal object placed in the center [1], [4].

Consequently, in this paper we suggest and implement mobile-based flower recognition system using Difference Image Entropy (hereinafter, DIE) and contour features of the flower object for robust flower recognition from the given original image with multi-flower objects. Our system framework includes 1) WiBro Net.-based transmission and designation module of relevant flower object by drawing the flower region in which the user is interested 2) a distributed image processing-oriented contour feature extraction module, and 3) DIE-based flower recognition module.

II. MOBILE-BASED FLOWER RECOGNITION SYSTEM

A. Overview

Figure 1 shows the overall system architecture of the proposed mobile-based flower recognition system. The system user draws and designates the flower region in which the user is interested on the given original image with multi-flower objects, and then transmits the two sub-images that include 1) the contour image and 2) the flower image using WiBro Net. to the recognition server. The contour features of the flower are extracted from the contour image with the flower's contour line of the contour image. They are used to reduce recognition candidates in the entire recognition

978-0-7695-3859-4/09 $26.00 © 2009 IEEE
DOI 10.1109/IITA.2009.407

process. The difference images are computed using pixel subtraction between the flower image and the normalized average flower images from the reduced reference images. Finally, it recognizes a flower pattern using the minimum DIE value, and then returns recognition result of the flower to the user.

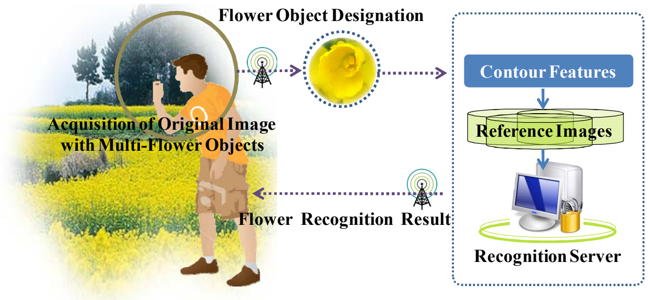


Figure 1. The overall system architecture

B. Flower Object Designation

In this step, the user draws, and designates with a contour line, the flower region in which the user is interested from the multi-flower objects on the given (input) original flower image (named "original image"). The original image is captured directly on one’s travels or in daily life with a digital camera or recorded on mobile devices, such as a cell phone. Then, the designated region is recorded by two sub-images: one for the sub-image of the designated user-interested flower region (named "flower image"), and the other is the sub-image with the flower's contour line (named "contour image"). All the sub images are resized to an 80×80 pixel array. Then, they are transmitted to the recognition server via the WiBro wireless internet to extract the flower's contour features and to recognize the flower pattern. WiBro is wireless broadband Internet technology; it is the South Korean service name for the IEEE 802.16e (mobile WiMAX) international standard. Figure 2 shows the acquisition steps of the two sub-images from the original image.

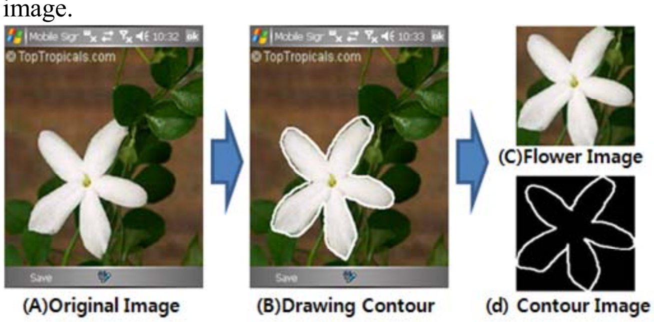


Figure 2. The two sub-images of the original image

C. Contour Feature Extraction

The classification of a relevant object from the given original image with multiple objects is part of the general problem in object recognition domains. This paper extracts three contour features of the flower to address some of these conventional restrictions and limitations: Zero-Crossing Rate (hereinafter, ZCR), the min distance (d), and contour line's length (l) from the contour image corresponding to the designated flower region of user interest. The zero-crossing rate is the rate of sign-changes along a signal, i.e., the rate at which the signal changes from positive to negative or back. The ZCR feature is extracted by the parameter d and l in Figure 3. It is defined as (1), where D is a value of d - *average_d* and the indicator function $I\{A\}$ is 1, if its argument A is true and 0 otherwise.

$$ZCR = \sum_{t=0}^{l-1} I\{D_t D_{t+1} < 0\} \qquad (1)$$

These three contour features of the flower can then be used to identify the object or to reduce recognition candidates, when attempting to locate the flower in a test image containing many other flower objects, from the contour image with contour-line. Figure 3 shows an example extracting the flower's contour features for the jasmine flower.

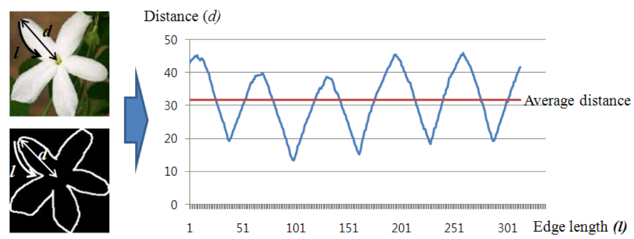


Figure 3. System block-diagram

D. DIE-Based Flower Recognition

Figure 4 shows the system block-diagram for the suggested mobile-based flower image recognition system using DIE.

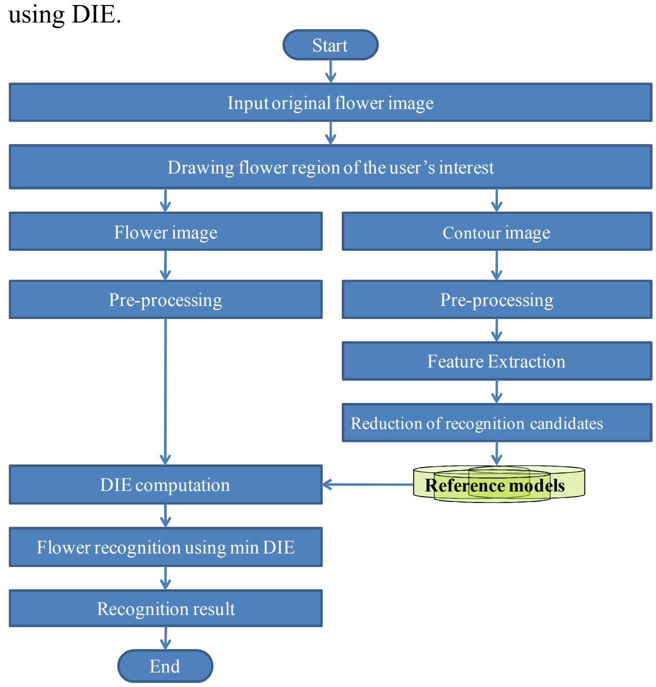


Figure 4. System block-diagram

The first step in the flower recognition process includes a pre-processing step to reduce recognition candidates, using the contour image. Since individual flowers have different contour features based on their number of petals and shape, this paper divides the relevant flower into groups (classification), comparing the extracted three contour features from the contour image to rule-based critical values of contour features.

DIE [7~8] is computed using histogram levels of gray scaled-difference image, which have peak positions from -255 to +255, to prevent information sweeping. The average image from the M reference flower images is given in (2).

$$S_{average} = \frac{1}{M}\sum_{m=1}^{M} S_m(x,y) \tag{2}$$

Where, parameter I_{input} is the input flower image, and reference flower images m^{th} are represented by $S_m(x, y)$. The difference image (D_{diff}) is defined as (3). Where, D_{diff} are computed using pixel subtraction between the input flower image and average image of the random collection of reference flower images.

$$D_{diff} = I_{input} - S_{average} \tag{3}$$

The DIE is defined as (4). Where E_g indicates DIE in gray images, and P_k denotes probabilities of the histogram frequency in difference images. Probability P_k is defined as (5). Where a_k indicates the histogram frequency from the -255 histogram levels to +255 histogram levels. The sum of each histogram in the difference images $G_{(T)}$ is given in (6).

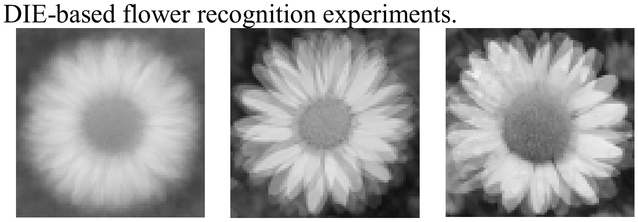
$$E_g = -\sum_{k=-255}^{255} P_k \log_2 P_k = \sum_{k=-255}^{255} P_k \log_2 \frac{1}{P_k} \tag{4}$$

$$P_k = \frac{a_k}{G_{(T)}} \tag{5}$$

$$G_{(T)} = \sum_{k=-255}^{255} a_k \tag{6}$$

III. Experiments and Results

The system is implemented in Microsoft Visual Studio 2005-supported C# and C++ using Microsoft. Net Compact Framework 2.0 and Windows Mobile 5.0 Pocket PC SDK. The operational platform in the experiments used a WiBro mobile station, the MSM 6500(EVDO) and 520MHz CPU-based SPH-M8200 model. The proposed system was evaluated using ten species of flowers with each twenty samples (i.e. 200 flower images in all). Ten samples of each species are used for the flower reference model's training; the other half, ten samples, are a recognition image set in the DIE-based flower recognition experiments.



ten images-based five images-based three images-based

Figure 5. Examples for the average flower image of the chamomile flower

Figure 5 shows examples for the average flower image that is constituted to a set of ten, five, or three images per species corresponding to individual candidates of flower object. The flower shape of average flower image is represented matching almost to the vertical axis and horizontal axis of the center line. Figures 6 and 7 illustrate examples for the flower database of ten species and contour images of the matching flower object.

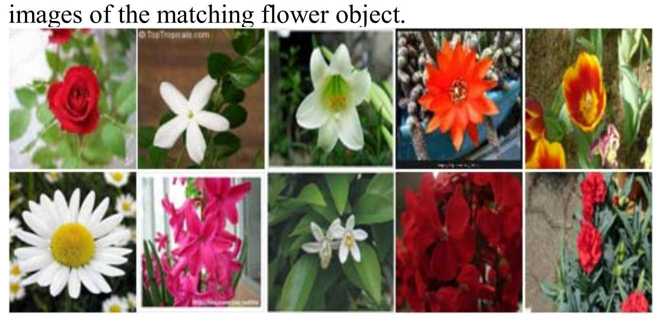


Figure 6. Some examples in the flower database

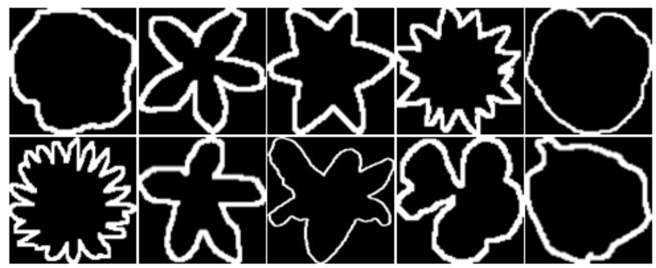


Figure 7. Contour images of the relevant flower

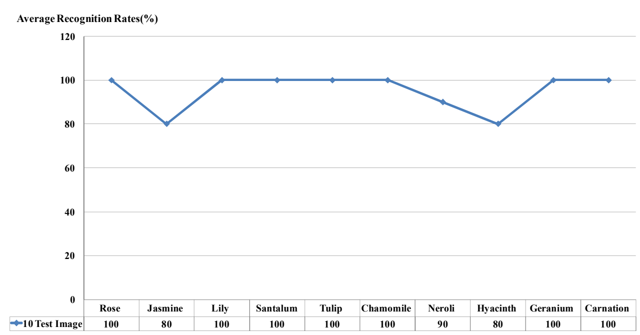


Figure 8. Average recognition rates [%]

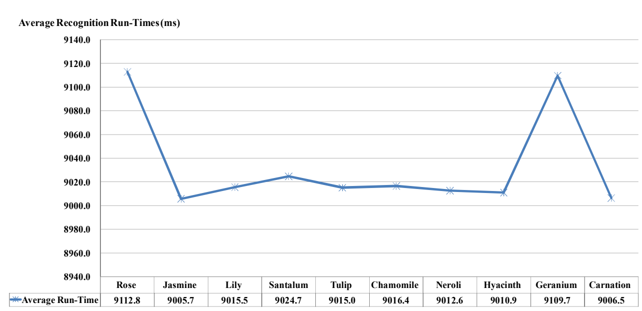


Figure 9. Average response run-times[ms]

The performance in this experiment is evaluated using the average recognition rates and average recognition run-times on Wibro mobile station for the ten flower images in the recognition image set. Where, the response run-time means the necessary time is how long it takes to complete from mobile-based transmission step of flower image to recognition step. As shown in Figure 8 and 9, experimental results achieved an optimum average recognition rate of 95% and average response run-time of 9,033ms, for a set of ten images per species.

IV. Conclusions

It is important that the set of features extracted from the training image is robust to changes in image scale, noise, illumination and local geometric distortion, to perform reliable recognition in multiple object recognition technology. Consequently, in this paper we proposed and implemented a WiBro mobile-based flower recognition system using DIE and contour features of relevant flower object. The contour features include ZCR, the minimum distance (d), and contour line's length (l). The system performance was evaluated with the average recognition rates and entire recognition run-times, using ten species of flowers, each with ten samples.

In the future, we will study advanced object recognition technology in collaboration with LBS and GIS. In addition, this will be extended to various application fields, such as real virtuality multimedia technology with portable olfactory exhaling apparatus.

Acknowledgments

This research was supported by MIC, Korea under ITRC IITA-2009-(C1090-0902-0046), the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korean government (MEST) (No. 20090058909). In addition, this work is financially supported by the Ministry of Education, Science and Technology (MEST), the Ministry of Knowledge Economy (MKE) through the fostering project of the Industrial-Academic Cooperation Centered University.

References

[1] Takeshi Saitoh, Kimiya Aoki, Toyohisa Kaneko, “Automatic Recognition of Blooming Flowers”, *in Proc.* IEEE ICPR'04, vol. 1, 2004, pp.27-30

[2] Jie Zou, and George Nagy, “Evaluation of Model-Based Interactive Flower Recognition” *in Proc.* the Pattern Recognition, IEEE ICPR'04, vol. 2, 2004, pp.311-314

[3] Zhenjiang Miao, M.-H. Gandelin, and Baozong Yuan, “A new image shape analysis approach and its application to flower shape analysis”, *Image and Vision Computing*, vol. 24, (10), 1 October 2006, pp. 1115-1122

[4] Stephan R. Harmsen, Nicole J.J.P. Koenderink, “Multi-target tracking for flower counting using adaptive motion models”, *Computers and Electronics in Agriculture*, vol. 65(1), January 2009, pp. 7-18

[5] Miao Zhenjiang, M.-H. Gandelin, Yuan Baozong, “An OOPR-based rose variety recognition system” *Engineering Applications of Artificial Intelligence*, vol.19(1), February 2006, pp.79-101

[6] Ji-Xiang Du, Xiao-Feng Wang, Guo-Jun Zhang, “Leaf shape based plant species recognition”, *Applied Mathematics and Computation*, vol.185(2), 2007, pp.883-893

[7] Jong-Bae Jeon, Jung-Hyun Kim, Jun-Ho Yoon, and Kwang-Seok Hong, “Performance Evaluation of Teeth Image Recognition System Based on Difference Image Entropy”, Third International Conference on Convergence and Hybrid Information Technology, vol. 2, 2008, pp.967-972.

[8] Jong-Bae Jeon, Sang-Hyeon Jin, Dong-Ju Kim, and Kwang-Seok Hong, “Facial Gender Classification Using LUT-Based Sub-images and DIE”, *in Proc.* HCII 2009, LNCS vol. 5620, pp. 36–45.