

OpenCV를 이용한 안드로이드 플랫폼 기반 꽃 인식 시스템

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Flower Recognition System Using OpenCV on Android Platform

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요 약

고성능 카메라와 고용량 메모리가 장착된 스마트폰이 출시되어 사람들은 야외나 산에서 촬영한 아름다운 경치, 꽃 등을 SNS에 많이 올리고 있다. 본 논문에서는 이동통신이 원활하지 않은 곳에서도 꽃의 정보를 얻을 수 있는 꽃 인식 시스템을 개발한다. 개발된 시스템은 OpenCV를 기반으로 안드로이드 스마트폰에서 사용할 수 있으며, 기존 꽃등록부와 꽃인식부로 구성된다. 인식처리 시간을 줄이기 위하여 RGB 색채널과 k-평균 클러스터링을 이용한 새로운 색분류방법을 제안하고, 특징 추출을 위하여 ORB, 매칭을 위하여 브루트포스 해밍 알고리즘을 사용한다. 4부류의 12 종류의 꽃에 대하여 60개의 이미지를 기준 DB 설계에 사용하고, 60개의 이미지를 테스트에 사용하였다. 모의 실험 결과 성공률은 83.3% 이고, 화웨이 ALEUL100 스마트폰에서 평균인식 시간은 2.58 s 이며, 제안된 시스템은 통신이 되지 않는 곳에서도 휴대용 스마트폰에 적용가능하다는 것을 확인하였다.

ABSTRACT

New mobile phones with high tech-camera and a large size memory have been recently launched and people upload pictures of beautiful scenes or unknown flowers in SNS. This paper develops a flower recognition system that can get information on flowers in the place where mobile communication is not even available. It consists of a registration part for reference flowers and a recognition part based on OpenCV for Android platform. A new color classification method using RGB color channel and K-means clustering is proposed to reduce the recognition processing time. And ORB for feature extraction and Brute-Force Hamming algorithm for matching are used. We use 12 kinds of flowers with four color groups, and 60 images are applied for reference DB design and 60 images for test. Simulation results show that the success rate is 83.3% and the average recognition time is 2.58 s on Huawei ALEUL00 and the proposed system is suitable for a mobile phone without a network.

키워드 : 안드로이드, OpenCV, 꽃 인식, ORB, 색분류

Key word : Android, OpenCV, Flowers Recognition, ORB, Color Classification

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I. INTRODUCTION

As a life style changes and life gets better, all members of family can often go hiking to beautiful fields in countryside or climbing mountains far away from a city. There are many beautiful flowers and people take pictures of flowers at the places where mobile communication can't be available. They sometimes want to know the names of flowers immediately there, but they can't get the information on flowers because there is no network. There are many flower recognition systems for Android platform, but they have long processing time or are focused on a special flower because a smart phone has low computing performance compared to PC. So a flower recognition system with algorithms that have short processing time and need a small size of memory and low computing power has been required running on a mobile phone.

In this paper, a flower recognition system based on OpenCV for Android smart phone is proposed to recognize flowers for as a short processing time as possible. Images are blurred to remove noises and classified into four color groups. Then the keypoints and descriptors of flowers are extracted by using ORB (Oriented FAST and Rotated BRIEF) and Brute-Force Hamming is used to calculate the Hamming distance of matches between reference images and test image. 120 flower images for 12 kinds of flowers with 4 color groups such as white, yellow, red, pink are used for reference registration and test recognition.

This paper is organized as follows. In section II, the related works are described. Section III presents the proposed system and describes how it works. Section IV shows the results and analyses of this recognition system. And section V concludes this paper.

II. RELATED WORKS

2.1. Color Classification

HSV rearranges the geometry of RGB color in an

attempt to be more intuitive and perceptually relevant. HSV is more useful in color clustering in most application, because it can better tolerate the color distortion caused by rays and shadows than the original RGB representation[1]. But in our system, we detect the color of flowers with the partially selected images, to reduce the effect of background. Just the average RGB values are used to decide the color of flowers to make processing time short, so we choose the RGB representation to clustering.

There are many clustering method to group the flowers that have different colors. K-means method has a simple structure and operates rapidly. The k-means method computes the centroid of image, which is used for color classification.

2.2. Feature Extraction

SIFT is most widely used keypoint detector and descriptor[2], but it is slow and computationally expensive. Considering this problem, SURF[3] improves the descriptor matching speed. But it still has too much information of keypoints to be computed for mobile device. FAST[4] detection algorithm does not have any orientation component. It gives one single dominant result of every keypoint instead of multiple value and computationally demanding. The result is called oriented FAST and it is sensitive to an orientation.

BRIEF[5] proposed an efficient feature descriptor by using binary tests between pixels. It is sensitive to a rotation and the result has a large variance.

ORB is an efficient alternative to SIFT and SURF. ORB builds on the well-known FAST detector and the BRIEF descriptor. ORB uses the intensity centroid to assign orientation to corners. These techniques have good performance and low cost. ORB first creates a steered BRIEF that mixes the orientation and binary tests. But the variance of responses is too low to make features more discriminative. To recover the uncorrelated outputs, ORB implements a learning method for choosing a good subset of binary tests. The result is called rotated BRIEF[2].

2.3. Matching Algorithm

OpenCV provides us two matching algorithms, Brute-Force and FLANN(Fast Library for Approximate Nearest Neighbors). The Brute-Force Hamming is a match algorithm that calculates the distance of descriptors between reference keypoints and test keypoints. Another alternative of Brute-Force Hamming is called FLANN, which works faster than Brute-Force when matching large datasets[6].

2.4. Flower Recognition Systems

Many systems[7-10] get good results with complex algorithm on PC. Such systems can not be directly converted for a smart phone.

Many papers proposed the recognition systems based on mobile device. Jung-Hyun Kim[11] implemented a mobile based system, but it takes 9 s to recognize the flowers. Treepop Sunpetchniyom's system[12] achieved an accuracy of 61.61% using color and shape features. The result is not good enough for a recognition system. I. Suryawibawa[13] proposed a recognition system of herbs on Android platform and compared the feature extraction methods between Invariant Moment and ORB. The result shows that ORB is better than Invariant Moment when the system recognizes the leaf of herbs. In some papers[3, 10], the sample images only contain the herb itself, but many flowers contain background so the recognition ratio will be decreased when taking a picture outdoor.

Some systems[14, 15] use Internet and server to transfer the data to user client. But in some situations, the user could not get good conditions of Internet in wild environments. So a flower recognition system running without a network is needed to give users good experience.

III. THE PROPOSED SYSTEM

The proposed system is composed of a registration and a recognition parts. Fig. 1 shows the whole process

of this system. The registration step starts with the Gaussian Blur method to reduce some noises in this phase and the images are resized if necessary. The color is classified by calculating the mean of RGB color channels. After the color classification, the test image is converted to a gray scale image for ORB. Then, the color and feature descriptors are stored into the database.

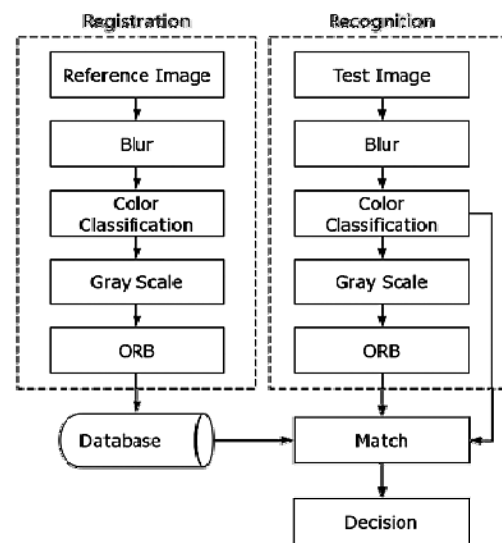


Fig. 1 Flow chart of the whole system.

The recognition part is shown at right side in Fig. 1. The test image is captured with the camera of smart phone. And it is resized if it contains too many pixels and the captured photo is compressed. The recognition process for the classification of colors and the extraction of shapes are almost the same with registration part. The features and colors are accessed from the database while recognizing flowers. The match phase is done by using Brute-Force Hamming with the test and reference image after ORB. The flower with a shortest average distance is selected to the match.

3.1. Color Classifying

The color is one of the obvious features in flowers. Test flowers have 4 different color groups. The test

images are classified by their colors. In this paper, we use the flowers with 4 kinds of colors to simplify the recognition system. Every color is presented by 3 integer values on a scale of 0 - 255, which correspond to red, green and blue color channel. Each channel represents the intensity of any particular color.

There are good segmentation methods such as GrabCut[16], but it takes too long time on a smart phone. The center region which is a rectangle shape with quarter size of original image is used in the color classification to remove the background of it.

Algorithm 1 Calculation of centers
1: Procedure
2: $R \leftarrow$ pick the center region for all samples
3: Initialize centers randomly $\{c1, c2, c3, c4\}$
4: Until convergence
5: Group R by Euclidean distance into centers
6: For i from 1 to 4
7: Shift centers by new group
8: end For
9: end Until

After getting the center region, the k-means algorithm is used to classify the color of images. Algorithm 1 shows the proposed method for the calculation of centers with the selected center region. As shown in Table 1, the dataset of this system contains 60 reference images. There are 4 colors and each color has 15 references images of 3 kinds of flowers. The RGB color channels of 60 reference images are shown in Fig. 2 (a). As shown in Fig. 2 (b), the 60 reference images are used to compute 4 centers for 4 colors by Algorithm 1. The 4 centers become reference values to classify the color of test images. The color of test images can be classified by calculating the Euclidean distances from 4 centers.

3.2. Feature Extraction

Feature extraction is done by using ORB method. It converts the features of image into binary values. We first create a feature detector that detects 500 keypoints

defined in OpenCV as the default count. Then, the descriptor is created with these keypoints using rBRIEF and are stored by JSON format in a database.

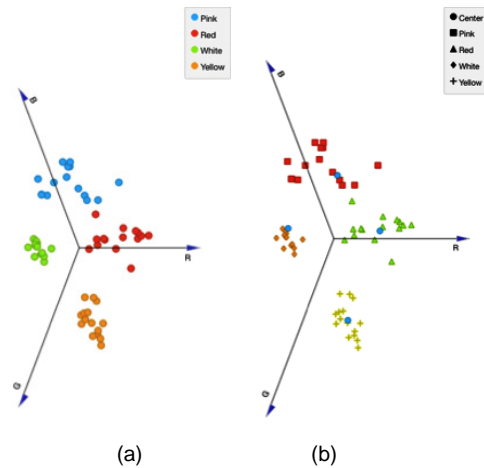


Fig. 2 RGB colors of reference images (a) RGB values (b) RGB values with k-means centers

3.3. Matching

The test image is matched with all reference images within the same color. The Brute-Force Hamming is used to calculate the distance of matches. This Hamming distance indicates whether the features are similar or not.

We get 500 Hamming distances by matching 500 features between reference and test image. We find the shortest Hamming distance among all Hamming distances and calculate the threshold value by three times the shortest Hamming distance. The match which stays below the threshold value is called a good match.

3.4. Decision

For one kind of flower, 5 reference images are matched to the test image. Then we get 5 mean Hamming distances of good matches and calculate the average of them. Decision is done by choosing the lowest average distance among 3 kinds of flowers within a same color.

IV. SIMULATION RESULTS AND ANALYSES

In this paper, the proposed system uses 12 kinds of flowers in 4 color groups. Each flower contains 10 images, 5 for reference and 5 for test respectively shown in Table 1 and they are from the well established Oxford 102-category flowers dataset like Fig. 3.

The 60 reference images are stored into SQLite 3 database on Android platform. And the 60 test images are in the storage of Android device.

Table. 1 The Dataset

Name	Reference	Test	Color
Daisy	5	5	White
Windflower	5	5	
Silverbush	5	5	
Daffodil	5	5	Yellow
Sunflower	5	5	
Black-eye Susan	5	5	Red
Anthurium	5	5	
Bishop of Llandaff	5	5	
Geranium	5	5	Pink
Osteospermum	5	5	
Hibiscus	5	5	
Pelargonium	5	5	



Fig. 3 12 Sample flowers.

Table. 2 Color Classification Results of K-means

Color	White	Yellow	Red	Pink
Number of success	12	15	15	12
Number of fail	3	0	0	3

To reduce the recognition time, we classify the color first. Fig. 4 presents the results of color classification process. The 60 test images are classified into 4 groups. Three white flowers and three pink flowers are failed as shown in Table 2. The light and background condition affects the results of color classification process and some flowers are classified to other color.

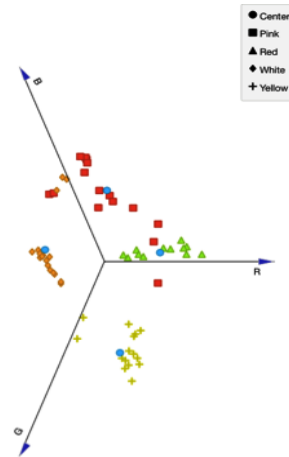


Fig. 4 Color classification results.

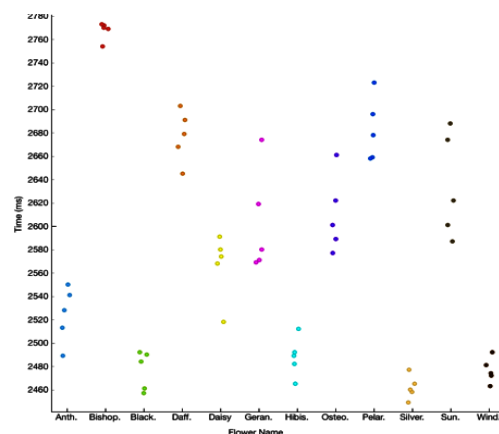


Fig. 5 The recognition time of 60 test images.

Fig. 5 shows the recognition time for all of 60 test images on Huawei ALE-UL00, whose CPU is Hisilicon-620 with a frequency of 1.2 GHz. This figure shows that the average recognition time is 2.58 s.

Table. 3 The Dataset

Name	Color	# of Test Image	# of Pass for Color Classification	# of Pass for Matching
Daisy	White	5	5	5
Windflower		5	5	4
Silverbush		5	5	5
Daffodil	Yellow	5	5	5
Sunflower		5	5	2
Black-eye Susan		5	5	5
Anthurium	Red	5	3	3
Bishop of Llandaff		5	4	3
Geranium		5	5	5
Osteospermum	Pink	5	3	3
Hibiscus		5	5	5
Pelargonium		5	4	4
Total		60	54	50

In Table 3, four flowers are failed in matching process. The sizes of the pistil in a sunflower are diverse. It is considered that 3 test sunflowers fail in recognition process because the leaves of the 3 sunflowers are so wrinkled that it is hard to extract exact features. The experiment results show that the success rate is about 83.3% for 60 test images and the accuracy rate of color classification is 90.0%.

Fig. 6 is the recognition app of our system and shows that the daffodil is recognized successfully.

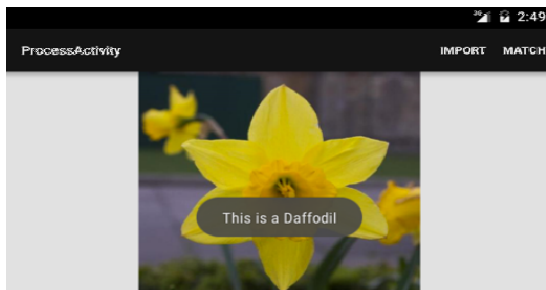


Fig. 6 The user interface of the recognition app.

The simulation results and analyses show that the proposed system is able to recognize flowers within a proper time on a smart phone.

V. CONCLUSIONS

In this paper, we implement an OpenCV based flower recognition system running on a smart phone without a network. The colors of flowers are classified by calculating the RGB color channels and the features of flowers are extracted by using ORB. After calculating the hamming distances of test images and reference images, the decision is made by choosing the shortest distance.

Simulation results for the 60 test images show that success rate is more than 83% and recognition time is less than 2.6 s on Huawei ALE-UL00.

The segmentation method between a flower and background in the image will be studied to increase recognition ratio on a mobile phone.

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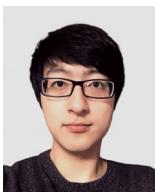
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