SakuraSensor: A Participatory Sensing System for Detecting Flowering Cherries with Car-Mounted Smartphones

Daichi Nagata†, Shogo Maenaka†, Shigeya Morishita†, Morihiko Tamai†,
Keiichi Yasumoto†, Toshinobu Fukukura‡, Keita Sato‡
†Nara Institute of Science and Technology, Nara, Japan ‡DENSO CORPORATION, Aichi, Japan

1. INTRODUCTION

Car navigation and routes recommendation services play an important role for providing drivers with comfortable and efficient driving. Scenic routes recommendation services have begun to be provided such as scenicbyways.info[1] in recent years. In the existing services, the number of pre-determined spots is relatively small and information update frequency on the spots tends to be low. Moreover, the scenery information consisting of texts and images is not sufficient for users to assess how good each route is, because it is difficult to intuitively grasp what kind of scenery will be able to view in advance from out-of-date still images or texts. Among various kinds of scenery along roads, in this paper, we target cherry-lined roads since the time period of flowering cherry is very short and its blooming degree changes day by day. Timely collection and sharing of flowering cherries along various roads are not possible with existing systems/services. To address aforementioned problems, we propose a system called *SakuraSensor*[2] which employs participatory sensing [1] to collect information about cherry-lined routes (including images and videos) from car-mounted smartphones and shares collected information among its users. Based on the collected information, a scenic routes recommendation service with up-to-date information can be provided, where the users search the best scenic route to a specified destination by viewing short videos along the searched route.

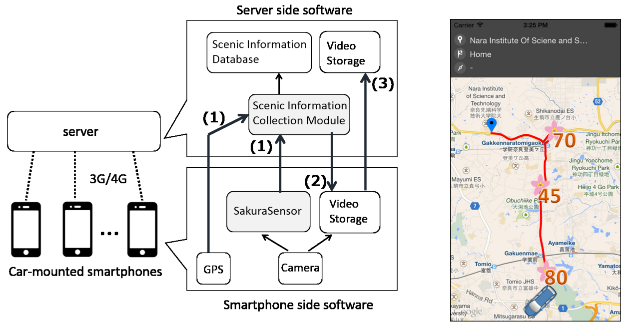
To realize the system, accurate detection of flowering cherry and its blooming degree (called *cherry intensity*, hereafter) from recorded video is essential. Thereby, we propose a novel image analysis method that quantifies the amount of flowering cherries recorded in the videos captured by car-mounted smartphones.

2. SYSTEM ARCHITECTURE

Fig. 1(a) shows the overall architecture of the system, which consists of the application running on a smartphone and the software running on the server. At the smartphone side, while a car is traveling, the smartphone continuously records GPS logs and videos captured by its camera. Cherry intensity is continuously calculated and uploaded to the server in real time (arrow (1) in Fig. 1(a)). The routes with flowering cherries are identified by associating the cherry intensity and location information (Fig. 1(b)). On the other hand, for the recorded videos, it would not be possible to continuously transfer them to the server due to the limitation on the communication bandwidth of 3G/4G network or monthly available communication amount limitation posed to users. To cope with this limitation, in the proposed system, instead of uploading the whole video immediately after recording it, the smartphone side software extracts *short videos* (e.g., 10 seconds) from recorded videos and uploads them to the server based on the requests by the server.

3. DETECTION OF FLOWERING CHERRY

To accurately detect flowering cherries, SakuraSensor employs histogram-based color analysis and region-based fractal dimension analysis techniques. For the color analysis, a color histogram that represents the color distribution of flowering cherries is generated in advance using various images that contain flowering cherries. Then, multiple frames are sampled from each video recorded by a car-mounted smartphone, and for each pixel of each frame, the frequency that the pixel belongs to flowering cherries is calculated. The cherry intensity is calculated for each frame as the mean value of the frequency of all pixels in the frame. We employed a technique to use only a part of HSV color space for analysis. In addition, to avoid misdetection of objects (e.g., artificial structures) that contains the similar colors in flowering cherries, SakuraSensor divides each frame to multiple image regions and applies to each region fractal dimension analysis to investigate if the region has complex edge patterns or not. We implemented SakuraSensor using OpenCV library[3]. We recorded videos while traveling cherry-lined roads by several cars mounting iPhone devices and evaluated the classification accuracy of SakuraSensor using the recorded videos. About 5000 short videos (each is 1 second long), which are extracted from the recorded videos, are classified into multiple classes depending on the amount of flowering cherries contained in each video using SakuraSensor, and compared the classification result to the manual classification by human. The results show that SakuraSensor can determine whether flowering cherries are contained in a short video or not with a precision of about 73 % and a recall of about 83 %.



(a) (b)

Figure 1: Proposed participatory sensing system

4. CONCLUSIONS

In this paper, we proposed SakuraSensor, a participatory sensing system for automatically collecting and sharing information (cherry intensity and videos) of cherry-lined roads by using car-mounted smartphones. We developed a method using color histogram and fractal dimension analyses for detecting flowering cherry and achieved practical detection accuracy.

5. ACKNOWLEDGMENTS

This work was supported in part by JSPS KAKENHI Grant Numbers 25280031 and 26220001.

6. REFERENCES

[1] J. Burke et al.:"Participatory Sensing," In Proc. of World Sensor Web Workshop (WSW'06), 2006

[1] http://scenicbyways.info
[2] Sakura means cherry in Japanese.
[3] http://opencv.org/