Place Recognition Based on Environmental Visual Features

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ABSTRACT – Many research studies have been conducted on the place recognition method, and introduced precise and accurate evaluation methods with complicated features extraction. However, it is believed that in some situations, it is not necessary to have a precisely and accurately identification as well as measurement methods in order to recognize a previously memorized place. In the proposed method, the advantages of environmental visual features have been used to recognize places with a less burden computation method. Experimental results demonstrate the effectiveness of our proposed method.

1. INTRODUCTION

Human recognize a previously visited place through a prominent object or through the whole panorama view of the place. For example, if we see Eiffel Tower, definitely we know that the place is Paris. This is called a landmark based place recognition. Meanwhile, if we recognize a place through the whole scenery view, this is known as appearance based place recognition. Visual recognition of previous visited places is a fundamental part of human daily life [1].

Inspired by the human visual place understanding capabilities, place recognition has attracted a significant amount of attention in computer vision and robotics communities. Various features have been used as landmarks such as overhead lights, doors, fire extinguisher, or even artificial landmarks, although artificial landmarks require for modifications [2]. Appearance-based place recognition was dominated by sophisticated local-invariant feature extractors such as SIFT [3] at the early stage, and recently many improved features generating methods have been introduced such as Convolutional Neural Networks (CNNs) [4], Convolutional Networks (ConvNets) [5] etc.

In this work, we propose a simple yet incomplex appearance based place recognition method which computes environmental visual features in the whole image to obtain an efficient performance of the place recognition.

2. METHODOLOGY

The place recognition method in our approach is presented in Figure 1. Firstly, we capture few images at those places that are to be recognized in the environment. In this research work, we have chosen two places in the AMC area of our faculty building. In order to provide a region for the recognition at each place, we have decided to take 5 images at each place, with 1 image at the centre and another 4 images at about 15cm from the centre to the front, back, right and left. These 5 images will be treated as 'main image'.

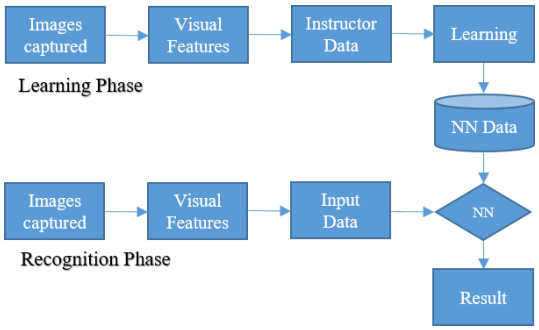


Figure 1 Recognition procedure.

Since Neural Network (NN) is used as the evaluation system for the recognition, it is necessary for an Instructor Data (ID) to be produced so that this ID will later be trained in the NN to obtain a NN Data that will be used as the reference for the NN evaluation process. To produce the ID, a number of images from places other than the memorized place need to be captured as well, and known as 'other image'.

Features of the main images as well as other images will be extracted and is given value 1.0 for main images and 0.0 for other images when trained in the NN to obtain NN Data.

In order to conduct the recognition evaluation using NN, another set of images of the previously memorized place are captured. In this paper, in order to observe the performance and the robustness of the proposed recognition system, two sets of images have been captured at each memorized place. In the first set, images are captured exactly at the same 5 points of where the main images are captured before, and in the second set of images, 25 images are captured randomly around the places within 20cm radius of area.

2.1 Visual Features

Human always like to look at color and used color as a distinction factor. That is why, we believe that by examining all the colors in an image of a place, the place can still be recognized as the memorized place.

Thus, we consider formulating a simple and easy way using the details of color information, by roughly separating the colors into 11 classifications through a separation of CIE chromaticity diagram. Those pixels whose colors fall into one color domain are considered to have the same color. Through this, the color disposition in a captured image is evaluated based on area ratio in the entire image and coordinates of the centre area (x and y coordinates) that produces a total of 33 data from color features (Figure 2).

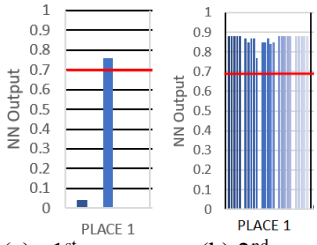
In addition to color features, we also extracted edges form the images using Robert operator. Furthermore, we are also able to obtain points which are connected through the edges. We used these points together with the extracted edges as the visual features and for that, all together there are 35 data of visual features used in the proposed recognition system. Through this, a robust system for place recognition that required just a simple algorithm and established fast processing capability.

Figure 2 Color and shape visual features.

3. RESULTS AND DISCUSSION

The two places determined in this experiment is shown in Figure 3. All the images acquired in this experiment have a resolution of 320 x 240.

Figure 3 Left image – Place 1; Right image – Place 2.

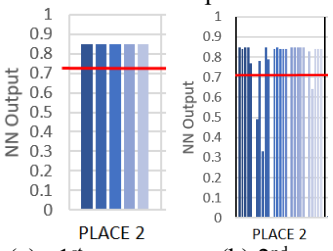


(a) 1st test (b) 2nd test

Figure 4 Result of recognition at Place 1.

Images captured for the Recognition Phase are expected to obtain the set threshold 0.7 or more against the NN Data, otherwise the recognition is considered as failed. The threshold 0.7 was determined in a preliminary investigation. As shown in Figure 4, which are the results of recognition of Place 1, out of 5 images of the first set, only 1 image is able to obtain result exceeding the set threshold. Interestingly, when we test the second set that consist of 25 images taken randomly around Place 1, no failure is recorded. All the 25 images obtained NN evaluation result of 0.7 or more.

There must be some factors that give effects to the failure of the test using the first set of images in the Place 1 because when we conducted the same NN evaluation for Place 2, as can be seen in Figure 5, the recognition is considered as successful. All 5 images of the first set came out with result that are exceeding the set threshold of 0.7. Meanwhile, only 3 images out of the 25 images taken for the second set were not able to achieve 0.7. Further analysis need to be done to identify the reason of the failures especially in the first test at Place 1. This is important in order to improve the performance of the proposed system. Basically, a quick thoughtful reason of these errors is might due to the flickering condition of lighting condition in the environment, but further experiment and analysis need to be carried out to confirm this prediction.



(a) 1st test (b) 2nd test

Figure 5 Result of recognition at Place 2.

Overall result is considered successful with only 7 failures out of the total 60 tests, which produced an 88.3% of successful rate.

4. CONCLUSION

The proposed system is able to achieve efficient place recognition performance. However, some issues arose that required to be tackled in a proper way in order to make sure that the proposed place recognition system is robust enough and ready to be used in any environment. Furthermore, analysis needs to be done on more places with few conditions to be considered such as weather effect, time effect, changes in the environment etc.

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