Indoor place recognition method for mobile robot

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ABSTRACT – Many research works have been done previously to find the best yet robust system for place recognition especially for the application on mobile robots navigation. This paper presents a method for visual place recognition based on environmental visual features in the whole image. In the proposed method, the visual features will be computed in an uncomplicated way and through Neural Network, it will then be evaluated whether the image is taken at the surrounding of the original place or not. Experimental results demonstrate the effectiveness of our proposed method.

1. INTRODUCTION

In many mobile robots' navigation systems, the capability to recognize place or position is an essential task for the mobile robot. Many research works have been done to identify the best yet robust place recognition system. Most of the research works were inspired by the capability of human to recognize a previously visited place where landmark [1] the whole image [2], or even sophisticated local-invariant feature extractors such as SIFT [2] have been used in the recognition method.

The problem with the previous methods is that the computation method used is complicated that burden the recognition system to compute for the similarity marks. Although the methods produced remarkable results, we do believe that not every situation or task required for the complicated recognition system. For example, if a robot or Automated Guided Vehicle (AGV) is used in a manufacturing environment to deliver parts or documents, precise localization is not always required. As long as the robot or AGV is able to arrive safely around the targeted point or place, then it should be good enough for the robot or AGV navigation. The main target of the robot or AGV is to arrive at the place even without any precise place recognition method.

In this research work, a simple yet uncomplicated appearance-based place recognition method which makes use environmental visual features in the whole image to be the basis of the computation on the similarity of the captured image with the previously memorized place appearance is propose. Colour and shape features are selected as the environmental visual features in our prosed method.

2. METHODOLOGY

In our proposed method, firstly, we capture few images at the selected places in an environment, in which those places are to be recognized in the later stage. A looks alike manufacturing environment in the Advanced Manufacturing Centre area of our university has been chosen, where four places have been identified to be the places to be recognized. In order to provide a domain area for the recognition at each place, we have decided to take 5 images at each place, where 1 image is taken at the centre point and another 4 images are taken at about 15cm from the centre to the front, back, right and left.

From these 5 images, the visual features will be extracted and are given value 1.0 in a Neural Network (NN) evaluation system. Since NN is used as the evaluation system for the recognition system, 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. This NN Data is used as the reference for the NN evaluation process that is taken place in the recognition phase later part. In order to have a good ID and NN Data, few images from other places than the selected place are also captured and the visual features of the images are given value 0.0 when trained in the NN to obtain NN Data. The place recognition method in our approach is presented in Figure 1.

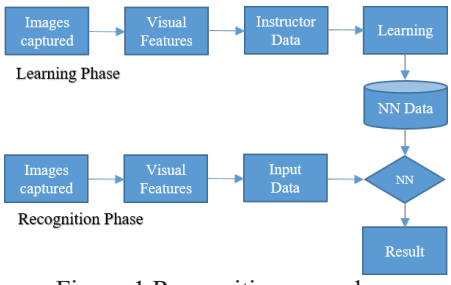

Figure 1 Recognition procedure

In order to conduct the place recognition evaluation on the previously selected memorized places, another set of images of those respected places are captured. 5 images have been captured at the same 5 points of where the images that are used to create the ID and NN Data were captured before. Then, another set of 25 images are captured randomly around the selected memorize places within 20cm radius of area in order to

observe the robustness performance of the proposed place recognition method.

2.1 Visual Features

Color has always been a good distinction factor. Considering this fact, we believe that by examining colors in an image of a place, the place can be recognized as the previously 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 used shape features in the recognition and distinction process. Points which are connected through edges in the image are used as the shape features. In order to obtain the connecting points, firstly we extracted edges form the image using Robert operator. Those connecting points of two edges are used as the shape features. Apart of these connecting points, the extracted edges are also used as the shape features. 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 is developed.

Figure 2 Color and shape visual features

3. RESULT AND DISCUSSION

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

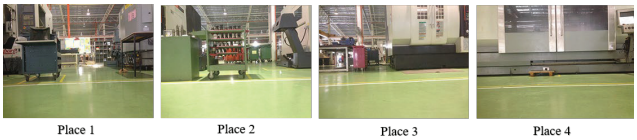

Figure 3 The 4 places selected in the experiment

If image captured for the Recognition Phase is exceeding the set threshold 0.7 against the NN Data, the recognition process is considered successful. Other than that is treated as fail result 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. We believe that there are some factors influencing the poor result of recognition process on the 5 images of the first set. Perhaps, factors like camera position, camera condition or even lighting condition might give effects.

When we conducted the same NN evaluation for Place 2, Place 3 and Place 4, as can be seen in Figure 4, the recognition is considered successful, as overall success rate is exceeding 86.75%, although some images of the second set at each place are not obtaining 0.7 in the NN evaluation result. All 5 images of the first set came out with good result by exceeding the set threshold of 0.7.

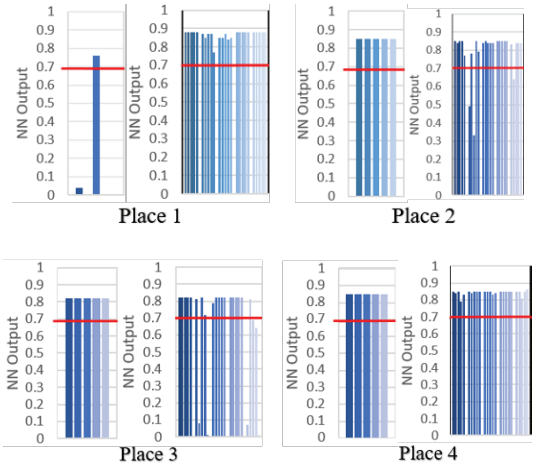

Figure 4 Result for recognition

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 method. 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.

4. CONCLUSIONS

As a conclusion to the result of this research work, the proposed place recognition method is achieving good performance. Regarding some failures that occurred during the recognition process, further investigation need to be done in order to find the affecting factor to the failure. Furthermore, to ensure that the proposed place recognition method is robust enough and applicable to any environment, analysis need 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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