An Online Visual Loop Closure Detection Method for Indoor Robotic Navigation

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ABSTRACT

Visual loop closure detection problem is an active area especially for the indoor environments, where the global position information is missing and the localization information is highly dependent on odometry sensors. In this paper, we propose an enhanced loop closure method based on unsupervised visual landmark extraction with saliency detection technique. In contradistinction to the previous methods, our approach uses additional depth information. Saliency regions are used to refer to the certain distinctive areas on the image patches. They are also suitable to represent locations in a sparse manner. In order to find out the similarity between two locations we use a straightforward function, that contains the detection confidences of the image and the landmark coordinates in 3D. Recognition of the previously visited and unvisited locations is also considered in the framework. Exemplary results and the practical implementation of the method are also given with the data gathered on the testbed with a depth camera (Kinect) mounted differential drive autonomous ground vehicle. Specifically, we adopt visual place recognition to close loops that is useful for the process of correctly identifying a previously visited location.

Keywords: Loop closure, depth map, zernike moments, computer vision

1. INTRODUCTION

In mobile robotics, autonomous navigation is an active research area especially for the indoor environments, where the global position information is missing and the localization information is highly dependent on odometry sensors. One of the major problems connected to robotic navigation is Simultaneous localization and mapping (SLAM) which still remains as an assertive problem in a lot of ways. Loop closing is defined as the correct identification of previously visited location in terms of SLAM. Information that is gathered from various data sources including LIDARs, RADARs, stereo and monocular cameras is highly utilized in loop closure detection. With the recent development of visual sensor technologies, the loop closure detection becomes a problem that is open for research in the field of computer vision.

In this paper, we present an enhanced loop closure method based on image-to-image matching in indoor environments with the additional depth information. Specifically, we adopt visual place recognition without using any metrical information such as rotation and exact location to correctly identify the previously visited location. This technique is quite simple to provide low computational complexity and performs in real-time with high loop closing accuracy.

The technique we implement relies on discrete Complex Zernike Moments (CZMs) in 2-dimensional space. They are extracted using a set of complex polynomials which form a complete orthogonal radial basis functions defined on the unit disc. These moments are used to represent shape information inside the image within the context of image processing. In this study, the use of CZMs are examined in predefined non-overlapping patches of the image. The complex moments

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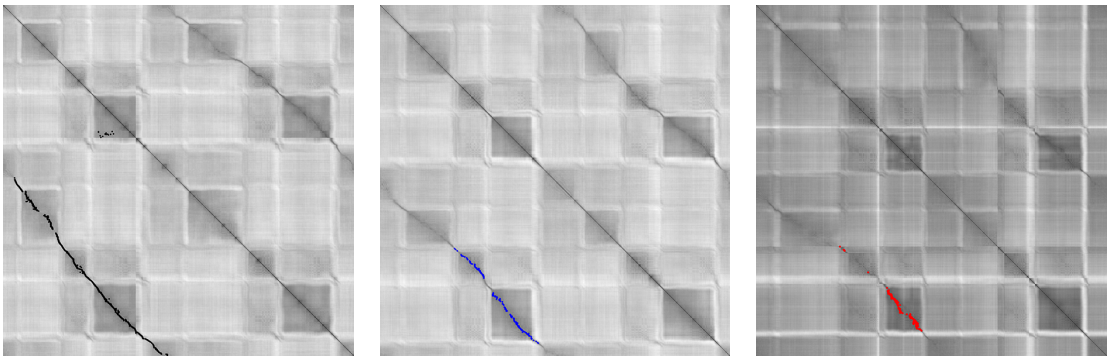
2. METHODOLOGY

Methodology will be written here.

3. EXPERIMENTS

Experiments will be written here.

Location offset: 100 frames



(a) Bright distances (b) Dim distances (c) Dark distances

Figure 1: Distance matrixes

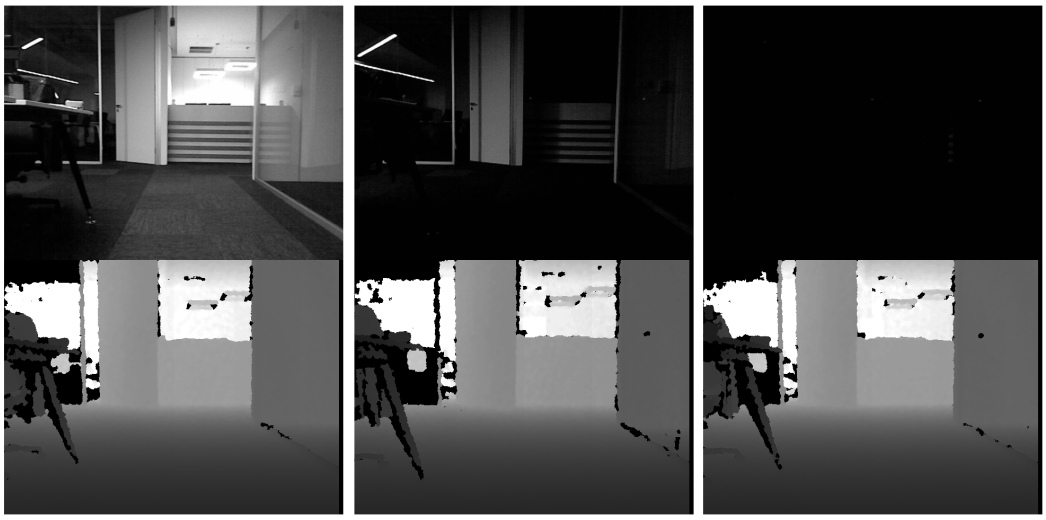


Figure 2: Dataset examples: (right) bright, (middle) dim, (left) dark

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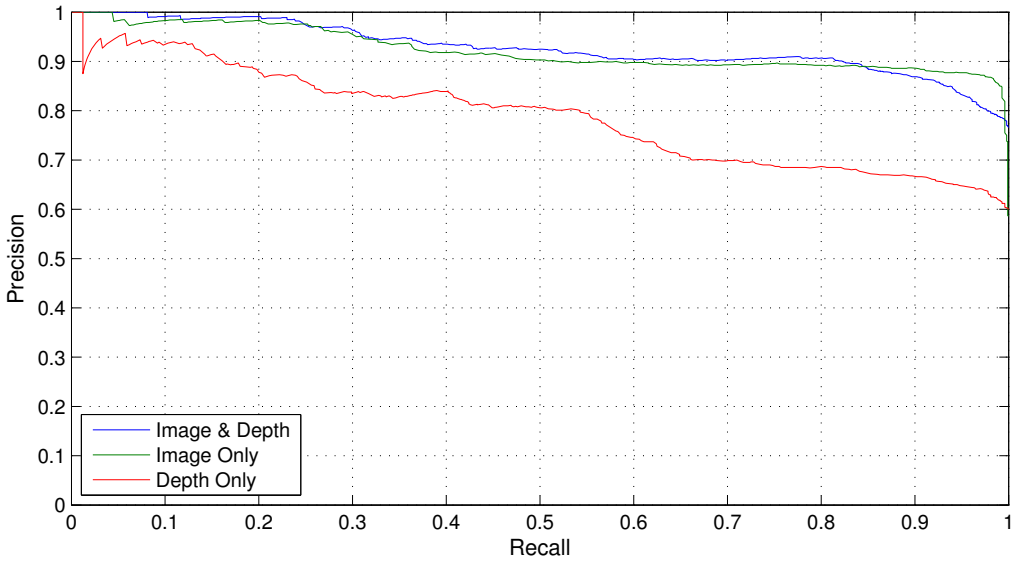

Figure 3: Bright dataset results

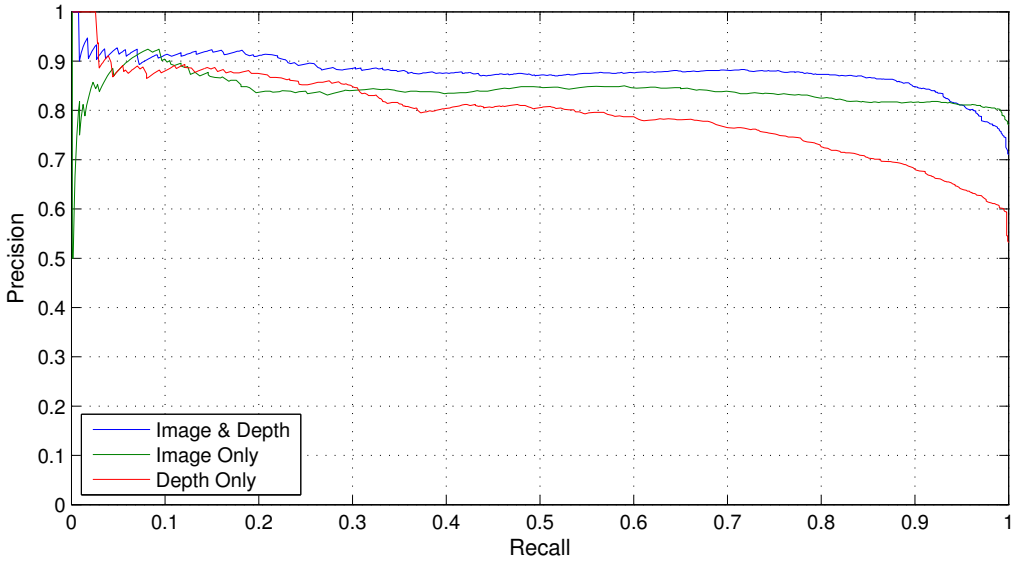

Figure 4: Dim dataset results

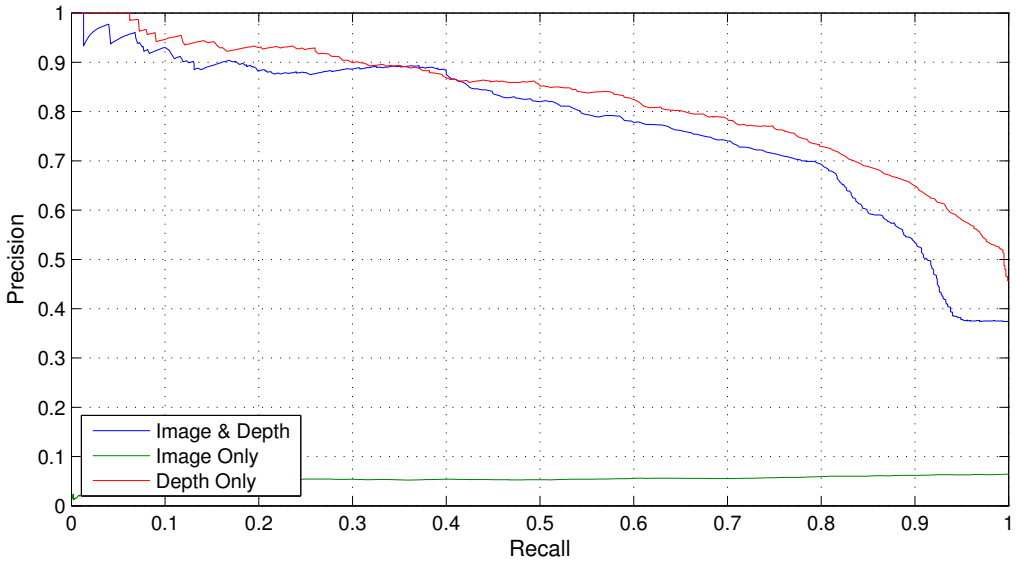

Figure 5: Dark dataset results