Calculation of Descriptor of Interest Points in Relative Self-Localization Estimation

Xing Xiong[1] and Byung-Jae Choi[2]

[1,2] School of Electronic Engineering, Daegu University
Jillyang, Gyeongsan, Gyeongbuk 712-714, Korea
[1]GaleWing@gmail.com and [2]bjchoi@daegu.ac.kr

Abstract. In the paper, we propose an improved method to calculate interest points' descriptors. The proposed method will satisfy descriptor invariant when image rotation.

Keywords: SURF, Descriptor, Rotation, Image Feature

1 Introduction

Mobile robot's self-localization is a mandatory task in accomplishing full autonomy during navigation. Various solutions in the robotics community have been developed in order to solve the self-localization problem. The solutions can be categorized into two groups: relative localization (dead-reckoning) and absolute localization [3].

As shown in many researches [4], visual images have provided a lot of valuable information such as color, texture, and shape of objects. The information has the potential to help robot to estimate its self-localization. Until now, most of the researches used ceiling feature, wall feature, or artificial landmark which attach in wall or ceiling to estimate self-localization of robot. All of these methods face with the problem of image matching. SIFT (Scale Invariant Feature Transform) and SURF (Speeded Up Robust Features) were proven that they have satisfactory image matching capability to image rotation, scaling, blur and affine. Some characteristics of SIFT, PCA (Principal Components Analysis)-SIFT and SURF were compared in [5]. Especially the SURF is more fast compared to the SIFT. However, the SURF is not good in an image rotation.

In our research, the SURF is used to extract interest points of image for its efficiency. Then the descriptors of interest points are extracted and matched these descriptors for finding the same interest points in two images. At last, we calculate the relative self-localization of robot according to the changing of interest points. In order to satisfy an invariance of descriptor rotation, a new method is proposed to calculate descriptor of interest points.

2 Calculation of Descriptor

In [2], the SURF calculates the descriptor of interest points according to the results after the neighborhood Haar filtering. The method can avoid some available problems caused by pixel drift, but it will bring into other pixels which do not belong to the neighborhood in an image rotation because the Haar filter is rectangle.

In order to remove this error, the pixels in the neighborhood of interest points are replaced by the sum of their sub-regions (see Fig.1) after Gaussian filtering. Each pixel has eight directions. Let's calculate the influence of pixels in eight directions. The length of each arrow represents an influencing value at each direction. The maximum influence is considered as an orientation of the pixels.

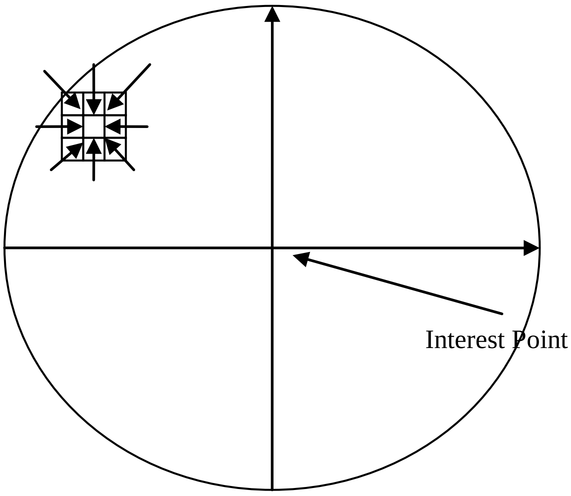

Fig. 1. Calculation of Descriptor. The descriptor is created by calculating the influence at each interest point of image in a neighborhood around interest points.

The neighborhood is divided into 2 × 2 subregions with the orientation of the interest points. And then we calculate the sum of each subregion at eight different directions and the sum of absolute values of eight different directions. So, the descriptors of interest point are 2 × 2 × 8 × 2 = 64 descriptors for each interest point. In [2], the sum of absolute sum was proven, which have high impact in descriptors' matching.

For each pixel in the neighborhood of interest points, it is only affected by eight pixels around it. No matter what image rotates, the neighborhood of the pixels remains intact. In fact, the scale of image is considered to determine the size of subregions.

3 Concluding Remarks

In this paper, a new method for calculating descriptors of interest points was proposed. The proposed method calculated every pixel influence in its neighborhood. It improved the accuracy of image matching when an image rotates.

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