Estimation of Relative Self-Localization for Indoor Mobile Robot

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Abstract. In this paper, we propose a relative self-localization estimation algorithm based on relative locations and orientation changes of some image features. We show that the proposed algorithm is valuable through some simulation examples.

Keywords: Mobile Robot, Self-localization, Image Feature

1 Introduction

With the development of science and technology, mobile robots have been employed for a wide area of industrial applications including factory automation, medical assistance, and rehabilitation for the provision of new forms of services. The recognition of a self-localization of mobile robots is becoming crucial matter. We can get a good idea from the concept of the GPS (Global Positioning System) for solving this problem. The GPS is widely used at outdoor environments. However its use is limited at indoor environments. Therefore the mobile robots require other methods for their self-localization.

As mentioned in [1], various solutions for the estimation of self-localization have been proposed in the field of robotics. As shown in many researches [2], 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. In general, the data of indoor environments can be used to determine the position and orientation of a mobile robot through visual self-localization algorithms. In this paper we propose a new algorithm to reduce computing time and complexity. The SURF is here employed for the extraction of interest points and an improved algorithm which was proposed in [4] is employed for interest points' orientation and descriptors' extraction. We propose a relative self-localization algorithm to estimate a location of the robot and it is based on the changing of the location and orientation of image features. In practice, because of matching mistakes of interest points and pixels offset, the calculated self-localization contains errors and it needs to be corrected.

2 Relative Self-localization and Error Correction

The relative localization system is described as shown in Fig.1. A series of interest points *I* are extracted using SURF [3]. The orientation and descriptors of interest points are extracted by an improved SURF algorithm [4] for fast calculation. These interest points all have three coordinate (*x*, *y*) and three direction Θ: a global coordinate (I_{Gi}), two relative coordinates (I_{1i} and I_{2i}) in two images (before and after moving). The relative self-localization is calculated by using transition of coordinates of interest points.

$$\begin{bmatrix} \hat{y} \\ \hat{x} \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} y \\ x \end{bmatrix}$$

where (*x*, *y*) and ($\hat{x}$, $\hat{y}$) represent the coordinate of robot before and after of the coordinate system transformation in two images, respectively. The Θ represents the relative angle of coordinate system transformation in two images.

So, for every interest points, the relative self-localization of mobile robot can be estimated through the transformation of two coordinate systems.

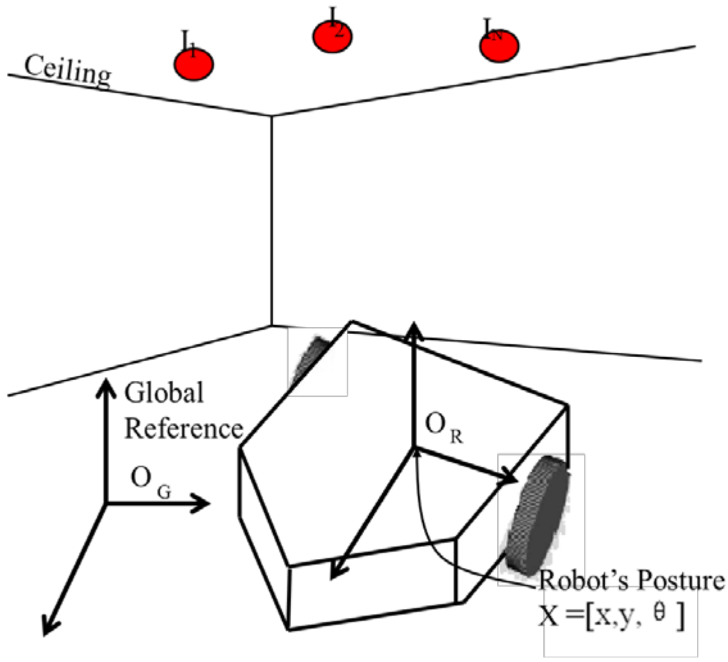

Fig.1. Vision based self-localization. The global coordinate origin O_G, the robot's current posture *X*, the interest point I_i. The arrows of the interest points represent their global direction.

3 Simulation Examples

Some simulations were performed to demonstrate the effectiveness of the proposed algorithm. It is conducted by using a PC hardware configuration with Intel(R) Core(TM) 2, 2.66 GHz, and 4.0 GB RAM and software configuration with Windows 8. In this simulation example we used 12 different images of laboratory and passageway.

From the simulation results, the average errors of the proposed algorithm generated are (0.0069, 0.009025), they are all below 1[cm]. It is enough to satisfy the accuracy for the self-localization estimation of a mobile robot at indoor environments.

4 Concluding Remarks

In the paper, a new algorithm for estimating relative self-localization of indoor mobile robot was proposed. The algorithm calculates the estimation of a relative self-localization through a series of the transformation of a coordinate system. Generally images and interest points are influenced by illumination or rotation. So, it results in an inaccuracy in the image matching, and causes an estimation error of the self-localization of a mobile robot.

References

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