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MOBILE ROBOT TRACKING USING IMAGE PROCESSING

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Abstract: *During the evaluation of autonomous mobile robot navigation routines the determination of true robot position on its track is essential. The paper presents simple yet reliable method of tracking robot position using processing of images acquired from the devices positioned above the operation space. The method consists of two steps for each image: detection of the robot in image space and transfer of its coordinates to operation space.*

Keywords: ***Mobile robot, image processing, object tracking.***

1. Introduction

To evaluate the quality of localization and path planning routines (Věchet 2011) with real robots, the determination of true position of the robot must be performed. This paper proposes simple yet reliable method of tracking the position of the robot based on the processing of robot images acquired by bird eye positioned camera. The method was used when the quality of Extended Kalman filter based localization was evaluated, as described by Krejsa (2012), focused on the utilization in the prototype of presentation robot Advee (Ripel 2011).

Proposed method consists of two steps. During the first stage the position of the robot in the image space is found, using the detection of marks placed on the robot. In the second stage found coordinates are recalculated into operational space, providing the correction of imprecise image acquiring device mounting, optic flow imperfections, etc.

2. Detection in image space

Two devices were used to acquire the images, differing in resolution and optical systems, in particular Canon 350D with Canon EF20/f2.8 lens and Pixelink PLB-762G camera with Edmund Optics SZ110M lens. Both devices were positioned 3650 mm above the operational space of the robot, as indicated on Fig. 1. Two white marks with diameter of 21.5mm were placed on the sides of the robot in 607mm relative distance.

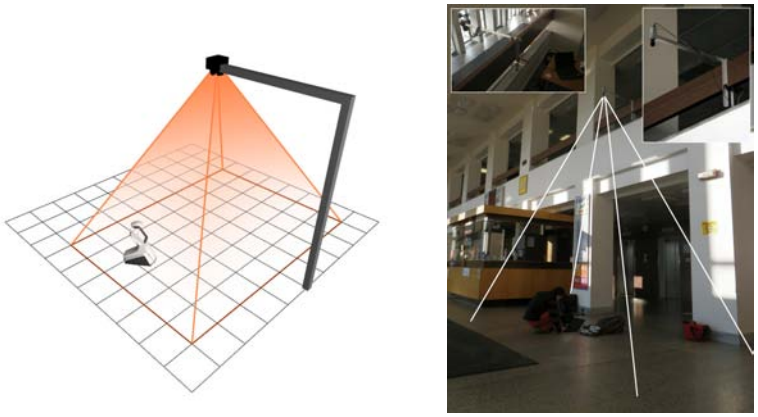

Fig. 1. Image acquiring, the principle (left), particular devices mounting (right)

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Acquired images were processed in following way:

- Format processing: raw to grayscale; region of interest (ROI) determination
- Thresholding ROI with given adaptive threshold value
- Evaluation of the intensity sums of rectangular image blocks uniformly covering the region of interest, with parametrically given overlay.
- Determination of priority blocks by sorting the blocks according to the intensity sum and selection of the blocks with given minimal distance in image space.
- Calculation of precise position of the marks in priority blocks using COG procedure.

3. Recalculation to operational space

Once the position of the marks is found, the next stage is to determine the position of the marks in the operational space. Due to the imperfections in camera mounting and optical flow the values can not be simply multiplied by a constant, but transformation using the polynomial is used instead. Calibration points are measured in both image and operational space. Points are centered and recalculated to polar coordinates and transformation from image to operational space is made using polynomial of 4^{th} order, thus the minimum of 15 calibration points is required. In reality more calibration points are used and polynomial coefficients are obtained by least squares optimization. The example of comparison of true trajectory detected from image processing and the estimate generated by Extended Kalman filter based localization technique for the experimental robot Leela is shown in Fig. 2.

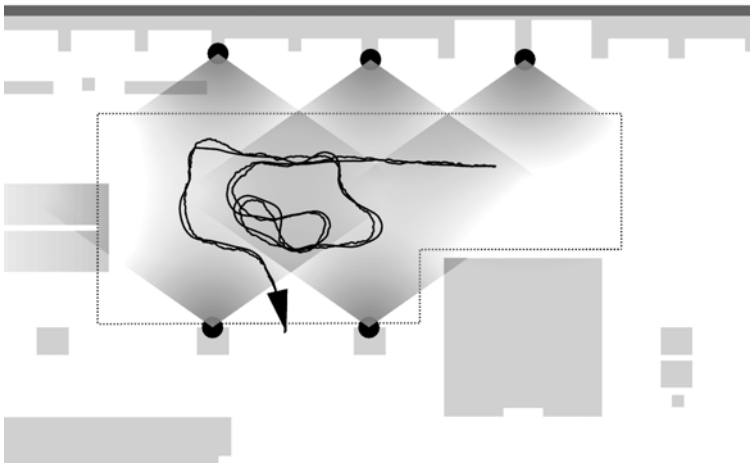

Fig. 2. Comparison of true trajectory of the robot and EKF based localization estimate

4. Conclusions

Presented method is simple and easy to implement. The processing was performed offline, but the computational requirements are low enough to perform online tracking. The precision of the method depends on the rate between the image resolution and covered operational space, the image detection can reach subpixel precision.

Acknowledgement

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