Stereo odometry based on Local Intensity Order Pattern

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Abstract

New generation autonomous vehicles use different data fusion techniques to solve the Simultaneous Localization And Mapping (SLAM) problems in urban terrains. However, the majority of the implementations uses high-cost sensors like LIDAR to obtain a high accuracy map. In this paper, we present a novel method to solve this problem using sequences of stereo images. Our approach uses Local Intensity Order Pattern (LIOP) based feature descriptors to overcome the problem of monotonic intensity changes and affine transformations of detected features. Egomotion of the vehicle is estimated using correspondence of features on the consecutive frames. Estimated motion parameters are then corrected using an extended Kalman filter. Depth of the detected features is calculated using stereo triangulation. Mahalanobis distance is used to avoid outliers in the detected features. The accuracy of the proposed method is evaluated using the measurements from a high accurate inertial navigation system. Method is tested using the odometry data set of the KITTI Vision Benchmark Suite.

1 Local Intensity Order Pattern Descriptor

The performance of a visual odometry system depends on extraction and representation of features. To achieve a consistent odometry in adverse weather and lighting conditions, the descriptor must be invariant to photometric transforms such as specular reflections, complex illumination changes and monotonic intensity changes. However, the widely used descriptors such as Scale Invariant Feature Transform(SIFT) and Gradient Location-Orientation Histogram (GLOH) are robust to geometric transformations but sensitive to photometric transformations.

The proposed system uses Local Intensity Order Pattern(LIOP) based descriptors to encode the regions detected by the Hessian-affine covariant region detector. In the preprocessing stage, image is smoothed by a Gaussian filter and feature position and shape are identified by Hessian-affine detector. Detected regions are normalized to circular areas of fixed diameter. These local patches are sorted based on the intensity level of the pixels and construct a histogram based on the order.

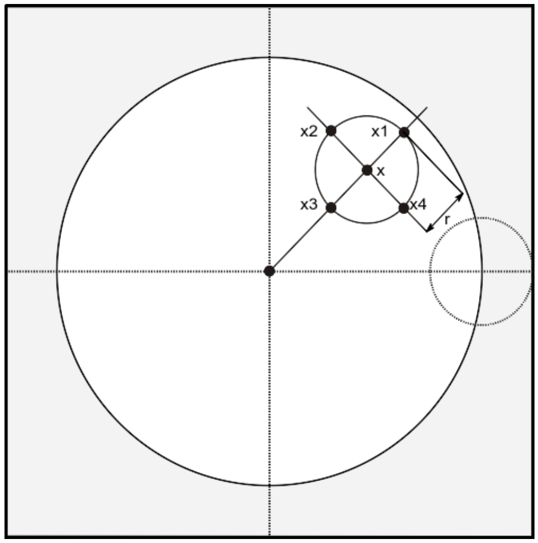

Figure 1: LIOP descriptor layout. courtesy: vlfeat.org

Rotation invariant is achieved by taking neighbourhood pixels of pixel x in the anticlockwise direction on a circle as shown in fig 2. In order to develop the histogram, the identified order of intensities in the neighbourhood of pixels will map to a linear index. Bins are constructed based on the weighted pooling of mapped linear indices in the region.

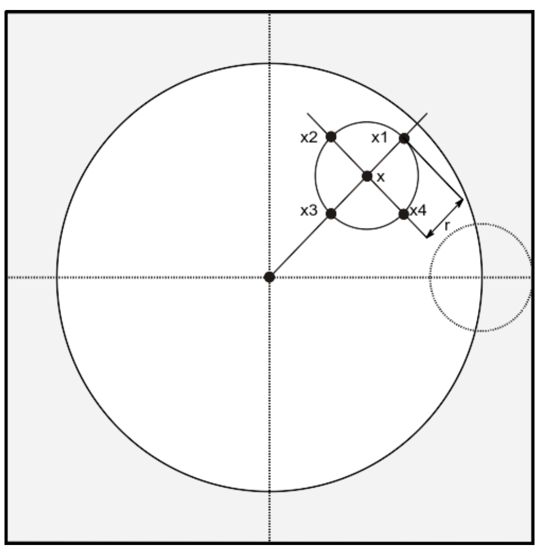

Figure 2: LIOP descriptor layout. courtesy: vlfeat.org