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Method of Object Detection for Mobile Robot

Surachai Panich
Srinakharinwirot University, 114 Sukhumvit 23,
Bangkok 10110, Thailand

Abstract: Problem statement: In general, there are two steps of object detection, which are object generation, where the locations of possible objects are in an image and object verification, where tests are performed to verify the presence of object in an image. **Approach:** The purpose of the proposed object recognition system was to detect the object which is in front the mobile robot so that it can send warnings to avoid possible collision. The information of detected objects can also help to control the robot to travel at an appropriate speed and direction to avoid possible collisions. **Results:** An object in an image was detected by the two steps of image generation and verification. When object localizations were hypothesized, sub-image of the object was extracted from the image. Gabor features extracted from the sub-image is input into the classifier to verify whether the hypothesized sub-image contain an object or not. **Conclusion:** Localizations of objects in image are generated and verified. Object generation was implemented by using horizontal and vertical edges on the way region of interest segmented by utilizing color information. The sub-images of object are verified by classifier trained on Gabor features of a training set of images.

Key words: Object detection, Gabor algorithm, mobile robot

INTRODUCTION

Vehicle detection can be improved considerably, both in terms of accuracy and time, by taking advantage of the temporal continuity present in the data. This can be achieved by employing a tracking mechanism to hypothesize the location of vehicles in future frames due to the fact that it is very unlikely for a vehicle to show up only in one frame. Therefore, past history and a prediction mechanism are necessary to generated future locations of a vehicle. The tracking performance dropped common hypothesis generation techniques could be deployed to maintain performance levels. The majority of existing on-road vehicle detection and tracking systems use a detect-then-track approach (Sun *et al*., 2002). With this approach, detection and tracking are resolved sequentially and separately. For example, template matching for vehicle detection and dynamic filtering for tracking vehicle are used. The tracker analyzed the history of the tracked areas in the previous image frames and determines how likely it was that the area in the current image contains a car (Aufrere *et al*., 2000). If the area contained a car with high probability, the tracker would output the location and size of the hypothesized car in the image. This dynamic creation and termination of tracking processes optimizes the amount of computational resources spent and thus, reduce the processing time.

MATERIALS AND METHODS

To build an object recognition system, a forward facing camera is mounted at the Pioneer II mobile robot. Because mono-vision based on mobile robot for obstacle detection has received much attention recently, a single camera attached on the robot is selected to experiment for detecting obstacles. To verify vehicle locations, appearance-based method (Avidan, 2004) is used, because this method is generally more accurate than template-based methods. The extracted features from Gabor filter response yielded a very high accuracy in object classification. In the acquired image, a region of interest in front of the robot is properly selected to find obstacles. Obstacle locations are found in the region of interest and these locations will be verified by the trained classifier in verification step.

Region of interest generation: Since the method of generating is mainly based on horizontal and vertical edges of objects on the way, a way region of interest is necessary (Cheng *et al*., 2006). When edges are computed in the way region in the image, most of surrounding objects are not considered. The algorithm for generating the way region is shown in Fig. 1.

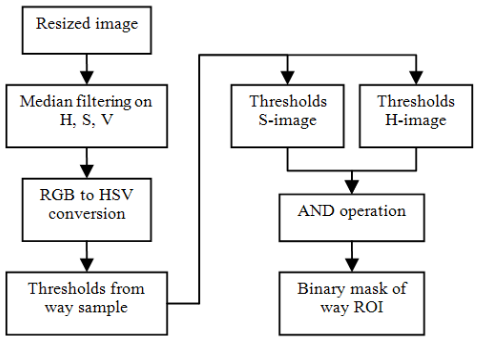

Fig. 1: Show image processing for object detection

The RGB sub image of the road sample is converted to HSV image. Median filter is then applied on Hue, Saturation and Value image. Then threshold ranges are computed from statistics for thresholding Hue and Saturation images. Two binary images of threshold Hue and Saturation images are found, which are then and operation to give a coarse binary image of the way region.

Localizations generation: This is main step for object localization that the robot can identify objects. The algorithm performing is mainly based on horizontal and vertical edges. The color image frame acquired from the camera is filtered and scaled down from which the gray image is built. The Region Of Interest (ROI) in the gray image is then found using the binary mask acquired from the previous step. The algorithm for object localization is performed on this ROI in the gray image. Preliminarily, horizontal and vertical edges in the ROI gray image are found to compute horizontal and vertical profiles.

Algorithm verification: Gabor features are used for feature classification (Shen and Bai, 2004). From the whole set of features, a strong classifier is obtained. Optimal features are also selected. This includes the design of sub-windows and Gabor filters for feature extractions. The implementation of Gabor filters to build the classifier for verification is also introduced. The Gabor filters are then applied on each sub-window separately. The motivation for extracting Gabor features from overlapping windows is to compensate for error in generation step.

RESULS

The region of interest which is the way region of image is found by using color information (Viola and Ones, 2001). Within this region of interest, horizontal and vertical edges are computed to localize the objects. The way region of interest is segmented using color features such as Hue and Saturation information. Therefore the segmentation is also affected by the lighting conditions. To deal with the problem, the software is able to adjust the brightness, gain, or shutter of the camera to gin e better contrast of the image frame. An object in an image is detected by the two steps of image generation and verification. When object localizations are hypothesized, sub-image of the object is extracted from the image. Gabor features extracted from the sub-image is input into the classifier to verify whether the hypothesized sub-image contain an object or not. Test of the classifier with manually cropped object yields that the classifier has a high classification rate.

DISCUSSION

One of the reasons for incorrect object localizations lies on the way segmentation using color information. Way region may be accurately segmented, however, the whole object is not inside the way region. The localization thus covers only a portion of the object which may not give enough information for the classifier. This requires algorithms using horizontal and vertical edges should be more robust in the sense that many hypotheses should be generated.

CONCLUSION

Localizations of objects in image are generated and verified. Object generation is implemented by using horizontal and vertical edges on the way region of interest segmented by utilizing color information. The sub-images of object are verified by classifier trained on Gabor features of a training set of images. Two types of Gabor features, the mean and standard deviation of a Gabor filter response, are used. Gabor features as well as the design of sub-windows to extract Gabor features for the classifier is found suitable for the problem. The algorithm for object generation which utilizes horizontal and vertical edges depends largely on the color information and the brightness of the way scene. The classifier has a very good performance and is suitable for object recognition.

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