UAV Detection & Localization of a Moving Vehicle

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Introduction

Many detection methods have been developed in the past decades in order to detect and localize a moving vehicle. However, only few of them considered a vision systems with a moving camera. The movement of the UAV camera imposes new challenges on the detection that include the large variations in the visual appearance of objects caused by viewpoint variation, background clutter, illumination, and shadow.

Objective

This work aims to provide a detection method of moving object using moving camera.

Fig. 1: A Quadcopter with a pixhawk controller

Template matching-based object detection methods

A template of the object to be detected is generated and used to match the image at each possible position to find the best matches.

- Strengths: Simple and easy to implement.
- Limitations: Scale and rotation dependent, sensitive to shape and viewpoint.

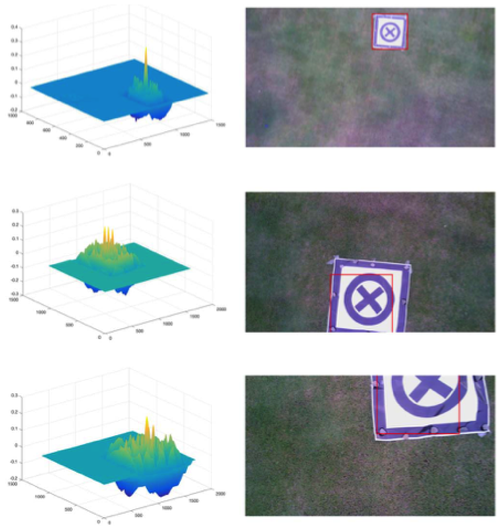

Fig. 2: Template matching by cross correlation

Object-based image analysis (OBIA)

OBIA involves two steps: image segmentation and object classification. The image is first segmented into homogeneous regions of pixels by selecting desired scale, shape, and compactness criteria. The real challenge is to define appropriate segmentation parameters for the varying sized, shaped, and spatially distributed objects.

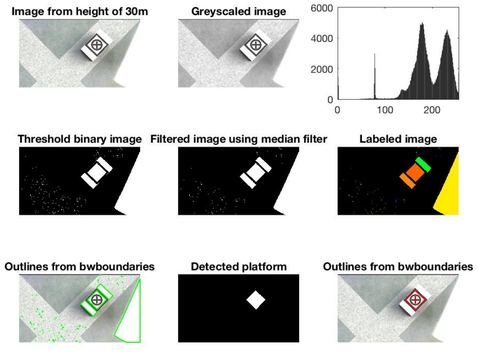

Fig. 3: Scale and rotation invariant OBIA

Once segments are generated, one can extract object features, such as spectral information as well as size, shape, texture, geometry, and contextual semantic features. These features are then fed to a classifier for classification.

- Strengths: The flexible incorporation of shape, texture, geometry, and contextual semantic features, as well as GIS-like functionality and expert knowledge, makes OBIA context-aware and multi-source capable
- Limitations: Generic solutions to the full automation of segmentation process are still missing; The expert knowledge for how to define the classification rules are still subjective

Fig. 4: Color detection on real images

Machine learning-based object detection methods

Machine learning-based object detection can be performed by learning a classifier that captures the features in object appearances from a set of training data. In the feature extraction step, the pixels of the image is mapped to a discriminative high-dimensional data space.

One of the best features to capture local shape information of the objects is the histogram of oriented gradients (HOG) feature. It represents objects by the distribution of gradient intensities and orientations in spatially distributed regions. These features of the training data-set is then used to train the a classifier. The training data-set requires both positive and negative samples.

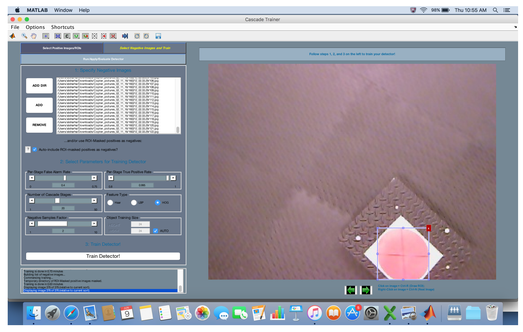

Fig. 5: Cascade trainer window in MATLAB

References

Himani S. Parekh, Darshak G. Thakore, Udesang K. Jaliya, "A Survey on Object Detection and Tracking Methods", International Journal of Innovative Research in Computer and Communication Engineering, Volume 2, Issue 2, February 2014.

Gong Cheng, Junwei Han, "A survey on object detection in optical remote sensing images", ISPRS Journal of Photogrammetry and Remote Sensing, 11–28, Volume 117, July 2016.

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