Moving Target Tracking with Dynamic Template Matching for UAV Gimbal

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***Abstract*—This paper presents an algorithm for real time target tracking that runs on windows operating system. The algorithm uses dynamic pattern template matching to detect and locate an object in the image. The system allows the operator on the ground control station to select the interest static or moving object for the UAV (Unmanned Aerial Vehicle) gimbal tracking. Tracking system is invariant to changes in illumination, translation, scaling and rotation of the object. The performance of algorithm was verified in the offline video test. The result show that the algorithm able to track a moving objects in real time. Flight testing of the system will be conducted at the next time.**

Keywords—Template Matching; Dynamic Pattern; UAV Gimbal; Target Tracking; Zero Mean Normalized Cross Correlation

I. INTRODUCTION

The UAV have a lot of potential and used in a wide range of task such as law enforcement, agriculture and military. Specifically, visual tracking system is an important system in surveillance, search and rescue and traffic monitoring [1]. For military operation such as tracking a car or ship with EO/IR payload as shown in Fig. 1.

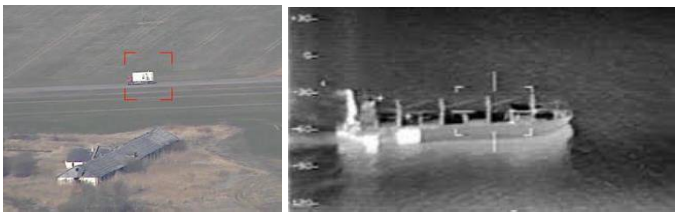

Fig. 1. Gimbal tracking with EO/IR camera

Small UAV have limited payload capacity and majority of the visual tracking systems are computationally expensive [2]. A lot of tracking method on computer vision have been used. Some object recognition algorithm are computationally expensive so it require a high performance computer. The ground station receives video image from UAV via video link after process the data sent back to the UAV with data link. A big disadvantage with running the tracking algorithm on ground computer is its dependency on communication between ground control station and UAV. The communication may be interrupted due to low quality equipment, radio frequency interference and electromagnetic interference. There for the final test of this project will be optimize the algorithm and install in small embedded computer such as PC104.

The tracking system with UAV gimbal used a commercial of the shelf image processing software running on a separate ground computer [3]. Another vision based tracking system for a UAV with a miniature gimbal camera [4]. The video sent from the UAV is processed on the ground then the target position sent to the UAV for gimbal control. The tracking system used a Scale Invariant Feature Transform (SIFT) algorithm for detecting salient points at every time tracking [5]. The result show satisfactory matching but at a rate not sufficient for real time tracking. An onboard tracking system eliminates the dependency on the communication with the ground control station and makes the system less prone to failure. However small UAV have limited payload capacity and power consumption.

The major challenges is target detection and localization while moving object at real time computation. Another challenge is the target might be illumination change due to varying lighting condition. The real factor while flying such as rotation of the object or camera that will make the object appear different. So, it needed tracking system which is rotation, translation, scaling and lighting invariant. The gimbal is also moved with motor controller in order to keep the object at the center of the image frame so that the object does not go out of the camera view.

II. SYSTEM DESIGN

The process of dynamic template matching algorithm can be described in the flowchart as shown in Fig. 2 and pseudo code below.