# Project Proposal

Mobile Robotics/CS-5313

**Instructor:**

Dr. Ahmad Kamal Nasir

**Group Members:**

14030009 – Muhammad Zeeshan

14030032 – Muhammad Omer

**Date:**

April 12th, 2015

Aerial tracking of ground based moving target

# PROJECT IDEA: Aerial tracking of ground based moving target

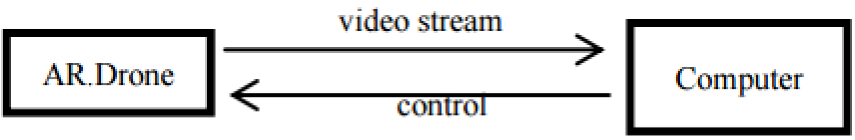
## A. INTRODUCTION AND MOTIVATION

Vision-based control of unmanned aerial vehicles (UAVs) is an exciting area of research with a wide range of practical applications. There is a remarkable increase in the utilization of unmanned aerial vehicles (UAVs), both in military and civilian applications in the past two decades. In the applications of aerial surveillance, border patrol and convoy protection, one common task of UAVs is to track a ground-moving target (GMT) autonomously.

There are two types of GMT tracking methods: one is cooperative and the other is non-cooperative. Under the cooperative method, such as in a convoy, the GMT is required to transmit its location to the UAV in real-time, whereas in the case of non-cooperative tracking (which is prevalent in the use of UAVs) the UAV is required to detect and localize the GMT in real-time.

## B. PROJECT OBJECTIVE

Object detection, tracking, and activity recognition are active research areas. The purpose of the project is to propose an integrated tracking system, which consists a vision-based estimator and a tracking law for the UAV to track a GMT. Image processing and localization of the UAV with respect to the target one frame at a time will enable us to achieve GMT tracking. There is a wide range of algorithms utilizing multiple frames for UAV localization but they are computationally expensive and are difficult to implement on the low-power computers typically found on-board of smaller UAVs. The proposed solution is described by the figure given below:




AR-Drone has limited computational complexity. Due to this reason, all computations will be conducted on a computer connected to AR-Drone wirelessly. This communication will take place through a ROS platform running on computer. Using the above approach we can run a wide range of algorithms on computer, which utilize multiple frames from video for localization and can control the AR-Drone (UAV) using the results of those algorithms.

## C. SIGNIFICANCE

As mentioned earlier, aerial tracking of ground-based moving target can be used in various applications like aerial surveillance, border patrol and convoy protection, one common task of UAVs is to track a ground-moving target (GMT) autonomously. Based on the current situation in Pakistan we can use aerial tracking against different terrorist activities and it will definitely save many human's life and will help the government in controlling different situations.

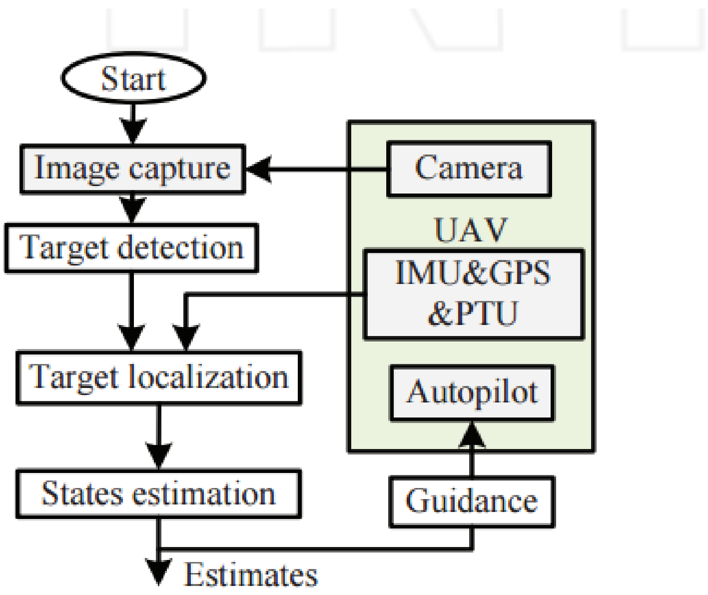
## D. Methodology

An image-processing algorithm is required for feature identification (which can provide us the semantic information also from images) and extraction as well as for continuously tracking features between the frames. The main criteria for selection of a suitable algorithm include the algorithm's sensitivity to changing environmental conditions, such as lighting, and it's ability to deal with images of low quality due to the image distortion or movement of the camera. We can use the Harris Corner detection or Sift feature detections algorithms here for detecting the common features between two images. Tracking could be achieved by continuously running this algorithm on each frame, however, that would be a rather inefficient solution. In order to track the two features identified by this algorithm between frames an optical flow algorithm is used.

Lukas-Kanade (LK) algorithm can be used for finding optical flow between frames. Lukas-Kanade algorithm works based on three assumptions about images and motion of features:

- Brightness of features is assumed to remain relatively constant through different frames. This means that the image-processing rate should be faster than change of lightning conditions so this assumption is satisfied in most cases.
- Points close together on an image do not move around relative to each other between frames. Since we are using iRobot, as iRobot is solid, points on it do not move relative to each other.
- Features in different frames have to be moving slowly as compared to the image update frequency. This is not an issue if image update rates are high or if the features being tracked are moving slowly (as iRobot do not move so fast so this will not create any issue in our case)

In the end we will use Kalman Filter to deal with the noisy measurements recorded from IMU unit and to predict the target position in case of a temporary target loss or occlusion. Measurements of the relative position and orientation between the quadrotor UAV and the moving target obtained from the image processing and estimation are noisy. A Kalman filter is designed to deal with noise as well as the prediction of target's position in case of a temporary target loss or occlusion. Basic flow of the Methodology is given below:



## E. Deliverables

- Project proposal, which describe the project significance and methodology for aerial tracking of ground-based moving object on **12th April 2015.**
- iRobot Tracking moving on a straight line on **4th May 2015.**
- Project Demonstration and Presentation on **13th May 2015.**
- Project Report on **24th May 2015.**

## F. REFERENCES


- Lecture Slides
- http://crcv.ucf.edu/papers/theses/thesis-reilly-V0993410-FINAL.pdf
- S. C. Spry, A. R. Giard, and J. K. Hedrick, “Convoy protection using multiple unmanned aerial vehicles: Organization and coordination,” in 2005 American Control Conference, Portland, OR, USA, June 2005, pp. 3524–3529.
- V. N. Dobrokhodov, I. I. kaminer, and kevin D. Jones, “Vision-based tracking and motion estimation for moving targets using unmanned air vehicles,” Journal of Guidance, Control, and Dynamics, vol. 31, no. 4, pp. 907–917, July-August 2008.
- Kontitsis M, Valavanis K (2010) A Cost Effective Tracking System for Small Unmanned Aerial Systems. J. intell. robot. syst. 57(1-4):171–191.
- Zhu S, Danwei W, Low C B (2013) Ground Target Tracking Using UAV with Input Constraints. J. intell. robot. syst. 69(1-4):417–429.