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Stereo Vision for Unmanned Aerial Vehicle Detection, Tracking, and Motion Control

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Abstract: An innovative method of detecting Unmanned Aerial Vehicles (UAVs) is presented. The goal of this study is to develop a robust setup for an autonomous multi-rotor hunter UAV, capable of visually detecting and tracking the intruder UAVs for real-time motion planning. The system consists of two parts: object detection using a stereo camera to generate 3D point cloud data and video tracking applying a Kalman filter for UAV motion modeling. After detection, the hunter can aim and shoot a tethered net at the intruder to neutralize it. The computer vision, motion tracking, and planning algorithms can be implemented on a portable computer installed on the hunter UAV.

A hunter prototype that can capture an intruder UAV in a tethered net and drag it to a designated location was developed before. This paper presents the development and evaluation of a visual-based UAV tracking algorithm and a UAV motion controller for the autonomous aiming of the hunter UAV. The UAV Targeting Algorithm involves: 1) Reconstructing the surrounding world using point cloud data from a stereo camera and computer vision, 2) Detecting the intruder UAV at each time instant, 3) Tracking the intruder UAV from a time history of the detections, and finally 4) Controlling the position of the hunter UAV to aim the net launcher at the intruder.

Keywords: Unmanned Aerial Vehicle, Video tracking, Stereo vision, Kalman filter, Robot control, Robot Operating System