Binocular vision-based UAVs autonomous aerial refueling platform—pilots are no longer needed

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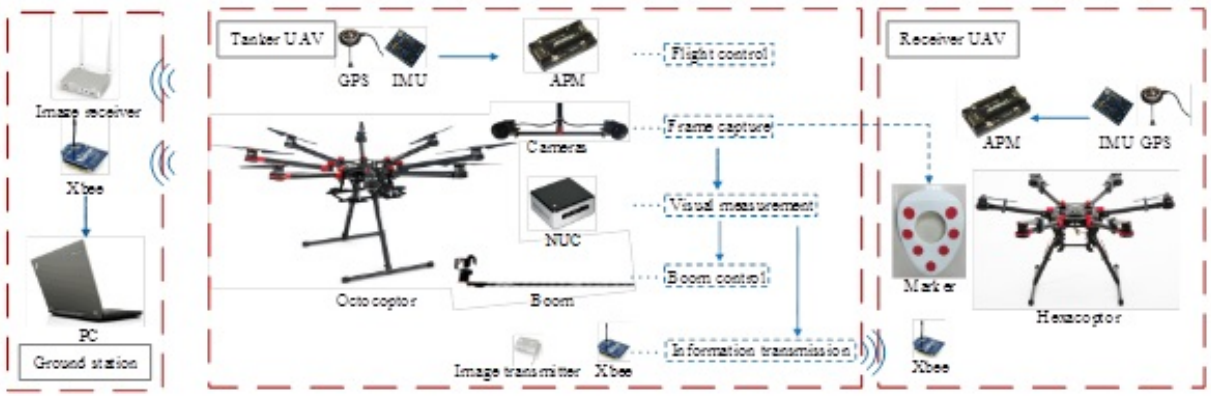
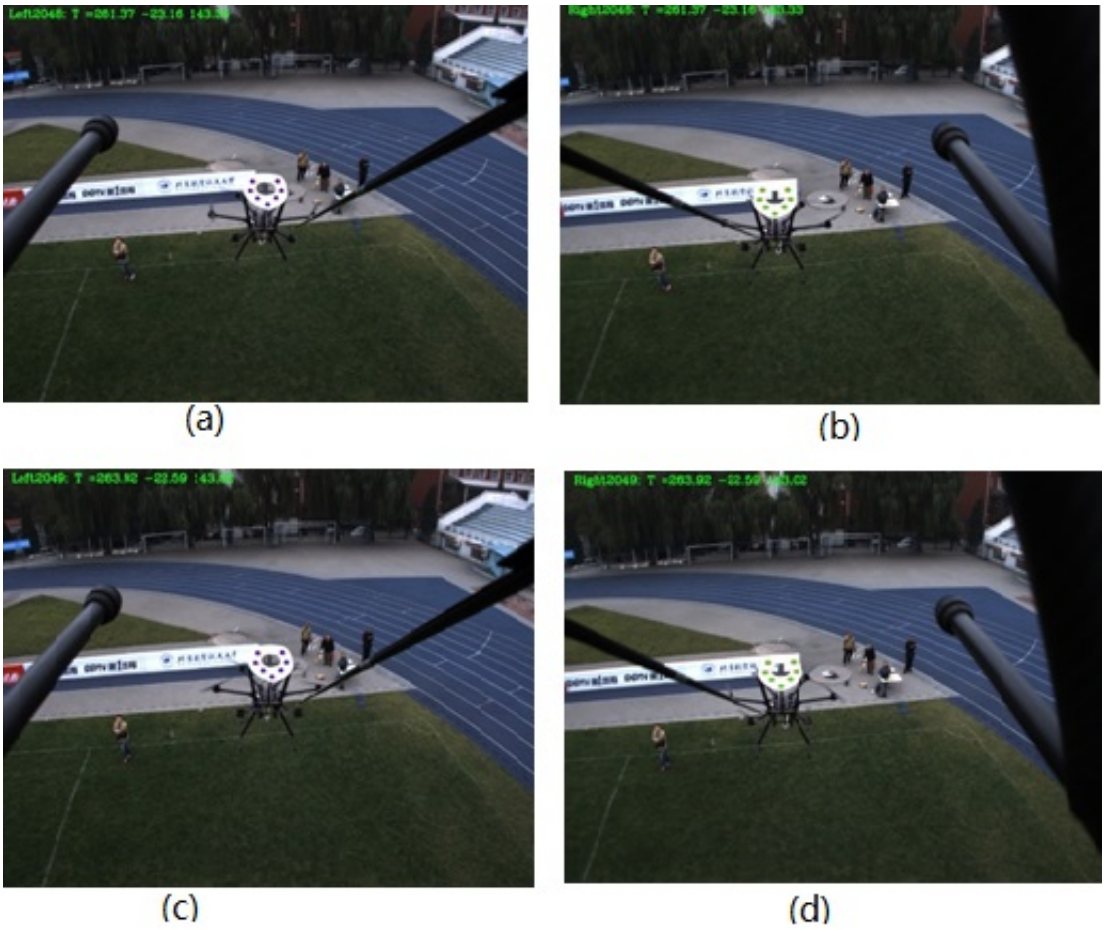


Architecture of binocular vision-based UAVs autonomous aerial refueling platform. Credit: ©Science China Press

Unmanned aerial vehicles (UAVs) are invaluable in today's military and civilian initiatives. However, most unmanned systems are being designed to execute the long-running mission. Thus, it is necessary for UAVs to return to the base for refueling. Autonomous aerial refueling (AAR) is therefore an important capability for the future deployment of UAVs. Vision-based sensor and navigation system are widely used in AAR, while experiments are done for both probe-and-drogue refueling system and boom approaches.

Researchers developed a platform to simulate AAR via real-time simulation. The system includes an octocoptor serving as a tanker UAV and a hexacoptor serving as receiver. When the receiver appears in the visual field of the cameras on the tanker (about 5 meters), the binocular vision system captures the marker on the receiver. The onboard "next-unit of computing" processor (NUC) analyzes the images and estimates the position of the receiver. Then the visual information obtained from the vision system is transferred to the flight controller and boom controller to control the flight of the UAVs and the movement of the boom towards receptacle. Figure 1 shows the configuration of our binocular vision-based UAVs autonomous aerial refueling platform.

The binocular vision system controls two primary procedures: feature extraction and pose estimation. The pixel coordinates of red markers painted on the receiver UAV are generated after feature extraction. The generated pixel coordinates are utilized in the position estimation process. The position estimation procedure calculates the relation matrix between the binocular vision system and marker coordination system.



The left frames captured on-board and the reprojection result on the corresponding right frame. (a) and (c) the feature extraction results on images captured with left camera; (b) and (d) relative projection result on images captured with right camera. Credit: ©Science China Press

To verify the effectiveness of the boom approach vision algorithm, researchers developed a mimical refueling boom system. After achieving the frame sequences of the marker on the receiver, the NUC conducts pose and position estimation. An arm microcontroller obtains the results, and figures out the level to control steering engines. The refueling boom points at the receptacle in the resolved pose and position, and implements connection in air. Figure 2 shows the experimental results of the binocular algorithm.

A series of out-door flight tests were conducted in various environments to verify the feasibility and effectiveness of this platform, including strong and poor light conditions. Considering the safety and easy observation, the flight height of the UAVs is about 10 meters. The experimental results verified the feasibility and effectiveness of the UAVs boom approach AAR platform.

More information: Haibin Duan et al, A binocular vision-based UAVs autonomous aerial refueling platform, *Science China Information Sciences* (2016). DOI: 10.1007/s11432-016-5553-5

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