

Mini-UAV Telemetry and Imaging Visualization for Searching Tasks

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Abstract

Fixed-wing mini-UAVs carrying imaging equipment are well suited for a variety of short-range searching tasks due to their mechanical simplicity, low cost, and high maneuverability. Miniature autopilots dramatically simplify operation of these aircraft by freeing the operator from the cognitive load of low-level behavioral control. We have created a PDA interface that creates a simplified view of reality by using the UAV telemetry to construct a “chase camera” perspective. Altitude, attitude, and airspeed can be manipulated relative to the world by directly manipulating the simple graphical elements of this perspective with the PDA stylus. Telemetry from the UAV is received through a “base station” laptop computer equipped with a medium-range radio transceiver and relayed through 802.11b wireless networking to continually update the PDA display, and PDA commands are relayed back through this same path.

We have further developed our concept of simplified reality and world-relative UAV control by creating a novel “physical icon” interface. The UAV operator holds a small model airplane which serves as a “physical icon” of the real UAV. The model has an onboard autopilot that continually tracks and broadcasts its attitude via radio modem to a laptop computer, which commands the airborne UAV to match the attitude of the model in the operator’s hands. The autopilot on the UAV handles the low-level control of the aircraft, and the user need only supply the desired flight characteristics by orienting the model as desired.

Mini-UAV imaging equipment is often mounted rigidly to the airframe due to weight, power, and cost concerns. In tasks where the UAV must execute rapidly changing banks to find or follow the search target, the UAV operator must mentally compensate for rotations of the video stream imposed by changes in the attitude of the aircraft. The cognitive difficulty of this task is demonstrated by novice users who rotate their heads in an attempt to place themselves in the inertial frame of the UAV camera. We remove this cognitive hurdle by rotating the camera feed using the bank angle provided in the UAV’s telemetry stream to reverse the apparent rotation of the world coordinate system. To allow the operator to remain aware of the state of the UAV, a translucent image of a virtual UAV in the current attitude of the real UAV is drawn in the stabilized video feed. This “chase camera” perspective allows the user to clearly understand the relationship between the UAV and the world while simultaneously eliminating the cognitive load created by the rotating image of the fixed onboard camera.

A wide variety of searching tasks require the UAV only for purposes of flying a camera to the proper location. The “simplified reality” produced by the combination of the video processing and interface designs described in this presentation place the mini-UAV in its proper role as a means to an end by abstracting away the complexities of flight as much as possible.