Flight Test of a Video-Based Automatic Station-Keeping System: Tracking Targets on the Ground

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Abstract

The Automatic Station Keeping (ASK) system, developed for water-based search and rescue hoisting operations, was designed to have a helicopter automatically track and follow a moving target. The ASK project was funded through a National SAR Secretariat new initiative and directed through the office of DAR 2-4. A video-based tracking system was developed that allowed the user to designate a target in the video image from a camera mounted on the NRC Bell 412 helicopter. The video tracking computer calculated the position of the target on the ground and sent this position to the helicopter's flight control computer. Using the control algorithms developed at NRC, the flight control computer maintained the helicopter's position relative to the target. If the target began to move, the helicopter moved to keep the target in the same relative position. This paper describes the basic architecture of the ASK system and the flight test of the system to determine the robustness of the video tracking algorithms and the overall temporal/spatial accuracy of the ASK system. Qualitatively, the system was capable of tracking high contrast targets indefinitely through the full range of aircraft attitudes. For lower contrast or variable contrast targets, the system was capable to tracking the target, but with increased chance of decoying to a non-target. The system was also capable of dealing with short (2-3 second) obscurations of the target, resuming tracking of the target when it reappeared. Early tests used stationary targets in surveyed positions to determine the basic accuracy of the ASK system in the hover. By comparing the differential GPS position of the helicopter to the surveyed position of the stationary target it was determined that the ASK system was able to maintain position with respect to the target to within ±0.54m. A portable INS/GPS was strapped to an aircraft tug, which was tracked and followed by the NRC B412 using the ASK system in order to determine the system tracking performance for moving targets. For moving targets (2-6 knots), the helicopter stayed within 4.6 m (±2.5m RMS) of the target, with only a 2-3 second lag in adjusting the position. An automatic approach sub-system was also developed, which allowed the operator or pilot to lock onto a distant target and have the system move the aircraft into the hoist position over the target. The auto-approach sub-system was able to close on a distant (150m)

target in less than a minute, coming into the hoist position after an additional 20 seconds. While further refinement of the tracking and flight control algorithms is warranted, the ASK system prototype shows promise for water-based hoisting operations and may also have applications for ship landing and ground/water vehicle surveillance.

Figure 1: ASK Camera Platform Installation

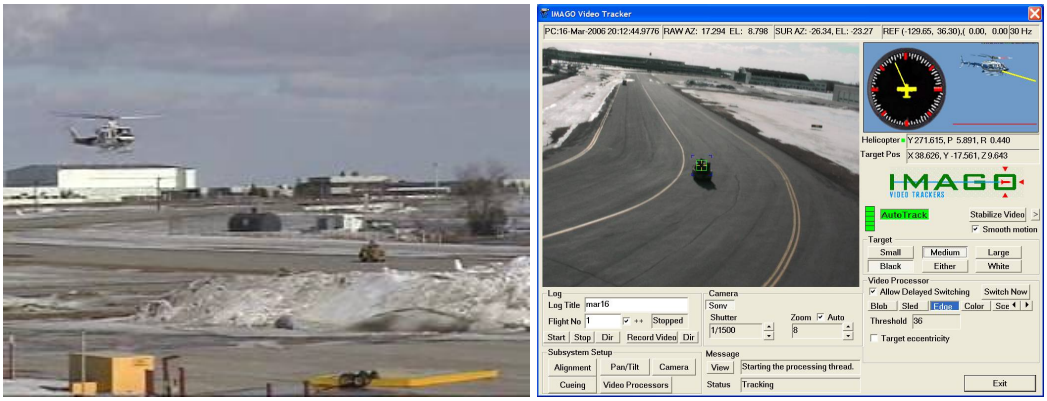

Figure 2: NRC B412 Automatic Approach and Tracking Aircraft Tug (left) and as Seen through IMAGO User Interface (right)

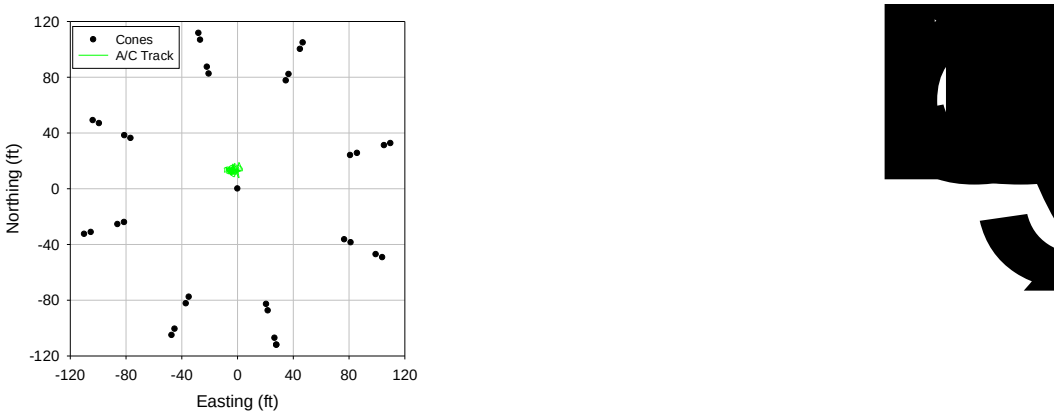

Figure 3: ASK Hover Positioning Performance (left) and Dynamic Target Following Accuracy (right)