April 14, 2022

Safe Autonomy

Kerianne Hobbs

Safe Autonomy Lead on the Autonomy Capability Team (ACT3), Air Force Research Laboratory, Dayton Ohio

ABSTRACT:

More than three miles above the Arizona desert, an F-16 student pilot experienced a gravity-induced loss of consciousness (GLOC), passing out while turning at nearly 9Gs (nine times the force of gravity) flying over 400 knots (over 460 miles per hour). With its pilot unconscious, the aircraft turn devolved into a dive, dropping from over 17,000 feet to less than 8,000 feet in altitude in less than 10 seconds. An auditory warning in the cockpit called out to the pilot ``altitude, altitude" just before he crossed through 11,000 feet, switching to a command to ``pull up" around 8,000 feet. Meanwhile, the student's instructor was watching the event unfold from his own aircraft. As the student's aircraft passed through 12,500 feet, the instructor called over the radio ``two recover," commanding the student (``two") to end the dive. As the student's aircraft passed through 11,000 feet the instructor's ``two recover!" came with increased urgency. At 9,000 feet, and with terror rising in his voice the instructor yelled ``TWO RECOVER!" Fortunately, at the same time as the instructor's third panicked radio call, a new Run Time Assurance (RTA) system kicked in to automatically recover the aircraft. The Automatic Ground Collision Avoidance System (Auto GCAS), an RTA system integrated on the jets less than two years earlier in the Fall of 2014, detected that the aircraft was about to collide, commanded a roll to wings level and pull up maneuver, and recovered the aircraft less than 3,000 feet above the ground. While Auto GCAS monitored the behavior of a safety-critical cyber-physical system with a human providing the primary control functions, the same concept is gaining attention in the autonomy community looking to assure safety while integrating complex and intelligent control system designs. This talk will discuss the AFRL Safe Autonomy Team's strategy to ensure the safety of autonomous control systems, particularly those trained with reinforcement learning.

The event described here occurred in May 2016. A video from the event was publicly released in September 2016 and the footage may be found at https://upload.wikimedia.org/wikipedia/commons/7/75/Auto-GCAS_saves_F-16.webm

BIOGRAPHY:

Dr. Kerianne Hobbs is the Safe Autonomy Lead on the Autonomy Capability Team (ACT3) at the Air Force Research Laboratory in Dayton, Ohio, where she investigates rigorous specification, analysis, and bounding techniques to ensure the safety of autonomous and learning controllers for aircraft and spacecraft applications. Her previous experience includes work in F-16 automatic collision avoidance at AFRL from 2011-2014 and Autonomy Verification and Validation research from 2012-2020. Kerianne has a BS in Aerospace Engineering from Embry-Riddle Aeronautical University, an MS in Astronautical Engineering from the Air Force Institute of Technology, and a Ph.D. in Aerospace Engineering from the Georgia Institute of Technology.