Safecopter: Developing a Collision Avoidance System Based on an Array of Time-of-Flight 3D Cameras

Tacescu, Robert

Multicopters have a wide range of applications from surveillance to package delivery and medical support. Although growing in popularity, they are not used yet on an industrial scale for safety reasons. The goal of Safecopter is to develop a modular collision detection and avoidance system that would make flying a multicopter in autonomous or tele-operated mode completely safe and responsive to the changing environment. Integrating an array of time of flight 3D cameras, the algorithm uses coordinate transformations to convert the point clouds provided by each camera into one main one, creating a 360° snapshot of the environment within a six meter radius. The challenge is to develop an algorithm fast enough to provide collision avoidance decisions in real time. Based on the research of multiple collision detection algorithms, the octree spatial partitioning system proved to be the most efficient. In comparison to the point cloud based algorithm, it was more than 320 times faster. Developed in C++, the algorithm was able to achieve this level of performance by organizing the data into tree-like hierarchies and performing binary operations. A key element of developing an advanced collision avoidance algorithm is the ability to simulate complex indoor and outdoor environments. Safecopter was modeled in 3D and, using the Gazebo physics simulator, different scenarios were tested, without running the risk of causing an expensive crash. Based on the testing performed, the system can reliably detect and avoid collisions in real time and route the multicopter to a collision free path in order to reach a specific motion goal.

Awards Won:
Third Award of $1,000
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category
Society of Experimental Test Pilots: Certificate of Honorable Mention
NASA: Second Award of $750