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FEASILITY STUDY OF USING ROBOEARTH'S CLOUD COMPUTING FOR RAPID MAPPING AND TRACKING WITH SMALL UNMANNED AERIAL SYSTEMS

Julien Li-Chee-Ming, Costas Armenakis

Geomatics Engineering, GeoICT Lab
Department of Earth and Space Science and Engineering
Lassonde School of Engineering, York University
Toronto, Ontario, M3J 1P3
{julienli}, {armenc} @yorku.ca

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A small unmanned aerial mapping system (sUAMS) is being developed at York University's GeoICT (Geospatial Information and Communication Technology) lab. The sUAMS is designed to perform 3D mapping, detect changes, and track and estimate the position of moving objects of interest (e.g., vehicles, people) in near-real time. The UAMS will also track continuous linear features such as pipelines, rail tracks, power lines, roads, rivers, or follow the terrain relief at a given attitude.

The mapping system is integrated with an ArduCopter quadcopter. It is equipped with a GPS sensor that provides positioning to about 2 meters accuracies, and an AHRS (Attitude and Heading Reference System) that estimates attitude to about 2 degrees. The quadcopter carries also an FPV (First Person Viewing) camera, which streams video to a ground control station, giving the operator a perspective view from the aerial vehicle's "cockpit". It is used as a visual aid in piloting the small unmanned aerial vehicle (UAV).

Our proposed solutions aim towards increasing the reliability and robustness of the navigation and stabilization system, and thus improving safety to the operation of UAV within a given environment. This is accomplished through the development of novel techniques that integrate the autopilot's sensor observations with the video data to increase the accuracy of the autopilot's navigation solution, and to provide positioning when GPS is not available. Further, innovative approaches are being developed to exploit the data collected by the UAV's sensors, in order to provide the user with a georeferenced and dynamic 3D visualization of the environment as it changes. This will increase the user's situational awareness, while reducing operator workload.

As both mapping and tracking algorithms require powerful computational capabilities and large data storage facilities, we explore the possibility of using RoboEarth's Cloud Engine. Incorporating this technology will allow the sUAMS to offload heavy computation, store data to secure computing environments in the cloud, and share and re-use data. The RoboEarth library provides software components commonly used in robotic applications, such as object databases, object recognition and learning models, and a visual SLAM system called C2TAM (Cloud framework for Cooperative Tracking and Mapping), that is based on a distributed framework.

RoboEarth has demonstrated its capabilities with terrestrial robots in small indoor environments. This paper demonstrates that RoboEarth can also be applied to mapping and tracking applications in outdoor environments by small unmanned aerial systems (sUAS). The test site used is York University where a 3D virtual building model of York University's Keele Campus is used as the known environment. The model consists of photorealistic reconstructions of buildings, trees, and the terrain. Video images captured from the onboard camera were processed using RoboEarth's Cloud Engine. Building models were identified, and the UAV localized itself and mapped the 3D environment. The estimated position and orientation parameters of the video camera indicate improvements in their accuracy when compared to the sUAS's autopilot solution, derived from the onboard single frequency GPS receiver and MEMS-IMU. The paper presents the proposed approach and the obtained results, along with their accuracies.