A GIMBALED PLATFORM FOR MICRO AERIAL VEHICLE AUTOPILOT SIMULATION AND CALIBRATION

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Abstract: A gimbaled platform that can be used to calibrate small autopilots or inertial measurement units (IMUs). This platform can also double as a flight simulator on which an autopilot can be evaluated and developed. The platform is controlled by five stepper motors, two for pitch, two for roll, and one for yaw. The stepper motors have a resolution of 0.18° per step using micro stepping technology. To complement the stepper motors, optical shaft encoders are affixed to all three axes. The shaft encoders supply accurate readings of the platforms attitude. By placing the autopilot on the platform while actuating the platform to simulate flight, IMU data and the corresponding shaft encoder data may be collected. This data can be used to fine-tune the contribution from each of the IMUs sensors to minimize overall error. Furthermore, the data can also be utilized in the training of neural networks or any other type of filter to further minimize IMU error. The platform can also be configured as a synchronization tool, e.g., synchronizing IMU and video images for target geolocation. This is accomplished by placing both the video camera and autopilot on the platform where they are synchronized with the optical shaft encoders. The exact IMU data corresponding to each video frame can then be obtained, thus rendering the target geolocation system more accurate. This platform has been integrated with X-Plane, a Federal Aviation Administration-approved flight simulator. This software was chosen to handle the flight dynamics calculations and provide data to both the platform and autopilot. New flight surface positions can be generated by the autopilot or interface module, which are then passed back to X-Plane, where the resulting change in airframe attitude is rendered. This new attitude data is also passed to the platform’s motor control system, updating the platforms attitude. In this configuration, global positioning system (GPS), as well as barometric and wind speed data generated by X-Plane, is supplied to the autopilot. For these sensors to operate correctly, additional hardware not yet integrated into the platform is required. Therefore, using the platform as a flight simulator will require modifying the autopilot code to accept the aforementioned data directly from X-Plane. Nevertheless, using the platform as a flight simulator will allow the evaluation of an autopilot’s control algorithms using different airframes, as well as performance testing under different weather conditions at the click of a mouse button.

Key words: platform, gimbal, control, MAV, autopilot, calibration, IMU, X-Plane

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