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UAV AUTOPILOT CONTROLLER WITH TEST DYNAMICS MODEL PLATFORM

Objective. Proposed report anticipates describing a test platform developed to utility during autopilot design process. The test platform here planned affords a surrounding for designed autopilot system that can be applied for modeling and simulating small class unmanned aerial vehicles (UAV).

Essentially, this test platform based up the Matlab/Simulink to run the autopilot controller to be tested, the flight experimental simulator using the UAV to be controlled, a microcontroller to command the UAV flight control surfaces and a servo to initiative these control surfaces. All that assets are connected over data buses in order to exchange command information. As research example, proposed report offerings the outcomes gained from tests conducted above an autopilot control system designed for as lateral movement, as for roll mode control.

Translational Motions. The lateral-directional motion, the roll motion, is the movement projected to be simulated on the projected test platform in demo case. To make simpler the planned situation, it was preferred to address precisely the roll motion.

The lateral-directional motion, exactly the roll motion, is the movement intended to be imitation on the projected test platform as demo example. To simplify the intentional instance, it was selected to discourse precisely the roll motion in this report. The fixed wing UAV roll motion can be measured by an autopilot system block diagram as shown in the Fig. 1 [1].

The roll attitude autopilot system gains K_G, K_a, and K_{RG} are defined over the root locus method bearing in mind the above rationale.

The core components for proposed test platform are next: 1) Matlab/Simulink covering the autopilot control system; 2) flight simulator, containing the UAV model to be controlled; 3) microcontroller to command model UAV flight control exteriors; 4) model fixed wing UAV digital servo to initiative that control exteriors.

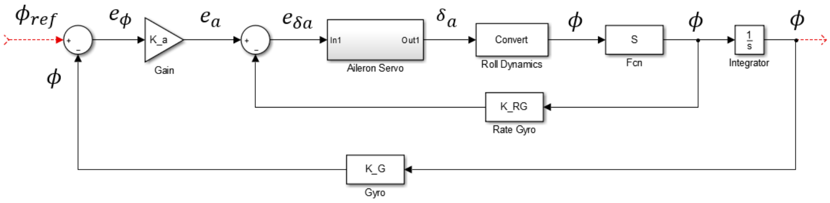

Fig. 1. Roll attitude autopilot system block diagram

Most of existing flight simulators use the steadiness derivatives system to calculate how an airplane fly. This method contains just imposing the UAV nose to return to a centred location along the flight route with confident acceleration for each degree of balance from straight-ahead flight. This is too crude to be used across the UAV's entire flight envelope. Moreover, those simulators cannot forecast how the UAV will fly.

The communication among Matlab/Simulink and Aircraft Dynamics Model Platform (ADMP) is completed over UDP (User Datagram Protocol). Amongst Matlab/Simulink and microcontroller it used RS-232 serial communication. The ADMP block diagram shown by Fig. 2, reviews the platform concept with Flight Control Surface Visualization [3].

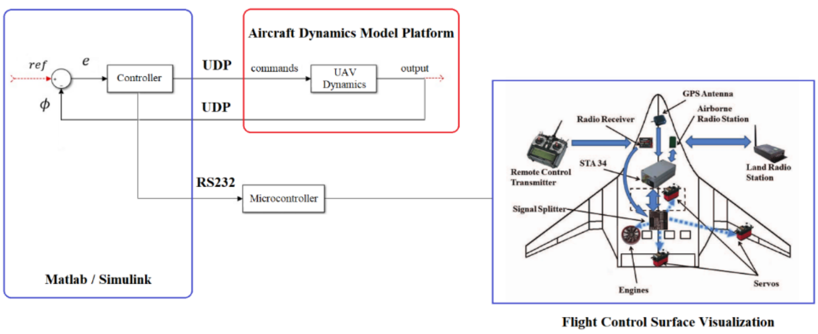

Fig. 2. Aircraft Dynamics Model Platform (ADMP) block diagram

Moreover, ADMP adapts the geometric form of many types of fixed-wing UAV and then figures out how that plane will fly. Those forces are then transformed into accelerations which are then integrated to velocities and positions. Proposed method of subtracting the forces on the UAV is much more comprehensive, flexible, and innovative than the flight model that is used by most other existing flight simulators.

The microcontroller signified by respected block on Fig. 3 represents the board MSP-EXP430F5438 manufactured by Texas Instruments and shown in Fig. 3.

Fig. 3. Microcontroller unit on board MSP-EXP430F5438

Test Results Analysis. In order to prove how the fixed wing UAV test platform could be applied in laboratory and support autopilot systems expansion, the roll attitude autopilot system was designed and integrated into the platform. The gains $K_G, K_a,$ and K_{RG} that structure were considered over the root locus method using the systems dynamics as shown in next two equations, which are the UAV roll to aileron and typical aileron servo transfer functions [2]:

$$\frac{N^{\phi}_{\delta a}}{\Delta_{Lat}} = \frac{s(149.42s^2 + 33.66s + 133.07)}{s(870.78x^4 + 628.63s^3 + 791.37s^2 + 438s + 5.47)}; \quad S(s) = \frac{10}{s+10}.$$

The intended system result is exposed on reference [4]. It is also shown which blocks will be simulated by ADMP and which ones will be joined into the test platform model at Matlab/Simulink.

The gains $K_G, K_a,$ and K_{RG} shall be fed into the controller executed at Matlab/Simulink. The gains calculation may be completed at the lab or be beforehand completed, being the lab experiments if possible used for test at the platform.

For the simulation disable, ADMP is overloaded in an experiment flight at 500 m altitude. As soon as the Model Platform runs, the designed autopilot system takes the UAV control. In opinion, for any roll angle applied as reference into the autopilot system, the UAV at ADMP shall reply resulting that reference. The reference signals applied as system input, the system response and also the commands sent to the UAV flight control surfaces actuators can be checked through real time graphs at Matlab/Simulink. In this study case, the input is the reference roll angle, the system response is the new UAV roll angle attitude and the commands are the deflections to be imposed to the ailerons.

Conclusion. The development of proposed Model Platform brings about in a valued device to service autopilot systems as for study as for design. It allows checking the UAV responses for an intended autopilot system with high degree of level-headedness.

The Model Platform similarly allows to study of fixed wing UAV longitudinal and lateral-directional movement, for which the proposed autopilot system is being designed.

References

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