LFK HARDWARE-IN-THE-LOOP FACILITY FOR MISSILE DEVELOPMENT AND EVALUATION.

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1 FLIGHT MOTION SIMULATOR

The FMS was built by ACUTRONIC Switzerland Ltd. within 14 month, which was a record delivery time for a FMS with this size. It is powered by a hydraulic power unit (HPU) with 2 electric motors, 75 kW each, expandable by a third motor. But only the two outer target axis and the inner pitch and yaw axis are driven by hydraulic. The roll axis is driven by an electric motor. The HPU was placed in a separate room with noise abatement.

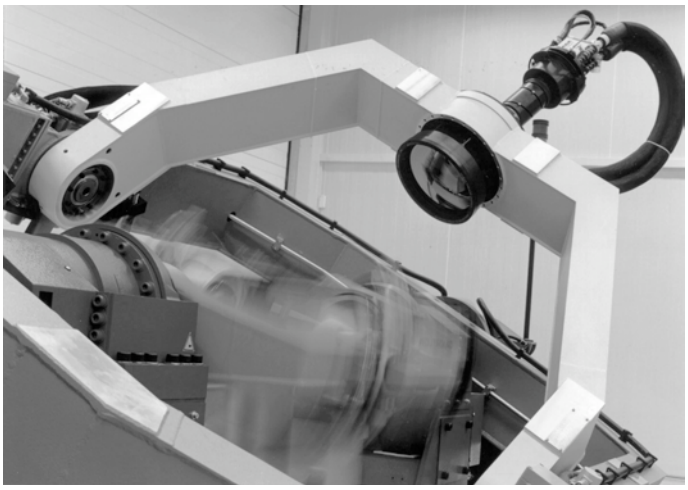

Figure 1 : Flight Motion Simulator in operation

One of the main requirements of the FMS design was, that there must be physically no way of collision between the collimator and the inner three axis. It turned out, that this was very challenging to build the FMS as compact as possible with taking care of the performance requirements and the payloads. As the result, the distance between the unit under test and the lens of the collimator is 85 cm (≈ 33 inch). This is small enough to have a feasible collimator design. The collimator was built by Janos Technology. The object lens has a diameter of 40 cm (16 inch), which is quite large. The frame is designed to carry the IR projector without any addition support (see Figure 1 and Figure 2). The collimator is manually zoomable to achieve an adjustable field of view for different IR seekers.

The payload for the inner three axis is specified with 30 kg (≈ 660 lbs.) , for the outer two axis with 60 kg (≈ 1320 lbs.) Some key requirements are shown in Table 1. Very remarkable is the high dynamic of the pitch axis within the very large displacement from -135° to +90°. This allows EADS/LFK to use the FMS not only in the 5-axis configuration with the inner axis looking at the outer axis, but also in a 3-axis configuration with the inner axis looking e.g. in an anechonic chamber. The continuous roll axis allows EADS/LFK to use the FMS for missiles with a rolling airframe. Most of the dynamic requirements are even surpassed.

Performance Parameter	ROLL AXIS	YAW AXIS	PITCH AXIS	Target Azimuth	Target Elevation
Displacement, degrees	Continuous	±60	-135/+90	±60	±45
Velocity, greater than, [degrees/s]	1500	400	400	100	100
Acceleration, greater than, [degrees/s_]	32000	15000	15000	1200	1200
Frequency Response [Hz] greater than	40	30	25	10	10
Position accuracy, [degree] less or equal	0.01	0.005	0.005	0.005	0.005

Table 1: FMS performance highlights

The FMS control is done by two ACUTROLs, one for the inner three axis (FMS) and one for the outer two axis (TMS). There is a serial and a SCRAMNet+ connection between the real-time simulation computer and each ACUTROL. The serial connection is used for command and status, which needs low bandwidth. To provide missile and target state vectors to the ACUTROLs at a frame rate of up to 1 kHz the SCRAMNet+ is used. It is also possible the configure the ACUTROL, that internal variables are written to the reflected memory. Especially the actual state vector of the FMS is the most interesting one. With the recording of the commands to the FMS and the feedback of the FMS an evaluation of the introduced latency can be done and a latency compensation can be implemented. The FMS can be operated in five modes: a position mode (only positions are commanded by the RTSC), a absolute rate mode (only absolute rates are commanded by the RTSC), a relative rate mode (only relative rates are commanded by the RTSC), a track mode (position, velocity and acceleration are commanded by the RTSC) and a synthesize mode (a sine motion is generated by the FMS controller). The ACUTROLs can be completely remote controlled by the real-time simulation computer. The two ACUTROLs can be synchronized with each other and with the RTSC, that reduces the latency in the communication and also makes it a well defined latency.

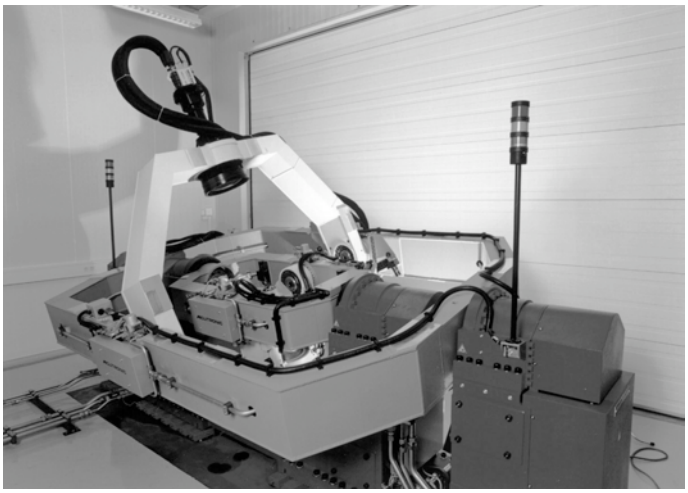

Figure 2 : FMS with UUT

The design and performance of the FMS was made to fit the requirements of actual and future missile projects.

Taken from: “Technologies for Synthetic Environments: Hardware-in-the-loop Testing IV, Robert Lee Murrier, Jr. Editor, Proceedings for SPIE Vol. 4366 (2001) Copyright SPIE