Automation of a Turbojet Engine Model

Degree programme: BSc in Mechanical Engineering
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Centrepiece of this project is a KJ-66 turbojet turbine whose primary application is in model aviation. In this project it is intended to lay out and develop the required sensory, actuation and data processing systems to operate the turbine automatically.

Problem Definition

Previously, the Engine was run with a rather rudimentary setup without any control loops and only a few state parameters that were sensed. Therefore, the engine was operated purely manually while providing only limited information for the operator.

Goal

The final product of this project should be a mechatronic system that automates the operation of the engine including start-up, normal operation and shutdown while supervising all critical parameters and enforcing their limits if necessary.

Methodology

Starting from the engine and the tasks aimed to be performed the necessary systems were defined first roughly in theory and then more and more in detail. After all components were defined they were ordered and assembled along which tests were continuously performed first on a components level then on a subsystem level and finally on a full system level.

Results

Hardware

During the theoretical thought process 11 subsystems were identified. First a system that interacts with the operator, second a central computer unit, then there are five sensory systems and finally four actuation systems. Parameters measured by the sensory systems are rotational speed, compressor discharge pressure, oil pressure, thrust force and exhaust temperature. The required actuation systems are a kerosene supply (Jet A-1), a gas supply (mix of butane and propane), a starting system (electric motor) and a ignition system whereas the kerosene supply is the only actuation system running during normal operation and all the others are only used during start-up.

Software

Analogous to the hardware, five subsystems were identified for the software. A system that handles all the reading and conversion of sensory data, a control system that adapts actuation to maintain or change the operating point, a safety system that handles the supervision of critical parameters, a system that handles all the commands and feedback for the HMI and finally a system that coordinates the previously mentioned systems and to handle the execution of procedures.

Assembly and development

With exception of a few component specifications that were not met all subsystems could be brought to full functionality. However, while commissioning the full system multiple component failures occurred and in addition to time intensive software complications the project goals could not be met in time. Automation could be achieved for ignition and warmup with gas which gave a brief glimps at the degree of optimization such a system would allow for.

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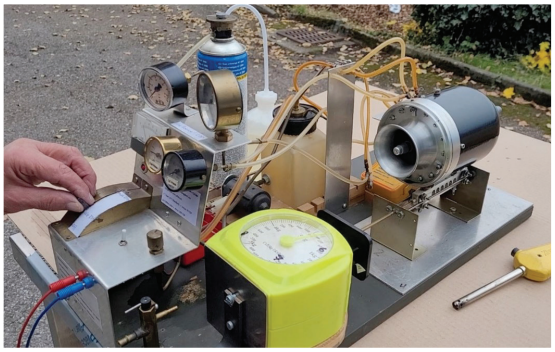
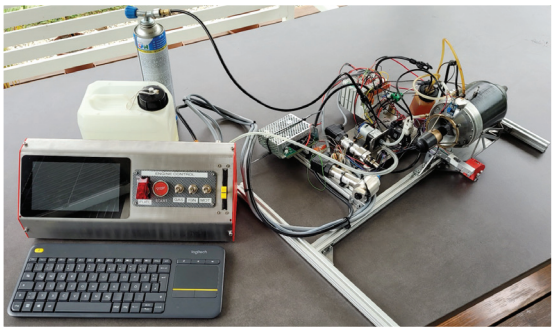


Previous Test Setup



New Test Setup