Machine Learning for Rocket Engine Test Facilities within the ESA FLAME Program

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Abstract: The DLR Institute of Space Propulsion has long heritage in Europe in the development and operation of engine test facilities. Since 1959, engines for space propulsion systems have been tested and developed at the Lampoldshausen site. Nevertheless, essential elements of the DLR Lampoldshausen technical center were designed up to 50 years ago. In the frame of the FLAME (Future LAMpoldshausen Exploitation) program, ESA has initiated multiple modernization measures to enhance the service levels of the engine test facilities. In order to guarantee a smart digital test infrastructure that is ready for the future, the potential of advanced control and monitoring systems are studied. In the long term, such intelligent control and monitoring systems promise to increase safety and reliability of the test bench.

The paper summarizes two pilot projects of the FLAME program. The first project evaluates the benefits and usability of artificial intelligence concepts for automated test sequence generation in rocket engine test facility operations: Reinforcement learning is used to find optimal test sequences according to user requirements in terms of time-dependent interface conditions and the expected engine operation point. The second project studies the use of artificial intelligence concepts regarding fault detection and isolation of rocket engine test facilities. Additionally, the paper provides an outlook on the implementation of the AI-based algorithms at the P5 test bench. It is discussed if the algorithms can be implemented in the existing infrastructure and how the can be run in parallel to the established monitoring logics.

Figure 1: Test bench schematics and generic test requirements