Master Project

Fault Detection and Isolation for High-End Industrial Printers

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Context

Canon Production Printing is a Canon subsidiary company located in Venlo, the Netherlands, that develops, manufactures and sells high-end industrial printers. Such a printer can be seen in Figure 1. The company's research and development department is dedicated to improving the quality of printing. As part of the R&D program, collaborations with academic partners are cultivated under specific projects, such as this master thesis project.

Figure 1: Canon's Colorado-1650 printer

Canon's printers consist of various components that work together to ensure their proper functioning. In this context, the focus is on the printhead, of which a schematic overview can be seen in Figure 2. In each printhead, several different faults may occur, such as air entrainment, partial or complete blockage of the nozzle or drying of the local ink. All of these are examples that would degrade the image and printer quality.

The proposed solution in this master thesis is a hybrid model- and data-based fault detection and isolation filter. To create the filter, the state-space matrices of the model that describe the fluid dynamics of the ink in the printhead

$$\begin{cases} \dot{x}(t) &= Ax(t) + B_u u(t) + B_d d(t) + B_f f(t) \\ y(t) &= Cx(t) + D_u u(t) + D_d d(t) + D_f f(t) \end{cases} \tag{1}$$

are divided into three categories: the known part, the unknown part, and the fault part. The filter is constructed in such a way that the signals connected to the unknown part, namely the internal state x and the disturbance d, do not influence the

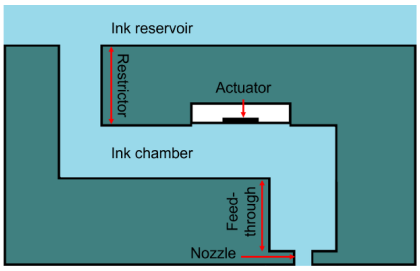

Figure 2: Schematic overview of the printhead

filter's output, while the signals connected to the known part, which are the input u and output y of the system, are utilized as inputs for the filter. The output of the filter, the residual r, is a signal that is equal to zero when no fault signal f is present and non-zero when a fault signal is detected. Real data is used to make the filter robust to model mismatches and disturbances. The residual of the fault detection filter can be used to reconstruct the faults in a fault isolation filter. A schematic overview of the process can be seen in the block diagram in Figure 3.

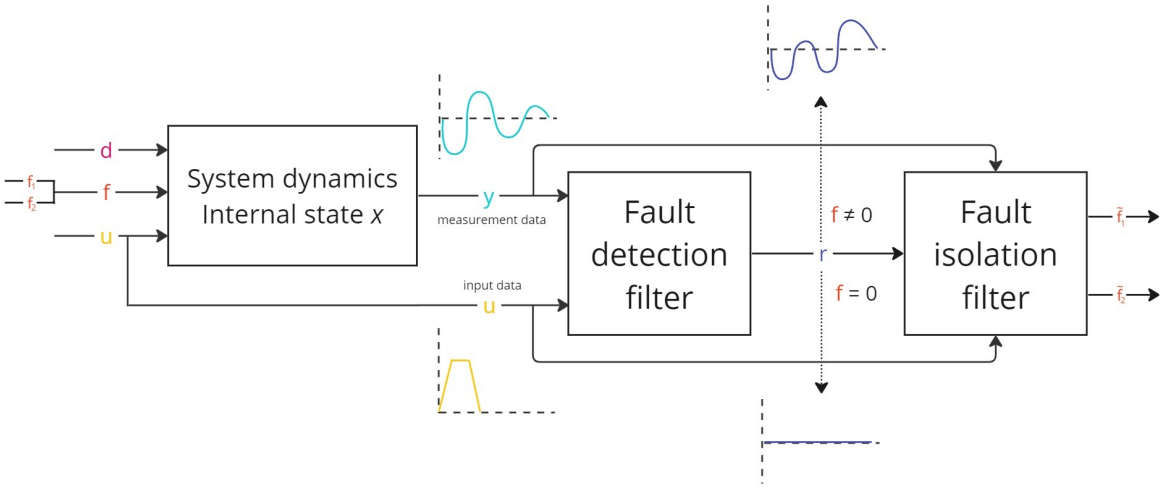

Figure 3: Block diagram of the system and filter.

Project tasks

This master thesis aims to propose a Fault Detection and Isolation (FDI) scheme for Canon's printers. To come to such a scheme, the following tasks are proposed:

1. Identify the parameters of a physical model for the printhead system;
2. Use the model to develop a fault detection filter using the identified model;
3. Robustify the fault detection filter against model mismatches and disturbances using real data;
4. Develop fault isolation filter;
5. Apply the designed FDI scheme to Canon's printers.