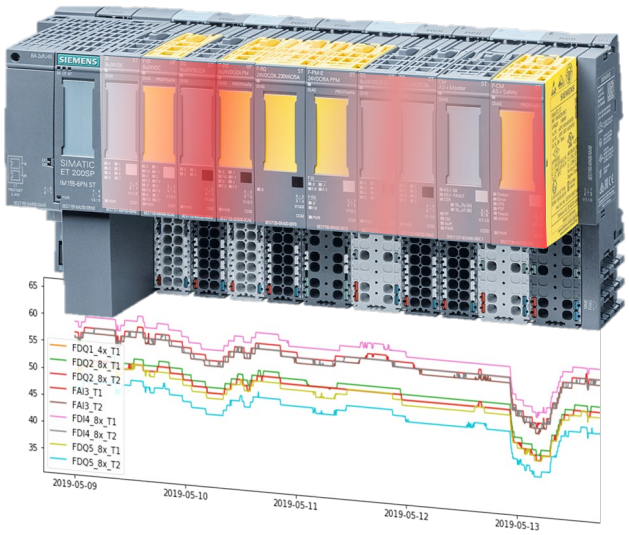
**SUCCESS STORY**

**Pro2Future**
**Products and Production Systems of the Future**

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Centre K1

Type of project: Simatic Failsafe 4.0, MFP, 2 years, single-firm




# CREATING AWARENESS IN AUTOMATION SYSTEMS

## ENHANCING AUTOMATION DEVICES WITH LOW-COST IOT EQUIPMENT ENABLES DEVICE-AWARENESS AND FOSTERS NOVEL COGNITIVE SERVICES

In the context of Cyber Physical Production Systems several research challenges have been identified. One constitutes the need for machines to contextualize themselves in the environment and thus gain awareness.

Recent advances in Data Analytics, Machine Learning, and Internet of Things (IoT) provide the necessary tools to enable awareness, however the adaption towards such technologies in automation is slow, due to the longevity of legacy systems. The project Simatic Failsafe 4.0 investigated how IoT can be used to retrofit legacy equipment in order to enhance it for contextual awareness. The investigated use case concerns enhancing programmable logical controllers with awareness regarding the temperature in environment to allow for the implementation of novel services such as condition monitoring enhancing the service portfolio of PLC systems.

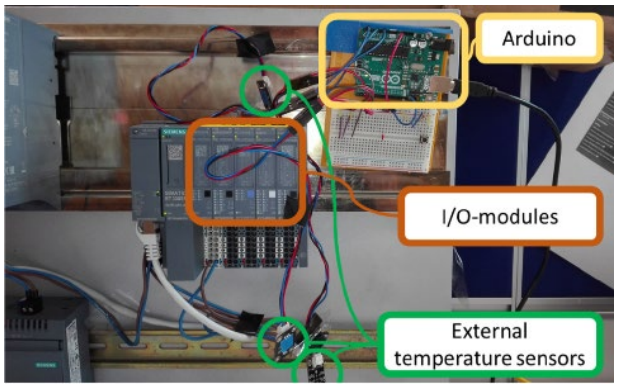



Figure 1: Experimental setup for enhancing PLCs with awareness: the five I/O-modules and three environmental temperature sensors that are connected to an Arduino. A temperature change can be achieved by shielding the PLC with a cover (Copyright Richard Bjetak)

The experimental setup used to implement temperature awareness within the project is shown in Figure 1. It consists of a Programmable Logic

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Controller SIMATIC S7/1500 (PLC) with Input/Output (F-IO) modules, a single board computer Raspberry PI 3 Model B+ (RPi), and an ATmega328 microcontroller (Arduino UNO). Each IO module has a microcontroller that is capable, among other features, to measure its own temperature.
Self-awareness is created by implementing an CUSum based change point detection algorithm, which monitors the processor temperature of the I/O-modules. Whenever an abrupt change happens the change point can be detected as fast as possible, keeping in mind the trade-off between the false alarm rate and the delay for detection. Besides self-awareness contextual awareness was realized, which allows the estimation of the environmental temperature based solely on IO module internal temperature measurements. In additional, thermal peer to peer comparison for the comparison of thermal behavior between different I/O modules was implemented.

The results of the changepoint detection algorithm are shown in Figure 2. Using the system, it is possible to detect thermal changepoints in the devices, furthermore this detection can be consecutively used to implement novel safety features and services on a device, edge or cloud level.

**Impact and effects**

The results demonstrate how environmental awareness can be established in legacy automation systems using affordable IoT equipment. By utilizing a minimal set of additional hardware such features can be implement allowing for a wide range of additional services such as condition monitoring thus leading to a further cognification of automation systems.

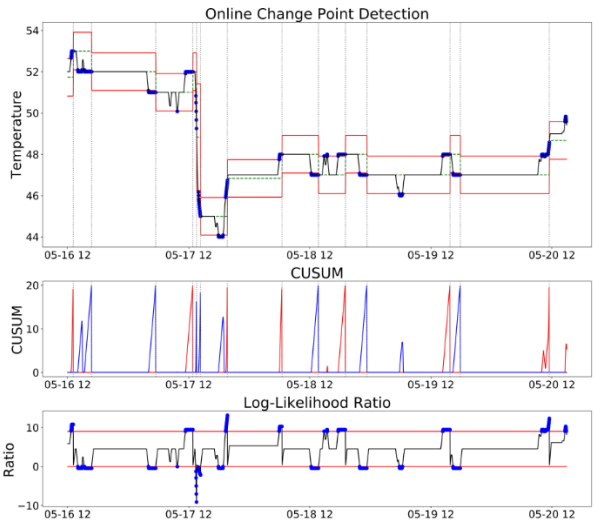


Figure 2: Results Changepoint Detection – The developed CUSum algorithm is able to detect changes in the environment, enhancing a PLC with contextual awareness (Copyright Richard Bjetak)

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