

Politechnika Śląska  
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## **Rozprawa doktorska**

### **Metoda detekcji uszkodzeń w diagnostyce procesów z uwzględnieniem kontekstu**

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# Fault detection method in process diagnostics using context-based approach

PhD thesis - Summary

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The PhD thesis deals with fault detection using context-based approach. It is well-known that fault detection is an absolute must for any practical systems. The main aim of the thesis was to elaborate and verify the method of fault detection using context-based approach whose parameters were automatically tuned using the NSGA-II multi-criteria optimization algorithm. Taking into account the context and the optimization algorithm in the developed method was crucial in finding an optimal solution. The solution should be able to reach as high detection rates as possible for fault and faultless states detection and keep high repeatability of the results. The another goal of the elaborated method was to reduce complexity of the obtained classifier.

In the literature, it is possible to find many publications related to the concept of context, but the definition and use of context differs from the area of research. In the case of diagnostics of industrial processes, the concept of context is also present, but it is not as widely used as in other fields.

This dissertation proposes a fault detection method using context based ensemble classifiers. The context allowed the base classifiers to be specialized to operate in a specific variant of the context, i.e. in a limited set of data and features. The additional use of the NSGA-II multi-criteria optimization method allowed for automatic finding of optimal values of classifier parameters. Each solution found by the multi-criteria optimization method is optimal in the domain of criteria functions. In the case of the elaborated method, optimization algorithm searches for solutions, which are repeatable, which false detection rate of fault is minimal and true detection rate is maximal. The set of found solutions allows to choose one, which is best for specific implementation.

The verification of the proposed method was carried out for data obtained during an experiment carried out on a laboratory stand FESTO S7 EduTrainer. This object exemplifies a physical miniaturization of an industrial installation used, e.g. in a chemical industry or a food industry and makes possible diagnostics of the continuous processes. The object consists of elements of hydraulic systems, such as pumps, valves and tanks. During the experiment, various types of faults that could occur during the operation of an industrial process were simulated. The results obtained during the verification tests confirmed the usefulness of the proposed method in the context of the defined research problem. The method of context based fault detection allowed to improve indicators describing the effectiveness of fault detection and to significantly simplify the structure of classifier models.

**Key words:** fault diagnosis, fault detection, context based reasoning, machine learning, multi-criteria optimization.