Technische Universität München

Model based diagnosis of cyber-physical systems: A UAV example

Master thesis

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Context

With the emergence of cyber-physical systems, there is a growing need to assess the safety of such systems in a systematic manner. One way to improve their safety is to develop detective mechanisms to learn from previous (mis)behaviors and increase the accountability of the system [1]. Model-Based Diagnosis (MBD) is a promising paradigm which has its roots in artificial intelligence community and has been successfully utilized in several domains such as automotive and space systems [2]. The basic idea of MBD is to feed the recorded inputs (which are recorded during run-time), to a model of the system. Then the output of the model can be compared with the real system's output. If there is a difference between the computed and recorded output, all combinations of components' healthiness and faultiness will be searched as a constraint satisfaction problem to find the correct combination.

In this thesis, we will formulate the diagnosis of the drone as a constraint satisfaction problem. For this purpose, an available software in the loop simulation environment will be used as the model of the system. Next, an appropriate solver will be chosen to solve the constraint satisfaction problem. Finally, the diagnoser will be evaluated on real drone crash examples.

Goal

The goal of this thesis is to develop an intelligent diagnoser based on Model-Based Diagnosis method to automatically find explanations for drone crashes.

Workplan

1. Study the literature on Model-Based Diagnosis
    a. Core idea
    b. Computation procedure
    c. Patterns in implementing MBD in other domains such as automotive systems
2. Prepare drone framework
    a. Understand the main components of a drone and their desired interactions
    b. Understand the frequent causes of drone crashes
    c. Install the available simulation environment
    d. Prepare the data for analysis (Recorded inputs and recorded outputs)
3. Prepare MBD toolbox
    a. Identify the available tools for MBD
    b. Determine the pros and cons of each and choose one
    c. Learn the prerequisites of the MBD analysis
4. Analyze the results
    a. Run the MBD tool over the flight log instances
    b. Analyze and improve the results
5. Write the thesis

Deliverables

- Source code of the implementation with user manual
- Final thesis report written in conformance with TUM guidelines

References

[1]. Zibaei, Ehsan, Sebastian Banescu, and Alexander Pretschner. "Diagnosis of Safety Incidents for Cyber-Physical Systems: A UAV Example." *2018 3rd International Conference on System Reliability and Safety (ICSRS)*. IEEE, 2019.

[2]. Peischl, Bernhard, and Franz Wotawa. "Model-based diagnosis or reasoning from first principles." *IEEE intelligent systems* 18.3 (2003): 32-37.