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A Novel Fault Detection and Diagnosis Methodology for Dynamic Systems

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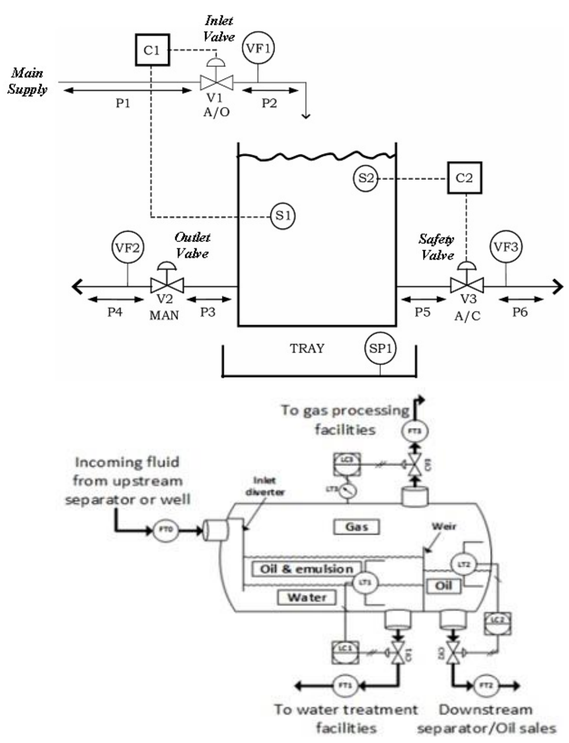
Introduction



Faults can have significant, negative impacts on the operation and performance of complex dynamic systems such as those in the power, chemical and nuclear industries. Failing to detect and diagnose the cause of faults on time may result in loss of life or other costly incidents such as explosions and emergency shutdowns.

Research Aim and Objectives

The aim of this research is to present a methodology for developing a computationally efficient, integrated model for monitoring the operational behaviour and online fault detection and diagnosis of a complex dynamic system.

The **objectives** are to:

- Develop a Generalised Stochastic Petri Net (GSPN) behavioural model for dynamic systems.
- Develop an integrated model GSPN and Bayesian Stochastic Petri Net (GSPN-BSPN) model for online fault detection and diagnosis of single and multiple faults of complex dynamic systems
- Implement the developed GSPN-BSPN model using Coloured Peri Net tool and C++ programming language.
- Evaluate the performance of the integrated GSPN-BSPN model of the dynamic systems in terms of fault detection rate and diagnostic accuracy.

Related Works

- Taleb-Berrouane, et al. (2019) proposed a BSPN approach for offline fault diagnosis of a system using a simple hydraulic pump as a case study.
- Vileiniskis, et. al. (2016) developed a Bayesian network (BN) model for a three-phase separator system
- Lampis et al. (2010) developed an offline fault diagnostic model for water tank level control system and fuel rig system using BN

Proposed Methodology

- The GSPN-BSPN methodology operates in two integrated modules (Module I and II).
- Module I uses GSPN to model the operational and failure behaviour of the dynamic system.
- The GSPN model establishes the causal relationships between component failures and system behaviour, identifying the faulty system state in the event of single or multiple faults.
- Module II consists of a diagnoser model developed using BSPN formalism, which traces the paths leading to the faulty state identified by the GSPN model in Module I.
- A GSPN model (Module I) for a water tank level control system is presented in the following section.

Operational GSPN Model of a Water Tank Level Control System

- The aim of the water tank system is to maintain the level of water in the tank at a required level.
- A GSPN behavioural model of the water tank system under normal and faulty operational modes was developed (Figure 1).

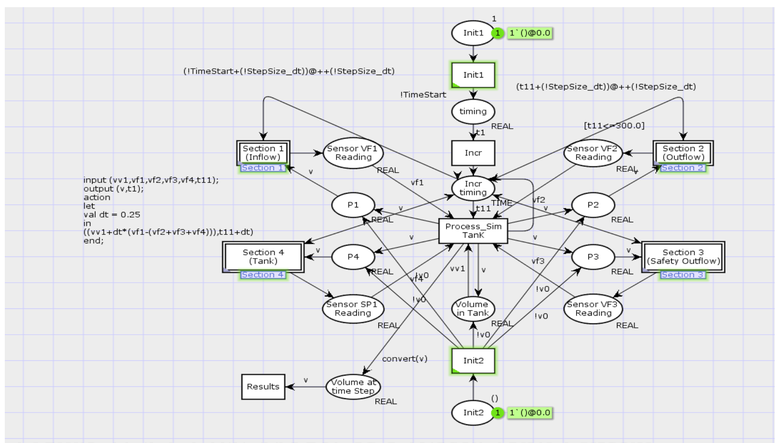
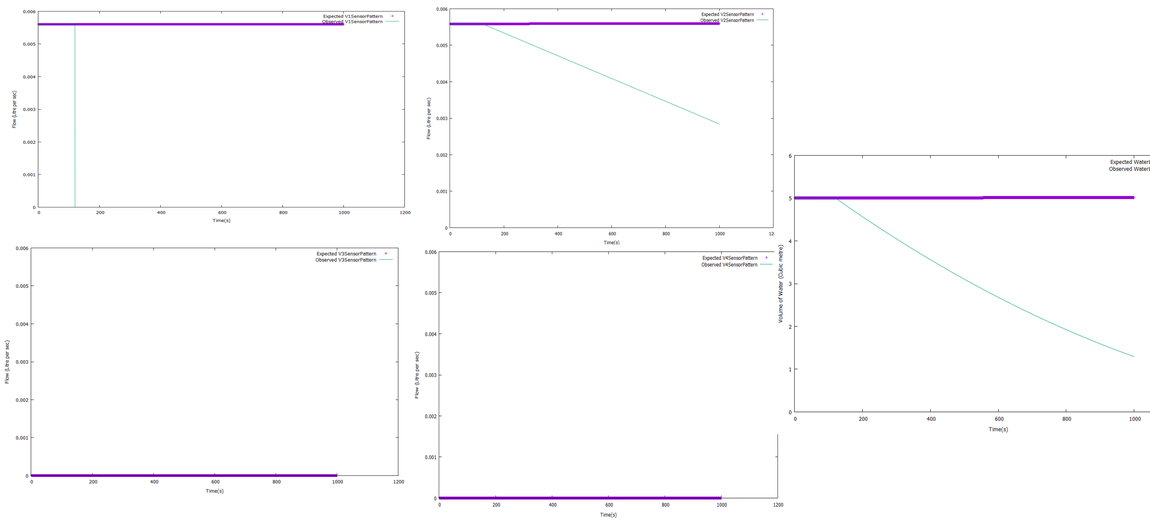


Figure 1: A GSPN Model of a Water Tank System

- With the initial volume of water inside the tank set to 5.0 m^3, the following figures shows the sensors readings observed on the system when Valve V1 had failed closed at 120 secs (2 mins).



Conclusion and Future Work

- The Module I of the proposed GSPN-BSPN model of a dynamic system has been achieved for a simple dynamic system (water level control system).
- The results presented shows the flexibility of using Petri net formalism for behavioural model of a dynamic system.
- The future work is aimed towards the complete development of the proposed integrated GSPN-BSPN model, its implementation and performance evaluation.

References

Lampis, Mariapia, & Andrews, J. (2009). Introducing Dynamics in a Fault Diagnostic Application Using Bayesian Belief Networks. 186–190.

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