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A Survey on Fault Detection and Diagnosis Models

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Abstract— The purpose of this survey is to present a critical overview of Fault Dependency (D)-matrix. And also focus on the ontology based text mining methods. Fault dependency (D)-matrix is an organized diagnostic model to pinch the graded system-level fault analytic information including the dependencies between identifiable symptoms and collapse modes connected with a system. Arranging this information is generally dependent on the previously known knowledge and research. But it's not enough to collect the information like symptoms, related analytical mechanism only once, since technology is improving day by day. It's challenging task to regularly inform the D-matrix to have best results. There is need to gather information regarding servable symptoms and collapse modes to modify the fault dependency matrix which can be helpful to build accurate and efficient fault diagnosis. Several existing works have been done by researchers to overcome all these issues.

Keywords— Data Mining, information retrieval, text processing, fault analysis, fault diagnosis.

I. INTRODUCTION

The increasing complexity and risk of modern control frameworks and the growing demand for quality, cost efficiency, reliability and security have led to an expanding demand for on-line automatic fault detection, isolation and accommodation capabilities in automatic control frameworks. Component failure can have disastrous effects for the operation of any framework and the outcomes can be to an extremely serious in terms of massive property damage and loss of life. For instance aircraft accidents claim the lives of many people and many accidents are the result of instrument failure.

Early detection and isolation of faults are critical tasks in present day process commercial enterprises. Numerous exploration works have been made amid a decade ago to enhance fault detection and isolation strategies. Extensive reviews of different fault detection and isolation methods can be found in the literature. Existing techniques can be gathered into three general classes: quantitative model-based methods, qualitative model-based techniques and data driven systems. Quantitative model-based systems have gotten impressive in recent years.[1] These methodologies utilize the mathematical model of the procedure to estimate its normal behavior. Differences between the assessed and the genuine conduct are side effects or blame markers. These distinctions are called residuals. In spite of the fact that, there is a comfortable relationship between the quantitative model-based procedures, onlooker based methodology have turned into the most common and vital technique for fault detection and isolation, particularly within the automatic control community.

Normally, developed system performed in its pre recognized working conditions. No need to find alternate solution for existing system until it is working accurately and gives worthy results. If the system is not as per the expectation, then we can say that this is introduction of fault in system. Identification of faults and its correction is a sub area of control designing which relate itself with managing a system, recognizing when a fault has happened, what are the reasons behind it and discover the sort of fault and its location [2]. It is important to discover the underlying driver of a

fault on the grounds since there may be possibility that other interconnected subsystems might likewise give fault indications that may conceivably shroud the underlying driver.
A complex system interfaces with its enveloping to execute a set of endeavors by keeping up its execution inside a satisfactory extent of resilience. Any deviation of a system from its satisfactory execution is managed as a deficiency. The Fault Detection and Diagnosis (FDD) are performed to find the fault and diagnose the hidden drivers to minimize the downtime of a system. Systems like On-Board Diagnostics (OBD) referring to a vehicle's self-diagnostic and reporting capability. OBD system has microcontroller based processing system which is used in automatically controlled devices such as automobile engine control systems, medical devices [3]. This system is able to diagnose faults, notify user of any abnormal condition and also indicate the cause of faults. After resolving the various problems, it is necessary to note down its causes, effect of the cause on the system in structured manner, so use this information latter while developing the system so as to make it perfect.

II. LITERATURE SURVEY

In [2] ontology is utilized to improve the exchanging-study capacity between heterogeneous frameworks and acknowledging authentic knowledge trade. As the information establishment of the entire framework, an ontology knowledge library ensures the acknowledgment of a higher-level knowledge trade. In order to expand an ontology method for the failure diagnosis of power transformers, it is important to investigate various concepts and relationships shown for force transformers. This work proposes a power transformer fault diagnosis system with ontology, which is concerned as a part of power system ontology. This ontology gives a semantic model to information representation also, data administration. It can be utilized to integrate a number of transformers diagnostic strategies, for example, transformer thermal checking and conclusion, dissolved gas examination, partial discharge analysis and frequency response analysis and so on.

In [3], author proposed a development methodology which utilizes the graph-theoretic representations of Timed Failure Propagation Graph (TFPG) pattern and present analysis on recently established diagnostic ontologism to decide measurable inconsistencies between that which is expected by the models and that which has been encountered in practice. These disparities are then analyzed to generate recommendations for developing the analytic models. Development recommendations include recognizing new dependencies and erroneous or tenuous dependencies.

In [4], M. Schuh at.el, developed a tool that encourages knowledge discovery from aircraft maintenance information through sequences of maintenance events. A few inter joined ontologisms were developed in OWL, based on properly described IEEE guidelines, also, use these ontologism to guide the data transformation, data mining, and interactive visualization processes. The instrument gives a simple to-utilize interface that makes pertinent arrangements of information in a noteworthy setting in a small amount of the time it would take area specialists to recover and show comparable data. They present an up-to-date overview of the current tool and extensions, which now includes several visualization options, ties together several ontology-based data sources, and enables a method of obtaining diagnostic maturation recommendations.

In [5] Prof. P. M. Frank proposed a Fault Detection and Isolation (FDI) approach which is based on analytical redundancy to achieve maximum robustness by decoupling the effects of faults and errors. But analytical redundancy-FDI method is applied on non-linear discrete time systems only.

Ontology-based error identification for power transformers by Prof. D. Wang which involves integration of methods using ontology for monitoring and diagnose power transformer faults. But the

ontology based diagnostic method lack in efficiency and veracity of fault diagnosis for power transformer [6].

An ontology model is developed for accurate and efficient fault diagnosis for power transformers. Through the use of this model, various transformer fault diagnostic methods can be integrated to describe and inference among fault phenomena, fault sources and causes of faults. In previous, the new concepts can be added into the ontology based on domain [7] but it requires some methods for evaluating and updating the result. So, it is very lengthy process.

In [8], S. K. Lukins at.el, focused on content clustering utilizing regular item sets. The principle commitment of this work is three manifolds. First, they exhibit a review on existing methods for record clustering utilizing frequent pattern. Second, another strategy called maximum capturing is proposed for document clustering. Third, tests are completed to assess the proposed technique in comparison with CFWS, CMS, FTC and FIHC methods. Moreover, topics produced by Maximum Capturing distinguished clusters from each other and can be used as labels of document clusters.

In [9], S.Singh, at.el, focused on Latent Dirichlet Allocation (LDA), a generative probabilistic model for accumulations of discrete data, for example, text corpora. LDA is a three-level hierarchical Bayesian model, in which each set of an accumulation is demonstrated as an infinite mixture over a hidden arrangement of subjects. In the connection of content demonstrating, the subject probabilities give an unequivocal representation of an archive. They exhibit effective rough inference techniques in view of variation methods and an inference technique for exact Bayes paper estimation. They convey text classification, and collaborative filtering, also, community oriented sifting, contrasting with a mixture of unigrams model and the probabilistic LSI model.

In [11], author proposed a novel mechanism for identifying the possible causes of process disturbances by utilizing the signed directed graph (digraph) representation of process interactions. The analysis is depending upon the forming logical statements which are discovered from the process digraph these are evaluated using on-line data to generate the diagnosis.
According to the rule-based approach, the diagnostic criteria are characterized explicitly, not hidden by a complex algorithmic procedure. This allows the diagnostic rules to be tailored to imitate the best available knowledge of plant behavior. The rules generated by this technique can be incorporated with other rules on plant operations using an expert systems framework.

In [12], proposed the new framework for developing the parity equation that prevents erroneous isolation decision in under marginal size failure. This method can be applied to single additive type failures on measured input and outputs variables.

In [13], authors build a corresponding bank of adaptive observers for Fault Detection and Isolation (FDI) purposes in a class of nonlinear systems with parameter uncertainties. Additionally, analysis of the effect of various faults on the measurements is presented. The results of this analysis would have a direct ramification on the minimum number of observers that may be required for FDI purposes.

III. SYSTEM ARCHITECTURE

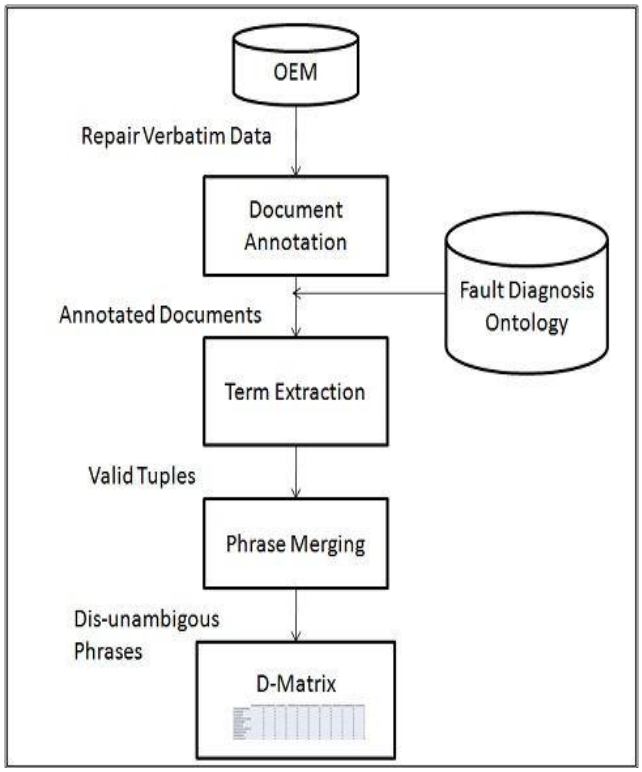

Fig.1 Text-Driven D-Matrix Development Methodology From Unstructured Text.[14]

A. Fault Diagnosis Ontology

Ontology is a mechanism that describes the concepts and also the relationships that hold between those concepts observed in the domain of vehicle fault diagnosis. In order to increase an ontology method for the error diagnosis of automobile systems, it is necessary to analyze numerous concepts and relationships exhibited.

B. Ontology-Based Text Mining

i. Document annotation
The document annotation helps to filter out the information that is not related for analysis and it provides a specific background for the reliable understanding of the data.

ii. Term extraction
Using this phrase, the vital terms desirable for the development of a D-matrix, i.e., symptoms and failure modes are extracted by using the term extractor algorithm.

iii. Phrase merging
Here the same failure mode phrases that are generally written with the help of a conflicting vocabulary are merged into a single, consistent failure mode phrase using phrase merging algorithm.

iv. D-Matrix
Graph generated for 2 datasets and unique along with common patterns are found to construct resultant d-matrix.

IV. CONCLUSION

This paper surveys on various fault detection methods and present a critical overview of Fault Dependency (D)-matrix. Fault Dependency (D)-matrix is a systematic demonstrative model which is used to catch the progressive system level deficiency symptomatic data comprising of dependencies between observable symptoms and failure modes connected with a framework. D- Matrix is a time consuming process. Developing a D-matrix from first standards and updating it utilizing the domain information is a work concentrated. Further, in-time increase of D-matrix through the disclosure of new symptoms and failure modes watched for the first run is a challenging task.

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