UNIVERSITI TEKNOLOGI MARA

CORRELATION ANALYSIS AND PREDICTIVE PERFORMANCE BASED ON KNN AND DECISION TREE WITH AUGMENTED REALITY FOR NUCLEAR PRIMARY COOLING PROCESS

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ABSTRACT

Efficient and safe maintenance of nuclear reactors hinges on the optimal condition of critical components, particularly the primary cooling system governed by sensor, pump, and valve conditions. The intricate nature of these systems demands a well-managed maintenance program, prompting the need for a comprehensive characterisation of the primary cooling system. This study addresses the challenges posed by traditional maintenance approaches within nuclear power plants, where lengthy procedures and a laborious working process hinder the timely identification and resolution of potential operational issues. Practical algorithms incorporating k-nearest neighbour and decision tree models with quantifiable performance metrics are proposed to streamline and optimise the maintenance process. The study aims to enhance the monitoring and maintenance of the primary cooling system through a multifaceted approach. Firstly, descriptive and correlation analyses characterise the primary cooling system based on temperature, flow, and conductivity data. These analyses provide nuanced insights into system operational dynamics and efficiency. Subsequently, predictive models employing k-nearest neighbour and decision tree algorithms are constructed and evaluated based on accuracy, precision, and recall metrics. Furthermore, the research introduces an innovative augmented reality application utilising a 3D marker-based technique. This application, integrated with a predictive model, offers real-time visualisation of primary cooling system characteristics through handheld devices. The study presents promising results, showcasing the effectiveness of the predictive model in fault detection and the initial design of an augmented reality application. Results include descriptive and correlation analysis revealing crucial primary cooling system data patterns. Predictive modelling using k-nearest neighbour demonstrates high accuracy, precision, and recall metrics, while decision tree modelling raises considerations for further refinement. The early design of the augmented reality application exhibits potential for real-time data visualisation, providing insights into optimal detection distances and angles. This research lays the foundation for future investigations into integrating methods for stable augmented reality applications in cooling systems. The findings contribute significantly to predictive maintenance practices, offering a comprehensive solution for efficient monitoring, early fault detection, and informed decision-making in nuclear reactor environments.

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TABLE OF CONTENTS

		Page
CONFIRMATION BY PANEL OF EXAMINERS		**ii**
AUTHOR'S DECLARATION		**iii**
ABSTRACT		**iv**
ACKNOWLEDGEMENT		**v**
TABLE OF CONTENTS		**vi**
LIST OF TABLES		**ix**
LIST OF FIGURES		**x**
LIST OF PLATES		**xii**
LIST OF SYMBOLS		**xiii**
LIST OF ABBREVIATIONS		**xiv**
CHAPTER 1 INTRODUCTION		**1**
1.1	Research Background	1
1.2	Problem Statement	3
1.3	Research Question	4
1.4	Objectives	5
1.5	Scope of study	5
1.6	Significance of Study	6
1.7	Organization of Thesis	6
CHAPTER 2 LITERATURE REVIEW		**8**
2.1	Primary Cooling System at Nuclear Reactor	8
2.2	Important Parameter for Primary Cooling System	9
2.3	Statistical Method of Analysis	10
2.4	PdM for Primary Cooling System	12
2.5	Predictive Analysis Model	14
	2.5.1 Prediction with k-Nearest neighbour algorithm	15
	2.5.2 Prediction with Decision Tree	15
2.6	Augmented Reality (AR) to Support Nuclear Reactor	16

CHAPTER 1
INTRODUCTION

1.1 Research Background

On the Insert tab, the galleries include items that are designed to coordinate with the overall look of your document. You can use these galleries to insert tables, headers, footers, lists, cover pages, and other document building blocks. When you create pictures, charts, or diagrams, they also coordinate with your current document look. You can easily change the formatting of selected.

Since its first criticality achieve in 1982, PUSPATI TRIGA Reactor (RTP) have been in operation for more than 40 years. As with any other nuclear reactor around the world with long operation period, the problem of ageing component has become more prominent issue [1]. The ageing reactor's life expectancy must be extended due to the high demand for nuclear studies at RTP. Important components must be inspected and, if necessary, replaced on a periodic basis to maintain the reactor's safe operation [2].

Nuclear power plants rely heavily on maintenance to ensure their operation's reliability, availability, and safety. Equipment used in power plants will inevitably degrade and become less dependable over time because of continual usage. This deterioration of equipment necessitates predicting its state in the future and planning a maintenance schedule to maximise its use and enhance its effectiveness, therefore avoiding catastrophic failures in the cooling system. The development of Prognostic and Health Management (PHM) is enabled by the evolution of information technologies and the increase in data availability. It makes advantage of a component's accessible data to discover early-stage irregularities, diagnose the source, and forecast its Remaining Useful Life (RUL). Its precise and dependable forecasting has enabled for more effective maintenance planning and implementation at the most convenient times [3]. As a result, a predictive maintenance (PdM) approach has been implemented, which utilizes actual data collected from the equipment to anticipate its future condition, allowing maintenance tasks to be scheduled effectively and reducing unwanted maintenance. Machine learning (ML) is a cost-effective tool that can learn from big data collection and find correlation within it, allowing it to create a model that accurately