Enhancing Chiller Plant Modelling Performance Through NARX-Based Feature Optimization

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***Abstract*—The research focuses on the modelling chiller plants in air cooling systems of large buildings. The existing evaluation of prediction efficiency and identification of efficient components in chiller plants has been limited. The goal of this research is to develop a methodology for modeling chiller plants by utilizing key parameters from their components. The resulting model accurately simulates the actual chiller plant system and can be used by organizations to predict future events, aiding in preventative maintenance and reducing maintenance costs, especially in critical buildings like hospitals. The research process include compiling the chiller plant's history, simulating the machinery using a regression technique called NARX, selecting crucial parameters using an optimization technique (BPSO), and validating the model. This study enhances our understanding and management capabilities of these important cooling systems by addressing the challenges of efficient modeling and prediction accuracy in chiller plant systems.**

Keywords—NARX, BPSO, Chiller Plant Modelling

I. INTRODUCTION

A chiller plant is a centralized system used for air cooling in large buildings, consisting of various components such as chillers, cooling towers, pumps, and storage tanks. These components have sensors or indicators providing status information for maintenance planning and troubleshooting. Efficient operation of the chiller plant, especially in critical buildings like hospitals, is crucial to prevent unexpected failures. Previous research has focused on modeling chiller plants for preventive maintenance, but there is a lack of evaluation of prediction efficiency and identification of significant components. This research aims to address this gap by modeling the chiller plant machine using significant parameters from its components. The proposed methodology includes collecting historical data, applying a regression technique (NARX) for modeling, selecting important parameters through an optimization algorithm (BABC), and validating the model. The expected outcome is an accurate model that can simulate the chiller plant system and predict future events, providing an effective tool for preventive maintenance and cost savings for organizations and governments managing large buildings.

II. LITERATURE REVIEW

The air-conditioning component of an HVAC (heating, ventilation, and air conditioning) system is provided by a chiller plant, which is a centralized system that cools the air for a building or group of buildings. It consists of chillers, cooling towers, pumps, and storage containers for chilled water. Frequently, refrigeration plants are used to cool large office buildings, hospitals, and multi-building campuses [1]. It can be difficult to manage chiller plants due to their complexity, and it is also one of the most difficult tasks [2]. There are numerous components in the chiller plant that serve as fault-causing parameters. In order to reduce the cost of maintaining a chiller plant, a well-designed prediction model can be used to detect any pattern deviations that may occur during chiller plant operation [2].

Cyber physical state modeling is one way to understand the behavior of any intended system [3]. Having to know the behavior, prediction of any consequences can be done for preventive purpose. In this research, work is focus on modeling the chiller plant machine using regression technique. Several reviews are present to show the previous work and method relevant to modeling technique.

Several works have been reported in the area of modelling HVAC system. The works includes monitoring and predicting [2, 4]. In this works, focus is on modelling where then it can be used for prediction. Recent work on modelling chiller plant and boiler is by [4]. This work focus on predictability of failure event using data in distributed control system. A years of data is used to study and understand the behaviour of the system. The plant's operator were interviewed to understand how they handle failure events. Data from logbook were extracted to be used during modelling process. The model is design using Decision Tree, Naïve Bayes and Random Forest Decision Tree technique where it based on remaining time-to-failure. It is reported that half of the modelled failure events (from 11) could be predicted accurately. In other research, a Long Short-Term Memory (LSTM) Approach is used for modeling the input-output relation of industrial chiller plant system[1]. This is an approach of using deep learning technique for modelling a system. As report, this model then be used for load monitoring. Data collected in range of two-week period and sampled at every 5 minutes. This data then used as input to LSTM for modeling and prediction purpose. Several variant deep neural network architectures were tested such as LSTM, Bidirectional LSTM, Time Distributed Dense Layer and Deep neural Network Layers but it is no single best algorithm able to disaggregate with the best accuracy since each algorithm has their unique advantage. Another works also reports on LSTM, deep learning approach where it is used for modeling and monitoring heating and cooling equipment