Chapter 11
Deep Learning Neural Networks for Online Monitoring of the Combustion Process From Flame Colour in Thermal Power Plants

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ABSTRACT

The combustion quality determination in power station boilers is of great importance to avoid air pollution. Complete combustion minimizes the exit of NOx, SOx, CO, and CO_2 emissions, also ensuring the consistency in load generation in thermal power plants. This chapter proposes a novel hybrid algorithm, called black widow optimization algorithm with mayfly optimization algorithm (BWO-MA), for solving global optimization problems. In this chapter, an effort is made to develop BWO-MA with artificial neural networks (ANN)-based diagnostic model for onset detection of incomplete combustion. Comparison has been done with existing machine learning methods with the proposed BWO-MA-based ANN architecture to accommodate the greater performance. The comprehensive analysis showed that the proposed achieved splendid state-of-the-art performance.

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INTRODUCTION

The boilers are steam generators which convert pre-heated water into super heated steam. This high pressure super heated steam drives the turbine connected to the generator to produce electric power (Gang Lu, 2007). Thermal Power Plant (TPP) – Expansion-I at Neyveli Lignite Corporation (NLC) has two units with generation capacity of 210MW each. The boiler height is 90m and the complete firing of coal is finished within 42m. Furnace is located at the 18th metre of the boiler. Initially, heavy oil is for initial firing and subsequently the firing is enhanced by using lignite as the fuel whose calorific value is 2350 kCal/kg and fired at a rate of 189 to 230 t/hr. The burners and the flame detectors are arranged laterally. It includes six mills to crush the coal so that it becomes fine powder. The coal is also pre-heated so that it is used as the pulverized coal (G. Lu, 2009).

Existing Vs Proposed Flame Monitoring System

The present scenario at NLC consists of an infrared camcorder, automatically positioned and surrounded by a water cooled envelope, operated by a servomotor. The video captured by the camera is displayed on the CRT monitor is used for identifying the ON/OFF flame status to prevent the explosion of boiler (Pu Han, 2006). The over loading of the furnace without a flame status tracker causes the boiler to explode and is perilous (M.G. Abdul Rahman, 2004). Figure 2 shows the schematic for existing and proposed flame tracker at NLC using AI methods. An additional device is needed to send the flame video to the laptop and Cannon video splitter was used to extract the frames from flame video (Ross J. Quinlan, 1992).

BACKGROUND

ANN is a computational model that is designed in a way that the human brain analyses and processes information. It is based on Artificial Intelligent (AI) and connects various processing elements; each is similar to a single node. ANN is comprised of interconnected processing components which are called neurons (M. Kanevski, 2002). All nodes take various signals based on the internal weight as an input and produce a single output. The generated output is the input for another neuron. The architecture of ANN is categorized into different layers such as input layer, various hidden layer, and output layer as in Figure 1. The input layer accepts the input and processes it. The output layer provides the final output. The mathematical function is performed in the hidden layers and it doesn't have any direct interaction with the user (Enrique Teruela, 2005).

ANN is capable to adapt its configuration based on the internal or external data that runs over the network during the learning process. ANN has the ability to mitigate the error, possibility of recalling, and provides a high-speed data (Jay D. Martin, 2004). Therefore, it is utilized to solve the complex problem like prediction and classification. ANN has been applicable for various filed such as prediction, character recognition and data forecasting etc., ANN learning can be either supervised or unsupervised. Supervised training is one of the common neural networks training which is accomplished by providing set of sample data with the expected outcome from every sample to the neural network (Sujatha, K, 2018). Unsupervised training is as same as supervised training the only difference is it does not provide the expected outcome to the neural network. These unsupervised training is occurred when the neural network classify the input into numerous groups (Sujatha, K, 2011).