Chapter 4
Machine Learning–Driven AI System for Automated Flow Control: Simple LR and Decision Table ML Algorithms

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ABSTRACT

This chapter proposes a new concept of Designing an automatic flow controller that is based on AI and using selected machine learning algorithms. The optimum smart controller uses machine learning concept by learning the knowledge often convectional flow controller. The acquired data set is used to train the built model using ML algorithm using a software tool called Weka 3.8.5 is an open-source software suite developed at the University of Waikato in New Zealand. A model with optimum performance is built, the performance criteria analysis like mean square error, root means square error. The Weka software is used to build a model with 60% of dataset and evaluated with 40% of data set. The evaluated result is Root mean square error ranges from 0.96 to 0.0028. The correlation coefficient is equal to 1 and the percentage Relative absolute error is 0.0467% for simple linear regression and 15.869% for Decision table ML algorithms. Hence the built model functions as smart flow controller and the output of this controller will be imitating the conventional PID controller.

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INTRODUCTION

Instrumentation and process control systems witness a surge in applications. Various industrial processes, encompassing measurements such as level, pressure, temperature, flow, quality control, assembly, robotic systems, and security, employ machine vision for efficient operation. The integration of artificial intelligence (AI) contributes to achieving high performance and fostering innovation.

AI finds application across diverse domains, and the corresponding software modules often require fine-tuning to meet specific time constraints. This fine-tuning is a continuous process throughout the application's lifespan. Additionally, there arises a need to develop versions of imaging software tailored for different user classes, catering to various market niches. Consequently, it becomes crucial to create software tools that empower engineers to efficiently target an array of computational devices.

A pivotal step in this process involves incorporating a software module capable of real-time monitoring and measurement of all system parameters, ensuring seamless operation.

Implementing an intelligent controller flow controller in a flow process station simplifies the tuning process and minimizes manual errors resulting from the challenges in monitoring the controller's actions. The impact of this smart controller is assessed through real-time experiments. Its performance is then compared to that of the traditional PID controller. In the context of the flow controller, it is important to clarify the terms manipulated variables, measured variables, and control variables. While these terms are often used interchangeably in the literature, they typically refer to either input or output signals. Control variables pertain to inputs such as flow rates, pressure readings, and temperature readings, while manipulated and measured variables relate to the output signals sent to the actuator. The implementation of a smart flow controller in a flow process station employs supervised machine learning algorithms via Weka software. The resulting smart controller exhibits the same characteristics as the conventional PID controller

The closed-loop system's optimal model for system governance is clearly illustrated in the block diagram, with the stem position being measured optimally, as depicted in Figure 1. This diagram not only demonstrates improvements in the early prediction of stem position but also contributes to the seamless and uninterrupted operation of the plant. It aids in the early identification of potential issues such as backlash and stiction problems, preventing system breakdowns.

The system is designed as a cascade loop, comprising a primary and secondary loop with two controllers—one overseeing flow and the other monitoring the process's level. Managing the continuously varying setpoint and tuning a controller for process stabilization in the secondary loop poses challenges. Consequently, an

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