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IoT Based Fuzzy Logic Controller for Boiler Level Control using LabVIEW

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Abstract: In this paper, a solution is proposed for maintaining and controlling the boiler drum level in industries using fuzzy logic controller. The system firstly senses the amount of water available in the tank part and then adjusts the state of the water pump in accordance to the water level information. The inlet flow is also monitored. The software part of the project has been developed using LabVIEW. NI MyRIO is used as a controller. The monitored parameter is transferred using IoT.

Keywords: NI LabVIEW, level, myRIO-1900, IoT, IBM Watson Bluemix.

I. INTRODUCTION

Boiler is essential in many power plant and chemical industries for steam production, batch reactor and oil refining process. Maintaining the level is very important. There is a requirement to control the level of the water drum by optimal control of the flow of liquid using pump. Over the past two decades, automation has become one of the most important areas in development of Industrial processing. The significant development of Automation technology has covered several technical aspects and is due to advances in the production, computing power, testing facilities, and most importantly due to the acceptance by various industries. Drum water level maintaining is essential in boiler working. Any variation in water level may lead to the explosion of boiler. This project mainly focuses on the methodology of maintaining the boiler drum level fuzzy logic controller. The myRIO is used as the controller which is interfaced with LabVIEW, a graphical user interface. The ultrasonic sensor is used to measure the level of the water in the drum. The set point is given to the fuzzy logic controller and the set point is compared with the desired value and the speed of the 12V dc pump is controlled. By controlling the pump, the level is maintained at the set point. The flow sensor YF-S20 is used to measure the flow rate of inflow. IoT- Internet of Things is used to transfer the monitored values of the level via internet. We have shortlisted three IoT platforms which includes Google cloud, Microsoft Azure and IBM Watson. They provide a better and more secure IoT platform for the student.

II. WORKING PRINCIPLE

Fuzzy logic is a basic system which relies on the degrees of state of the input and therefore the output depends on the state of the input and rate of change of this state. In other words, it's a logic system works on the principle of assigning a specific output counting on the probability of the state of the input. Fuzzy logic is utilized in processing and various intensive applications in AI.

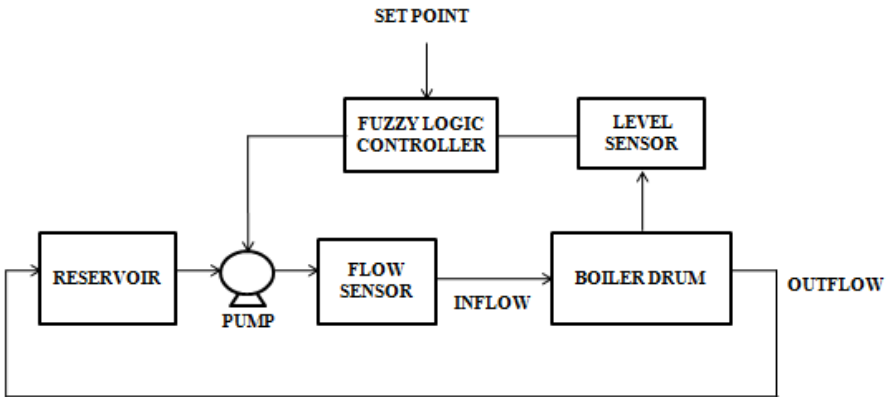

Figure 1: Block diagram of Boiler level control

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Fuzzy logic are extensively utilized in modern control systems like expert systems. Fuzzy Logic is employed with Neural Networks because it mimics how an individual would make decisions, only much faster.

In this paper we discussed the maintaining and controlling of the boiler level using Fuzzy Logic controller. Here the level and flow are the process variables. The above figure shows the block diagram representation of the boiler level control. The water is pumping from the reservoir by 12V dc submersible pump to the boiler through the pipelines. The YF-S20 is a flow sensor placed in the middle of the pipeline which measures the inflow of the boiler. The ultrasonic sensor is placed at the top of the drum which measures the level of the water. The set point is given to the controller and it controls the process variable.

The set point is given to the fuzzy controller through LabVIEW and the set point is compared with the desired value and the speed of the 12V dc pump is controlled. Here myRIO act as a controller. The setpoint is also can be varied depends on the supply and demand. By controlling the pump, the level is maintained at the set point and controlled. The inflow of the boiler is also monitored. The outflow of the boiler is feedback to the reservoir. It is a cyclic process of maintaining of the boiler drum level.

III.THE STRUCTURE OF FUZZY CONTROL

A simple fuzzy logic system is implemented in LabVIEW. The LabVIEW allows the user to select an input value, and output value is calculated and displayed based on the fuzzy system. The input signal is defined with five fuzzy set are uniformly spaced between 4-10. The output signal with five matching fuzzy set between 0-1. The fuzzy set rules are implemented. A one to one mapping exists between the input set and the output set. The system test is very useful in visualizing the input-output relationship. The fuzzy system file is loaded into LabVIEW. The fuzzy system controller implements the rule defined in fuzzy system file. The program takes crisp input value and produces a crisp output value which is based on the fuzzy system.

Fuzzification is the process of changing a real scalar value into a fuzzy value. This is achieved with the different types of fuzzifiers (membership functions) Fuzzification. Fuzzy Linguistic Variables are used to represent qualities spanning a particular spectrum. Fuzzification is the first step in the fuzzy inferencing process. This involves a domain transformation where crisp inputs are transformed into fuzzy inputs. Crisp inputs are exact inputs measured by sensors and passed into the control systems for processing, such as level. Fuzzification is the process of making a crisp quantity fuzzy.A membership function(MF) is a curve that defines how each point in the input space is mapped to a membership value between 0 and 1.

They produce fuzzy results which usually have to be converted into crisp output. To transform the fuzzy results in to crisp, defuzzification is performed. To transform the fuzzy results in to crisp, defuzzification is performed. Defuzzification is the process of converting a fuzzified output into a single crisp value with respect to a fuzzy set. The figure 4 shows the linear input output relationship of the boiler level control.

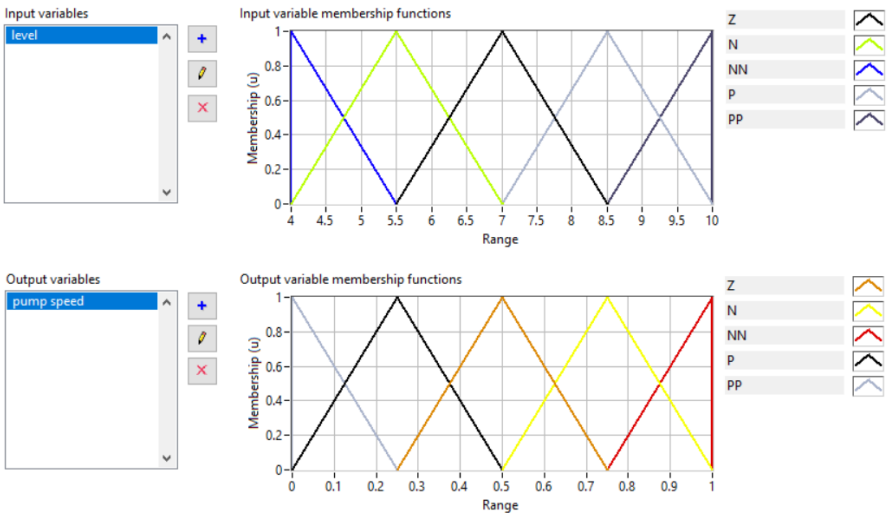

Figure 2: LabVIEW fuzzy system

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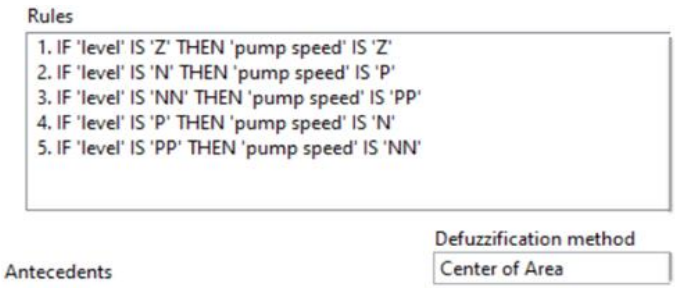

Figure 3: Fuzzy set rules

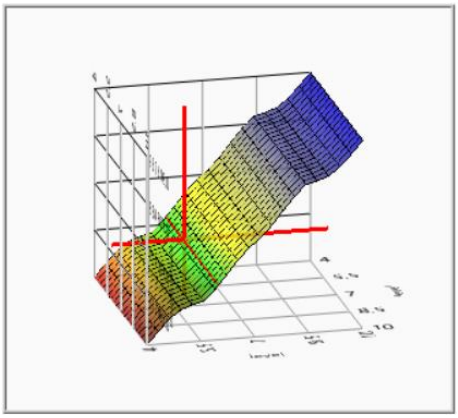

Figure 4: Input – output relationship

IV. MEHODOLOGY OF THE LEVEL CONTROL PROCESS

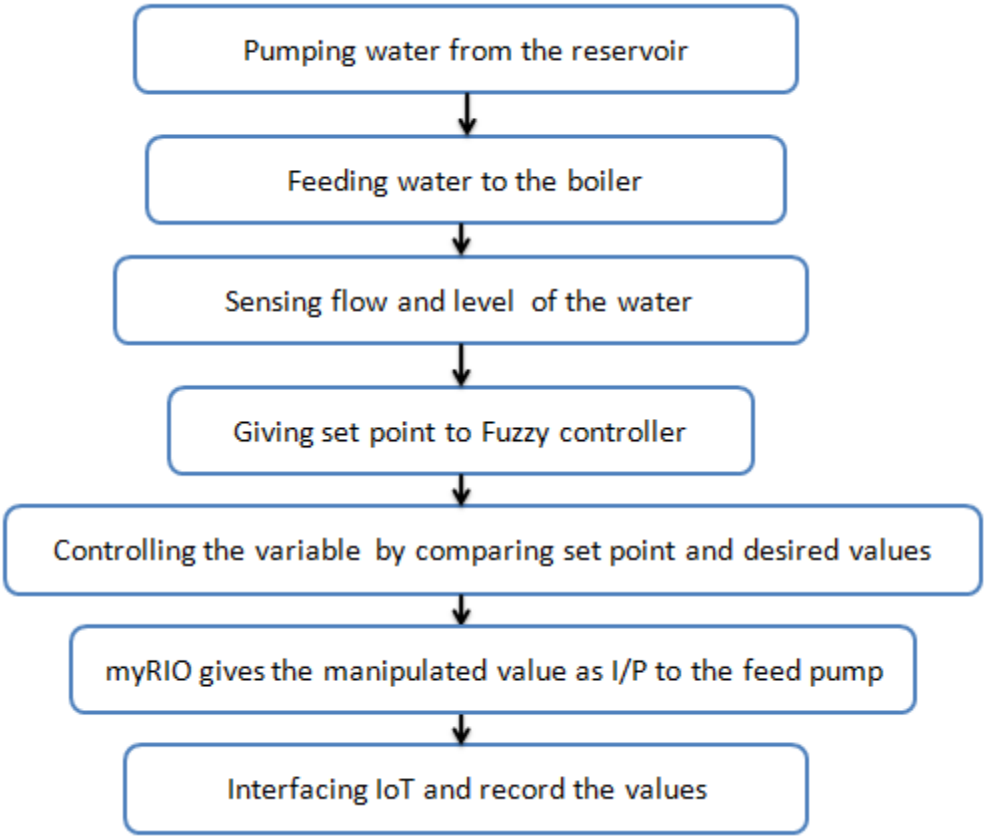

Figure 5: Methodology of the process

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IV. SCHEMATIC DIAGRAM

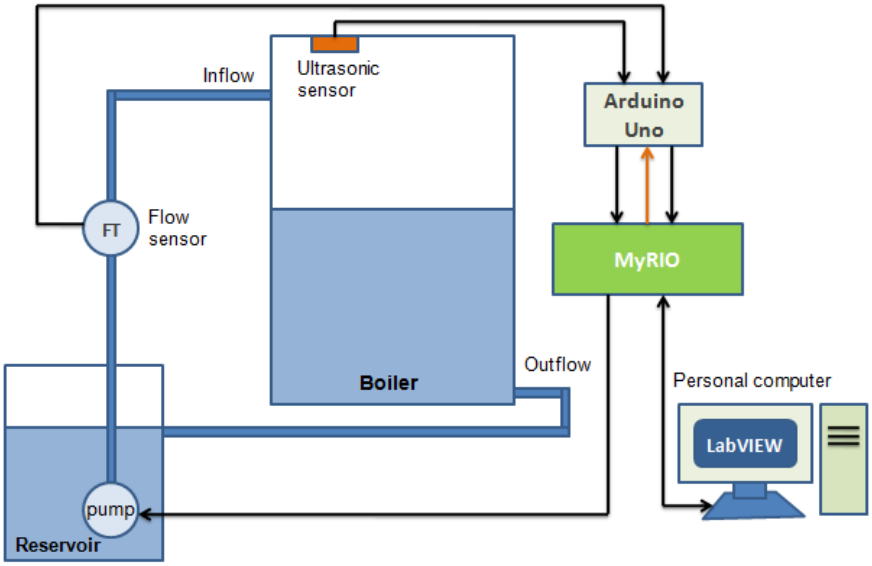

Figure 6: Schematic diagram for boiler variable management

The above figure is the schematic representation of boiler level control. The flow of the process is shown clearly in this figure. The water from the reservoir is fed to the boiler by using 12V dc pump. The flow sensor is placed between the reservoir and boiler. The ultrasonic sensor is placed at the top of the boiler to measure the level. The outflow of the water from the boiler is feedback to the reservoir. The output signal of ultrasonic and flow sensor are given as the input to the Arduino Uno controller.

The power supply for Arduino is given by MyRIO controller. The Arduino and MyRIO are interfaced to transfer the signal to each other through UART. The set point was already initialized in the Fuzzy controller. Fuzzification is the first step in the fuzzy inference process. This involves a domain transformation where crisp inputs are transformed into fuzzy inputs. The output signal of level sensor from the MyRIO controller is compared with the fuzzy value. The difference between these values varies the speed of the pump. The defuzzified value in FLC represents the action to be taken in controlling process. The myRIO is interfaced with the LabVIEW. The LabVIEW is a software to display the manipulated value of the level. IoT is used to transfer the data from the measurand.

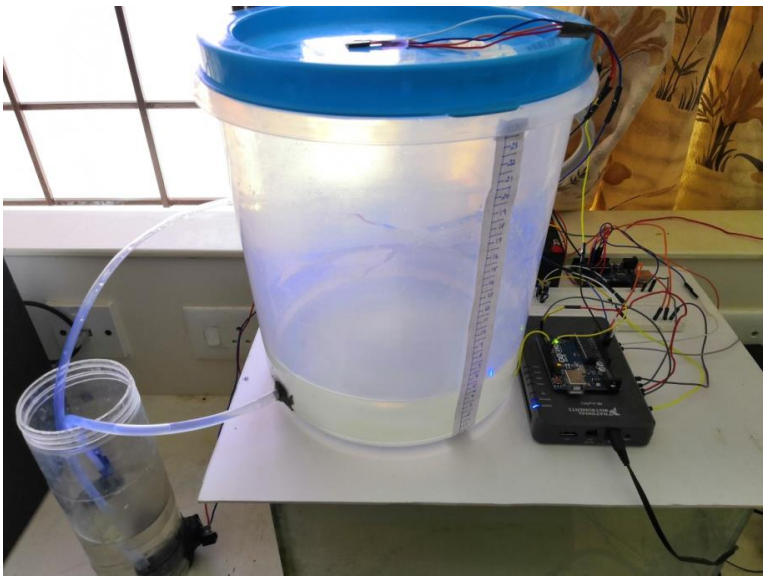

Figure 7: Experimental setup of Boiler level control

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VI. RESULT AND DISCUSSION

The designed LabVIEW front panel is shown in Figure 8. The level of the boiler drum is measured using ultrasonic sensor is displayed in the front panel. The fuzzy value is initialized in the fuzzy controller. The measured value from the ultrasonic sensor is compared with the fuzzy value and controls the level of the boiler by varying the speed of the pump. The PID controller is used to control the speed of the pump. The 12V battery is used as a power source to the pump. The inflow of the boiler is measured using flow sensor. Flow rate is displayed through the output indicator in the front panel. Depends upon the supply and demand the set point will be varied. The IoT is used to transfer the data by network.

VII. CONCLUSION

The level of the boiler is measured and controlled by 12V dc pump using MyRIO controller. The inflow of the boiler is monitored by the controller using Arduino Uno which interfaced with MyRIO controller. Based on the methodologies proposed in this research for the fuzzy logic controller for Boiler level control the level can be controlled. The solutions are non-linearity and boiler dynamics, guaranteed smooth, quality to the consumer. Figure 8 contains the LabVIEW front panel of the boiler level control using fuzzy controller. The controlled output values are displayed in the IoT platform which is represented by figure 9. The defuzzified value in FLC is to be taking action in controlling process. By this, the efficiency of the boiler drum level is improved.

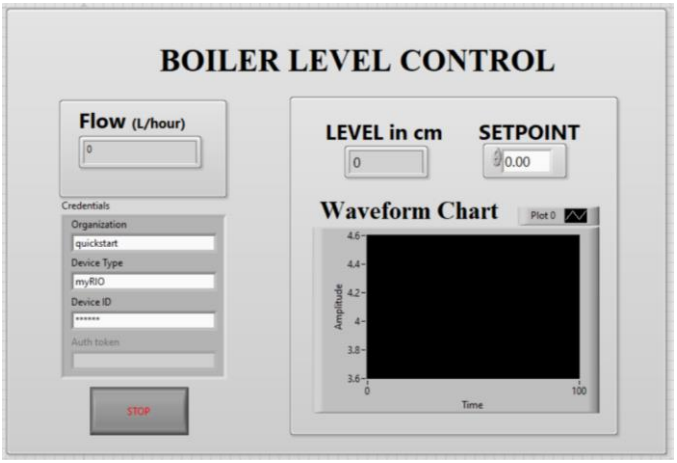

Figure 8: LabVIEW front panel of Boiler level control

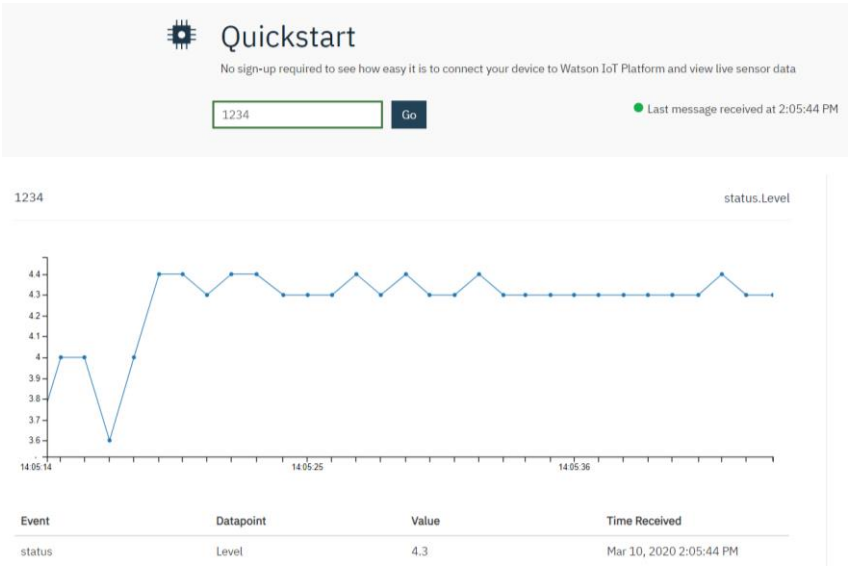

Figure 9: IBM QuickStart IoT platform to monitor level controlled output

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