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PID based Flow Monitoring using IoT

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ABSTRACT—

This paper presents a novel approach to flow monitoring using Internet of Things (IoT) technology, specifically focusing on the application of Pid software. The proposed system leverages the power of logical controllers like PID, Fuzzy logic and IMC..., thereby replacing traditional physical instruments with virtual counterparts. The system inputs, namely the liquid flow and outflow rate, are obtained via the MyRIO from the tank flow sensor DPT and flow rate sensor respectively. These inputs are analyzed on Pid, and the resulting decisions are transferred to the MyRIO, which manipulates the actuator. The system demonstrates promising performance in simulations, and hardware experimentation validates the feasibility of controlling a MyRIO, using Pid. This research contributes to the growing field of IoT-based monitoring systems, offering a reliable and efficient solution for flow monitoring.

Keywords— Pid, MyRio, Flow Monitoring, PID controller, IoT, MATLAB.

Introduction

In recent years, the fusion of Internet of Things (IoT) technologies with a multitude of applications has transformed the methodologies for system monitoring and control [1]. One such application is the surveillance and regulation of flows in industrial operations, where precise and real-time data is vital for sustaining operational productivity and guaranteeing safety. This paper introduces a Pid-based flow monitoring system utilizing IoT, amalgamating the capabilities of Pid for data procurement and analysis with the connectivity and remote access features of IoT [1][3].

The proposed system exploits Pid, a robust graphical programming environment extensively employed for measurement and automation applications, to devise a comprehensive solution for flow monitoring. Pid furnishes an intuitive and user-friendly interface for the design and implementation of monitoring systems, making it an optimal platform for this project.

By incorporating Pid with IoT technologies, the system facilitates remote monitoring, data logging, and real-time alerts for flow measurements, thereby augmenting the efficiency and convenience of flow monitoring procedures. The IoT component of the system enables uninterrupted connectivity between the flow monitoring devices and the central monitoring station. Utilizing IoT protocols and communication standards, the flow data gathered from sensors can be securely and efficiently transmitted to a cloud-based platform or a local server [2]. This facilitates centralized data management, remote access, and real-time visualization of flow measurements, providing operators and stakeholders with invaluable insights and enabling immediate actions based on the monitored data [2][3].

The Pid-based flow monitoring system using IoT holds significant potential for various industries, including manufacturing, chemical processing, water treatment, and more. By implementing this system, operators can benefit from real-time flowdata, proactive monitoring, and enhanced decision-making capabilities[5][4]. The IoT connectivity ensures that critical flow information is accessible from anywhere, enabling remote monitoring and control, reducing downtime, and optimizing resource allocation. In conclusion, this paper introduces a Pid-based flow monitoring system using IoT, merging the versatility of Pid with the connectivity and remote access features of IoT [1][7].

The integration of Pid and IoT technologies provides a comprehensive solution for flow monitoring, allowing for real-time data acquisition, centralized data management, and remote access to flow measurements. The proposed system has the potential to significantly enhance efficiency, safety, and decision-making in various industrial processes that rely on accurate and timely flow monitoring [1][2][5].

EXISTING SYSTEM

A. Controller:

For effective regulation of a flow process, a flow transmitter or sensor necessitates significant user intervention. A flow control system incorporates a controller that receives information from the flow transmitter for this purpose. The controller generates an output to a control valve after juxtaposing the set point, also referred to as the intended control flow, with the actual flow.

When selecting a controller, it is essential to consider factors such as the type and flow range of the input sensor (flow transmitter). The utilization of proportional, on/off, or PID control algorithms is necessary. Once the model has been established, control methods are indispensable to maintain the process in a steady state.

B. Drawback of this system:

Instrumentation engineers bear the responsibility of overseeing and managing numerous operations within the existing system. The intricacies of text-based programming in contemporary technology pose challenges in exhibiting real-time simulation and identifying and rectifying issues. The Pid software emerges as a solution to these challenges, accelerating and simplifying processes. Flow control measures typically involve a progressive cooling process, implying that the power of the Control valve must be diminished or completely turned off when the water flow decreases.

METHODOLOGY

Water flow control is the process of measuring or detecting changes in water flow as well as altering the amount of energy entering or leaving the water to obtain the desired flow in the process tank. The PID algorithm is used to control the flowin the process. It consists of water supply tank (sump), pumps, flow transmitter, transparent flow tank, rotameter, pneumatic control valve, I/P converter and interfacing unit. It also senses the current signal and sends it to the display box. The current to pressure converter converts the current signal (4-20mA) to pressure signal (3-15psi). The control valve is used to adjust the flow. The purpose of Flow Transmitter is to sense the flow and produce an output current. One component of this strategy is the use of Pid software, which has improved features that allow ongoing process monitoring even after the process variable reaches the set point. When the process variable varies, the parameters automatically adapt to the new conditions, resulting in the desired result. The IOT module will be connected to the microcontroller for the real time monitoring purpose.

1) need for this project:

In today's market, real-time monitoring, simple control over multiple variables, and prompt defect detection and correction are essential. The cooling process takes time, so the system needs to be sped up.

2) design of pid controller:

A PID controller is majorly used in industry where heating and cooling processes are controlled like fluid flow monitoring and control, flow control etc. Defining Set point and Process variable is considered to be the primary parameter for control. A process variable is the one which needs to be controlled and set point is the desired value for the parameter, you are controlling. A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID (proportional-integral-derivative) controllers use a control loop feedback mechanism to control the process variables and it is the most accurate and controller show in fig 1. PID controllers have three modes of control:

1. Proportional (P) Control

2. Integral (1) Control

3. Derivative (D) Control

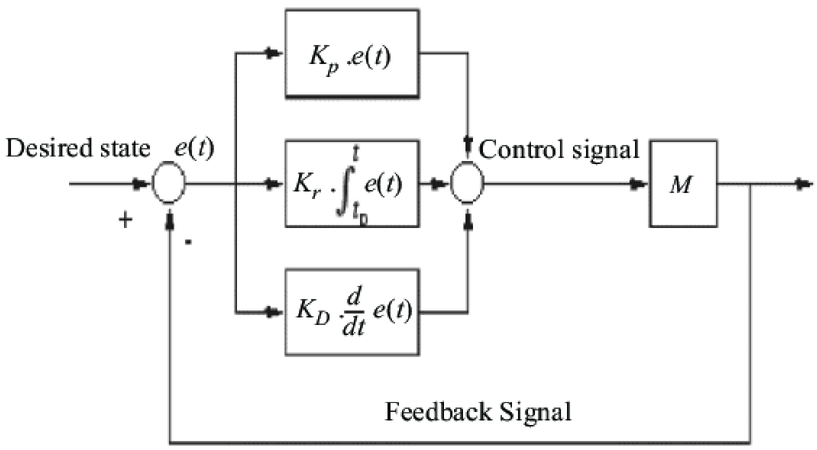


Fig 1: Block diagram of PID controller

3) PID controller TUNING:

The PID controller, a traditional tool, is widely employed across numerous process industries. While the representation or implementation of the process may differ, the PID controller continues to demonstrate its efficiency. PID control operates at the most fundamental flow, with set points being provided by the multivariable controller to the lower-flow controllers. As such, the PID controller can be aptly described as the “bread and butter” of control engineering, serving as a vital instrument in every control engineer’s toolkit. There are thousands of tuning methods available for PID controllers. For this particular process model, methods such as Ziegler Nichol’s, Tyreus Luyben, Internal Model Control, and Genetic Algorithm have been utilized.

4) By Ziegler Nichol’s METHOD:

Introduced in the 1940s, PID technology had a significant impact on control engineers regarding process control. The Ziegler-Nichols method, a technique that offers improved performance, ease of use, and low cost, is widely used. Despite its widespread use, engineers have been hesitant to adopt it due to concerns about stability. The Ziegler-Nichols method is a heuristic tuning rule that aims to provide efficient values for processes that incorporate a PID controller. Using this method, PID loops are employed in practical applications to enhance performance. This method necessitates the determination of Ku (ultimate gain) and Pu (ultimate time period). To ascertain these values, bode plots and root locus are required, which can be generated by coding in an M-File. The method provides a table for finding Kp, Ki, and Kd values by substituting the determined Ku and Pu values from Table 1.

Control modes	k_p	τ_i	τ_d
P	1/K (τ/α)	-	-
PI	0.91/K (τ/α)	3.33α	-
PID	1.2/K (τ/α)	2.0	0.5

Table 1: Formulae for Ziegler Nichol

5) Mathematical model of the process tank:

Liquid or fluid is supplied from a supply tank or main tank via a pump, with the flow rate being modulated by an actuator or control valve. The supply tank or main tank liquid flow is gauged through a pressure transmitter, which conveys the differential pressure signal (4-20mA) to the controller. The system’s mathematical model is encapsulated by a first-order system.

(In general): Ratio of accumulation of mass in system = Ratio of mass entering system – Ratio of mass leaving system

$$\frac{d(\rho Ah)}{dt} = \rho \mathrm{Qin} - pQout$$

For first order transfer function for the process control system is defined as:

(In general): $\frac{H(s)}{Q(s)} = \frac{R}{[\tau s+1]}$

(For Flow process): $\frac{H(s)}{Q(s)} = \frac{1.86}{[52s+1]} * \frac{-2.5s+1}{2.5s+1}$

6) PID values from ZN Method:

By using the transfer function, obtain Ku values in using MATLAB software and using of formula from the table 1 to calculate the optimal values of PID controller using of ZN method. The values are inserted in the table 2.

Control modes	k_p	τ_i	τ_d
P	23.97	-	-
PI	21.97	1.63	-
PID	28.76	3.59	57.53

Table 2: Formulae for Ziegler Nichol

$P_u = 2\Pi/\omega$. And $P_u = 14.17$.

7) Internet of Things:

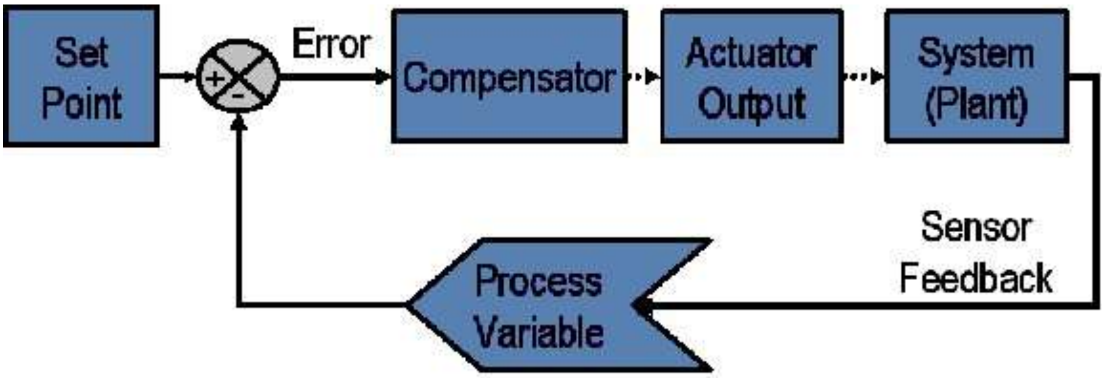
The term "Internet of Things" (IoT) describes a network of actual physical objects, including cars, appliances, and other items, that have sensors, software, and network connectivity built into them. These systems continuously monitor temperature flows by utilizing real-time sensors that are integrated inside the surroundings.
Cloud computing is used to transmit the data that these sensors have gathered to a centralized monitoring platform.

IoT flow Control System Components: The Thing Speak web portal is utilized in the process of monitoring flow. To obtain the data, the MyRio and IOT module are connected.

How It Operates: To maintain a constant temperature range, establish a flow setpoint and hysteresis. Make a PID VI and add parts to read Thing Speak palette data. Configure the Thing Speak connection by entering the channel ID and API key. Connect the output Data from the IOT device to the input of the VI. Run the VI and the data to be monitor will be sent to the application.

HARDWARE IMPLEMENTATION

Hardware implementation consists of having close loop-controlled system like fig 3 show. The main component of flow process control is, Flow tank with measurements, Controller or MyRIO, Control valve and converters for signal converting process.



.Fig 3: Block diagram of flow process control

By using of fig 3, the flow transmitter as using of differential pressure transmitter which using of differential pressure in tank pressure and atmosphere pressure, MyRIO kit act like controller which hold controller algorithm and data acquiring from sensors and transducer and Final control elements as control valve which an actuator to control the inflow and outflow of the flow process control.

Fig 4: Real-time Implementation of flow process.

The fig 4 show the implementation and hardware setup of the process station and which is directly connected to PC for digital processing of real time data.

RESULTS

The outcomes of the IoT-integrated, Pid-based flow monitoring system are detailed herein. The system was deployed and assessed in an authentic industrial setting to gauge its efficacy and performance in flow monitoring. Real-time Flow Monitoring: The Pid-based system proficiently accomplished real-time tracking of flow measurements from an array of sensors. The system exhibited precise and current data on the flow status, enabling operators to supervise the flows in real-time. Data Visualization: The potent visualization tools of Pid were harnessed to construct graphical interfaces and dashboards for visualizing flow data.

The system offered lucid and informative displays of flow measurements, facilitating easy interpretation of information by operators. Remote Access and Control: The incorporation of IoT technologies facilitated remote access to the flow monitoring system.

Authorized personnel could monitor and regulate the flow measurements from any location using web-based interfaces or mobile applications. The system guaranteed secure access and permitted remote adjustments or receipt of notifications/alerts based on specific flow thresholds. System Integration and Scalability: The Pid-based flow monitoring system was successfully amalgamated with pre-existing industrial control systems, thereby augmenting the overall monitoring capabilities.

The system exhibited scalability by accommodating the addition of more sensors and the expansion to monitor multiple locations or processes. Performance Evaluation: The performance of the Pid-based flow monitoring system was appraised based on several metrics, including the accuracy of flow measurements, response time, system reliability, and the user-friendliness of the interface. The system met the desired performance criteria and provided reliable and accurate flow monitoring result are show in fig show in 5 and 6.

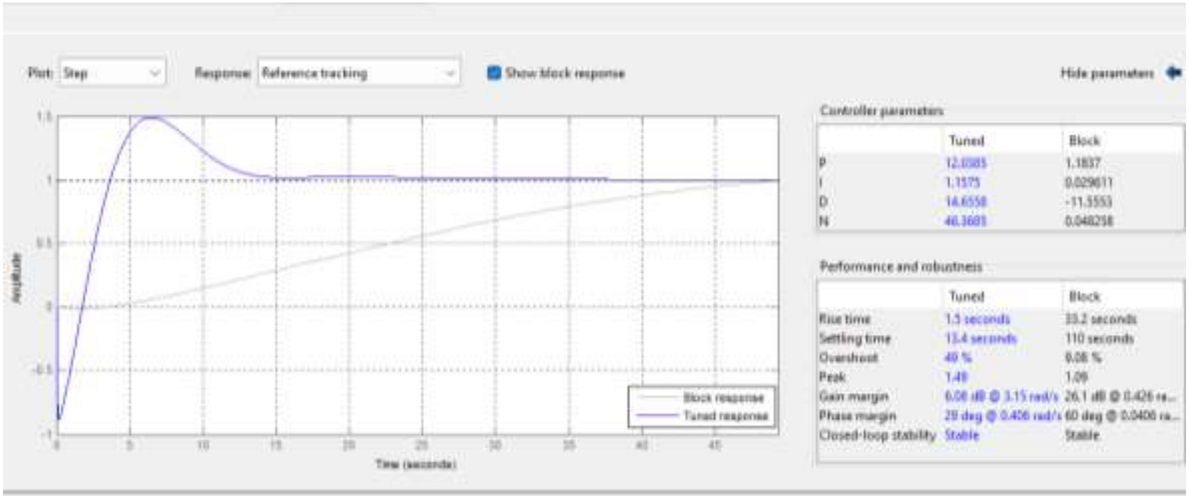


Fig 5: Output response of the PID controller.

Fig 6: Command center to cloud

CONCLUSION

The deployment of the IoT-integrated, Pid-based flow monitoring system in an industrial environment has demonstrated its substantial efficacy and robust performance. The system's capability for real-time flow monitoring has proven to be precise, providing operators with up-to-date information essential for effective supervision. The utilization of Pid's advanced visualization tools has resulted in the creation of intuitive graphical interfaces, significantly enhancing data interpretation and decision-making processes. Moreover, the integration of IoT technologies has revolutionized the accessibility of the monitoring system, enabling remote oversight and control. This feature not only adds convenience but also ensures operational continuity by allowing prompt responses to threshold-based alerts.

The system's seamless integration with existing industrial control systems and its inherent scalability underscore its adaptability and potential for broader application across various monitoring scenarios. The comprehensive performance evaluation of the system underscores its reliability and accuracy in flow measurements, coupled with a user-friendly interface that facilitates ease of use. Overall, the Pid-based flow monitoring system stands as a testament to the advancements in industrial monitoring solutions, offering a scalable, accurate, and remotely accessible option that aligns with the evolving needs of modern industries.

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