Supervision and Control of Flow Process Parameter Based on IoT

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ABSTRACT
In industries there will be many pipes carrying different types of liquids, including flammable liquids, inflammable liquids and corrosive liquids. It is important to monitor the flow rate of the liquid for enhancing the processes and to avoid the accidents. The paper proposes a methodology to monitor and control the flow rate of liquid using IoT. There are various systems to do the same process, but this is about to supervise and control the flow rate of liquid using application software and mobile application with the help of Raspberry pi. The flow rate of the liquid is measured by orifice plate based flow meter. The pulses from the flow meter are sent to Raspberry pi, a microcomputer to control the control valve which is connected to the flow station.

KEY WORDS
Flow meter, Raspberry pi, Orifice plate, Control valve, IoT.

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1. Introduction
Flow is defined as a physical property of fluid which is very critical and widely measured variable in all process control industries. In industries there will be many pipelines carrying different types of liquids including flammable, inflammable and corrosive liquids. Thus it is necessary to monitor the flow for enhancing the processes and to prevent the accidents. In the existing system SCADA system is used to monitor the flow process that operates with coded signals over communication channels. In SCADA systems process signals are transmitted to the local controller. The controller is in communication with central computer. The software performs the function of data acquisition, display and analysis. The controller settings can be changed from computer. The computer has a supervisory role as controlling is done by local controller.

The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of remote equipment for display or recording functions. In this methodology the user can notify the flow only near the flow station. Human errors may occur due to incorrect readings. This is overcome by using the concept of IoT.

2. System Overview
The system consists of the process setup which consists of supply water tank fitted with pump for water circulation. Differential pressure transmitter is used to measure differential pressure across orifice meter. The process parameter (flow) is controlled by microprocessor based digital indicating controller which manipulates pneumatic control valve through I/P converter as shown in Fig 1. The control valve is fitted in water flow line. These units along with necessary piping are fitted on support housing designed for table top mounting. The controller is interfaced to the computer for monitoring the process in SCADA. The SCADA system is used to monitor the process that operates with coded signals over communication channels. The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or recording functions.

Figure 1 Flow process station

3. Proposed Methodology
In this paper the main objective is to monitor the liquid flow in the pipeline of industries through web server. There are many systems to do the same process but this is about monitoring of flow of liquid using the concept of IoT with the help of Raspberry Pi. The flow rate of the liquid is measured by orifice plate sensor based flow meter. The analog signals from the flow station is given as an input to the ADC (MCP 3008) where it is converted into digital pulses and sent to the Raspberry Pi. From Raspberry Pi information is sent to the cloud server which is supervised using a monitoring device. This adds an advantage such that the user can determine and control the flow rate from anywhere using the internet access.
Figure 2 Block diagram of the flow process

As shown in Fig 2, the pump intakes the water from the tank present in the flow process trainer kit. This water then passes through the orifice plate. The orifice plate measures the flow by taking the difference between the inlet pressure and the outlet pressure. This pressure is then given to the two wire differential pressure transmitter which converts the pressure into 4-20 mA current. Here a 15 volt is given as an input to the pressure transmitter. I to V converter is designed where the input current is converted to voltage of 6.7 volts. Raspberry pi can produce a voltage of 3.3 volt such that divider circuit is designed to give the corresponding voltage. The analog input is converted to digital output using ADC. Interfacing of raspberry pi with MCP 3008 is done using SPI communication. The python programming is done in the raspberry pi processor according to the desired set points.

Cloud server is used to store the data for monitoring and controlling the flow rate. Thus the user can monitor the flow rate from anywhere using software in personal computers, and mobile applications. The flow chart for the entire process flow is shown in Fig 3.

Figure 3 Flow chart of Flow Process

4. Hardware Description

The hardware experimental set up for the proposed method is illustrated in Fig 4. The each component is explained in the following subsections.

4.1 Orifice Plate

An orifice plate is a sensor based device used for measuring the flow by restricting the flow. It works on the principle of Bernoulli’s principle which states that there is a relationship between the pressure of the fluid and velocity of the fluid. Whenever the velocity increases the pressure decreases and vice versa.

4.2 Pressure Transmitter

A two wire, type capacitance differential pressure transmitter is used. In this flow station model EJA110A is used to determine the flow by calculating the difference between the inlet and outlet pressure. The range is from (0-200mm) and the output is in the form of 4-20 mA current.

4.3 MCP 3008

The MCP3008 is programmable to provide four pseudo differential input pairs or single ended inputs. Communication with raspberry pi is done by interfacing the device using SPI communication.

4.4 Raspberry Pi

The raspberry pi is a series of credit card-sized single-board computers. All models have a Broadcom system on a chip (SOC), which includes an ARM compatible central processing unit (CPU) and an on chip graphics processing unit. CPU speed ranges from 700MHz to 1.2 GHz for the pi3 and on board memory range from 256 MB to 1GB RAM. The programming for the flow is done using python language. The operating system used in this project is Raspbian. A web link is created to store the corresponding flow parameter in the cloud server. This is then monitored using application software in personal computers and mobile applications.

4.5 V to I Converter

A voltage converter is an electrical power converter which changes the voltage of an electrical power source. In the proposed system a V to I converter is designed to convert the 6.7 volts to 3.3 volts since the raspberry pi can produce a voltage of 3.3 volts.

4.6 I to P Converter

The current generated from the V to I converter is used to determine the pressure at which the valve opens by using the I to P converter. The pressure is found by using the formulae

\[ \text{VALVE OPENING} = (X - 4/16 * 100) \%
\]

4.7 Cloud Server

A cloud server is a logical server that is built, hosted and delivered through a cloud computing platform over the internet. Cloud servers possess and exhibit similar capabilities and functionality to a typical server but are
accessed remotely from a cloud service provider. The cloud server setup is depicted in Fig 5.

Figure 5 Architecture of Cloud Server

5. Results and Discussions

The proposed method using Raspberry PI is simulated and the output is shown in Fig 6.

Figure 6 Result Analysis

The various process parameters of the flow of Control based on IoT is illustrated in Fig 7.

Figure 7 Monitoring using software

The mobile app also has been developed for the proposed system and the monitoring of the process control flow using mobile app is shown in Fig 8.

Figure 8 Monitoring using mobile application

6. Conclusions

Measurement of the flow of liquids is a critical parameter in many industries. The inaccurate measurement of flow leads to failure of instruments. The data from the flow station is stored in a credit card sized small computer called raspberry pi which sends the stored data to the cloud server. Any changes occurring in the flow parameter is sent to the monitoring device so that the changes in process variables can be changed frequently. Thus by using the IoT concept the flow is supervised and controlled using Mobile App and Application Software which sends the information frequently to the user.

References

