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# Embedded Based Flow Control Using Fuzzy

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**ABSTRACT**: The industrial application of flow rate measurement and control is very important and essential, especially in petroleum refineries, pharmaceutical and chemical process industries. Flow control is very important in medical appliances also. For maintaining the saline and blood flow rate is play a very crucial role in hospitals. In pharmaceutical and chemical process industries also the flow rate maintenance is essential for perfectness of medicine composition . The flow rate is measured and control is developed by implementing software programming Fuzzy.

**KEYWORDS:** Flow, Fuzzy logic, Microcontroller.

## I.INTRODUCTION

The flow measurement and control system can be developed by microcontroller using software fuzzy logic choosing Mean of Maxima method. Implementing software we the system avoid the hardware complexity and easily understood the logic application with flexibility. The total control system is most applicable in industrial applications and medical applications. The steady state error is very less to maintain the entire process in flow control system.

## II.PROCEDURE

The flow measurement and control system is developed by using flow sensor, the output of sensor which is in the form of pulses is given to the Arduino Mega2560 microcontroller implementing Fuzzy logic the PWM of the controller is given the signal to DC water pumping motor through ULN2003 current driver. The hardware system consists of different modules and explanation for each module is given in detail. They are

1. YF-S201 Flow sensor
2. Arduino MEGA2560 Microcontroller
3. ULN 2003 Relay driver
4. DC motor
5. Personal computer as display unit

**YF-S201 Hall Effect Water Flow Meter / Sensor**

This sensor placed in line with the water line and contains any simple level sensor to measure how much liquid has pumped through it. There's an integrated magnetic Hall Effect sensor that outputs an electrical pulse with every revolution. The Hall Effect sensor is sealed from the water pipe and allows the sensor to stay safe and dry. The sensor comes with three wires: red (5-24VDC power), black (ground) and yellow (Hall Effect pulse output). By counting the pulses from the output of the sensor, you can easily calculate water flow. YF-S201 Water Flow Sensor can be used to measure the flow of liquids in both industrial and domestic applications. This sensor basically consists of a plastic valve body, a rotor and a Hall Effect sensor. The pinwheel rotor rotates when liquid flows through the valve and its speed will be directly proportional to the flow rate.

**Fig 1.** YF-S201 Hall Effect Flow Sensor

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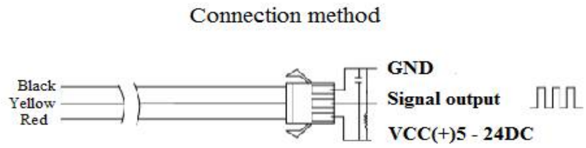


**Fig 2.** Connection for YF-S201 Flow Sensor

The flow sensor placed in line with the water line and contains a pinwheel sensor to measure how much liquid has pumped through it. There's an integrated magnetic Hall Effect sensor that outputs an electrical pulse with every revolution. The Hall Effect sensor is sealed from the water pipe and allows the sensor to stay safe and dry. The sensor consists of three wires. They are Red wire: +5V, Black wire: GND, Yellow wire : PWM. Hall-effect transistors also can be used. These transistors change their state when they are in the presence of a very low strength (on the order of 25 gauss) magnetic field. By counting the pulses from the output of the sensor, we can easily calculate water flow. Each pulse gives approximately in milliliters and the pulse rate does vary a bit depending on the flow rate, fluid pressure and sensor orientation. It will need careful calibration if better than 10% precision is required.YF-S201 Water Flow Sensor can be used to measure the liquid flow in both industrial and domestic applications. This sensor basically consists of a plastic valve body, a rotor, a Hall Effect sensor, inlet and outlet. The pinwheel rotor rotates when water or liquid flows through the valve and the speed of sensor will be directly proportional to the flow rate. The Hall Effect sensor will provide an electrical pulse with every revolution of the pinwheel rotor. The rate of water flow will be directly proportional to the number of pulses counted . The pulse signal is a simple square wave so it's quite easy to log and convert into liters per minute.

**Arduino Mega2560 microcontroller**

It is the heart of the module of the entire system. It is controlled total parameter value and provides a communication between client and server by interfacing this to the PC. The YF-S201 water flow sensor module can be easily interfaced with Arduino Mega2560 microcontroller Connect the PWM output of this module to interrupt pin of microcontroller unit and count the number of pulses or interrupt per unit time. The rate of water flow will be directly proportional to the number of pulses counted. Based on the pulses, derive an expression for flow rate in milliliter (ml). The signal which is connected to the PWM as an output signal which fed to DC pumping motor which is attached to the flow sensor through the ULN 2003 driver.

**Dc Motor**

A water pumping DC Motor which operates with +12V by 1Amp power supply for pumping the liquid. It consists of one inlet and one outlet for maintaining the Flow rate in a tank by pumping water. In this work the motor controlled by a controller line of PWM which operates with +5V/+12V by using Fuzzy with PID software. The application software for the present work developed through communication interfacing with PC and USB .One advantage of it is, its operating voltage is +5V same as controller.

**ULN 2003 Relay Driver**

The ULN2003A devices are high-voltage, high-current Darlington transistor arrays. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. It has a 2.7-kΩseries base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. The controlled signal which is followed by PWM of microcontroller is given to the input pin of the ULN 2003 driver. The output pin of it is connected to the water pumping DC motor.

**Personal Computer**

The computer is the most important and integral part of the entire control system as it plays a vital role in data acquisition, display, record, and generate graphs. The predominant interfaces between personal computer and microcontroller are USB and Ethernet. In this contest USB communication is implemented to transfer data to and from controller to PC to display and store in database. Computer is loaded with windows 2008 operating system, Arduino and Processing software.

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## III.SOFTWARE

**Algorithm**

- Initialization the microcontroller and Flow sensor
- Count the number of pulses
- Calculate the flow rate based on pulses
- By using ULN 2003 through PWM driver controller control the motors for pumping of the liquid for controlling the flow rate of the pipe.
- If the flow rate is greater than or less than the set point, the DC motor controlled by the PWM of microcontroller which is depending on the Fuzzy signal.
- If flow rate reached set point the motor will be in stable state
- Stop

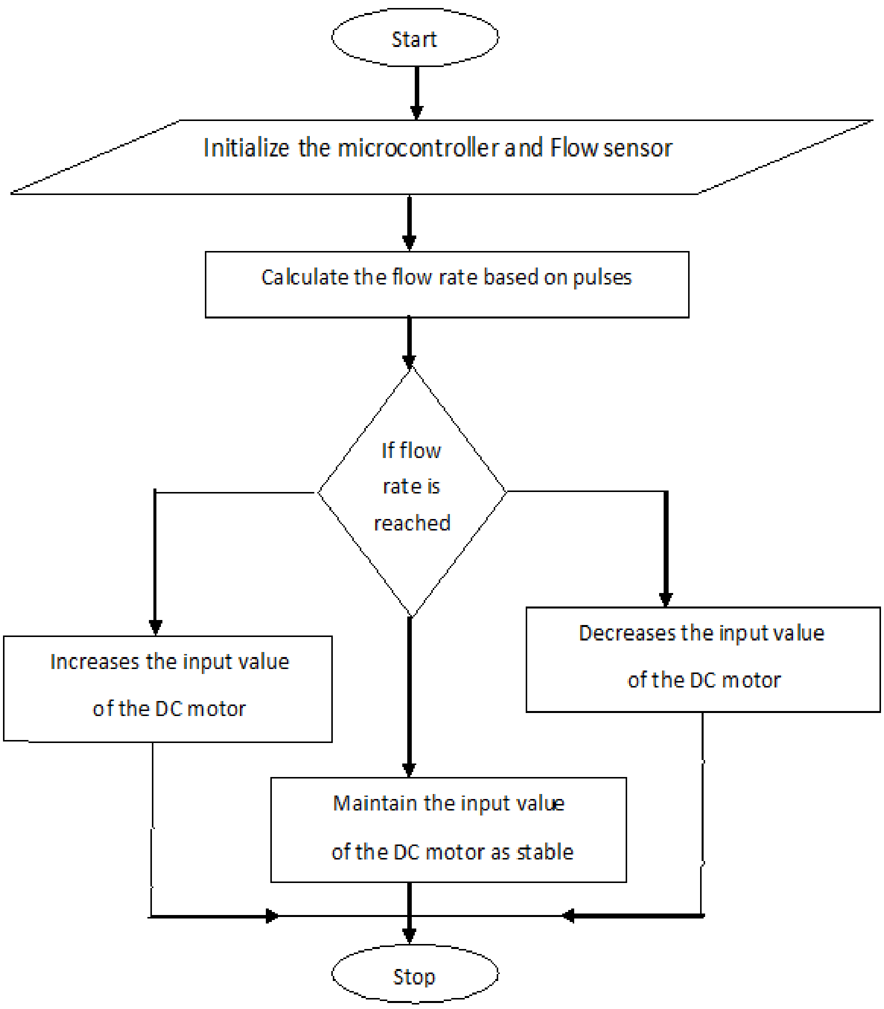


**Fig 3.** Flowchart for Flow rate measurement and control using Hall Effect sensor implemented with Fuzzy logic

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## IV.FUZZY LOGIC APPLICATION

**Table 1.** Matrix arrangement of flow

| Flow in milliliter/sec | Low | Medium | High | Very high |
|---|---|---|---|---|
| Low | No Pumping | Pumping IN | Pumping IN | Pumping IN |
| Medium | Pumping OUT | NO Pumping | Pumping IN | Pumping IN |
| High | Pumping OUT | Pumping OUT | NO Pumping | Pumping IN |
| Very high | Pumping OUT | Pumping OUT | Pumping OUT | No Pumping |

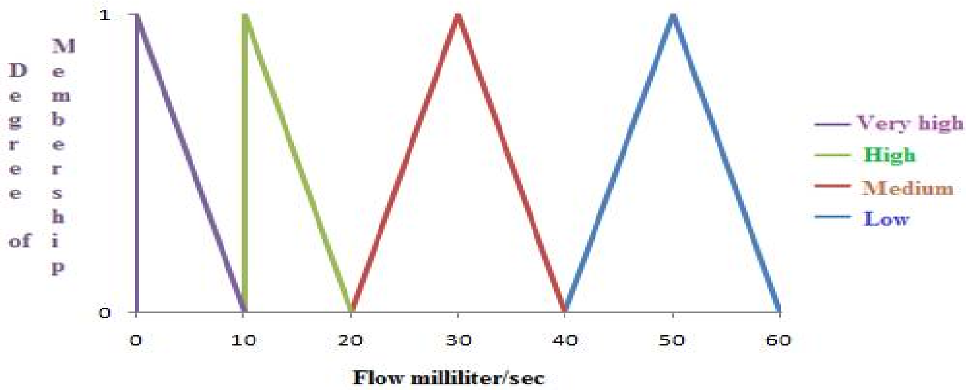


**Fig 4.** Membership Functions for

F (flow) = {Low, Medium, High, Very high}

## V. RESULT AND DISCUSSION

The below table shows the steady state error and accuracy of total control system with response, set time and controlled time.

| Set Flow rate (ml) | FUZZY | | | |
|---|---|---|---|---|
| | Response Time (sec) | Set Time (sec) | Controlled Time (ml) | Steady State Error (ml) |
| 60 | 12 | 15 | 64 | 4 |
| 50 | 19 | 24 | 54 | 4 |
| 40 | 29 | 33 | 42 | 2 |
| 30 | 38 | 41 | 34 | 4 |
| 20 | 47 | 49 | 24 | 4 |
| 10 | 58 | 63 | 15 | 5 |
| 5 | 64 | 68 | 9 | 4 |

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## VI.CONCLUSION

The design of software Fuzzy implementing flow controller with active rule selection mechanism. The proposed system is tested in real time environment and the output performances are evaluated. In this system which is key point to reduce the cost by implementing software algorithm. We have successfully experiment this system in lab and therefore proposed a web based flow monitoring and controlling network with flexibility. This could have a substantial benefit from this research work for efficient management of liquid flow.

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