DIGITIZATION OF GLASS TUBE ROTAMETER [GTR]

A Project Report

Submitted in partial fulfilment of the requirement for the degree bachelor of engineering.

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2019-2020

CERTIFICATE

This is to certify that the Synopsis of Project entitled **"DIGITIZATION OF GLASS TUBE ROTAMETER [GTR]"** is a Bonafide work of:

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PROJECT REPORT APPROVAL

This project report entitled, **"DIGITIZATION OF GLASS TUBE ROTAMETER [GTR]"** by **Sayyed Asif Akbar, Shaikh Faizan Sadique, Shaikh Mohd Akbar Abdullah, Shaikh Mohd Faizan Mohd Faheem** has been approved for the **bachelor degree** in **Mechanical engineering** under **Mumbai university**.

Internal Examiner **External Examiner**

DECLARATION

We declare that this written submission represents our own ideas in our words and other's ideas or words have also been included, we have adequately referenced and cited the original source. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/date/source/fact in any submission. We understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the source which have thus not been properly cited or for whom proper permission have not been taken when needed.

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ABSTRACT

Measurement of flow rate is an essential requirement of process Industry. There are many methods which are employed for flow measurement based on the requirements. The most commonly used device for low viscosity, transparent fluids are Glass Tube Rotameter (GTR). The principle of operation for a GTR is based on the mechanical force balance between the weight of the float and the magnitude of flow rate. The current work aims at converting the GTR into a digital device using the halleffct sensor (turbine flow meter). halleffect sensor will be connected at the inlet of the rotameter & its reading will be calibrated according to the rotameter reading. Hall effect flow sensor consists of a plastic valve from which water can pass. A water rotor along with a hall effect sensor is present the sense and measure the water flow. When water flows through the valve it rotates the rotor. By this, the change can be observed in the speed of the motor. This change is calculated as output as a pulse signal by the hall effect sensor. Thus, the rate of flow of water can be measured. The output reading of halleffect sensor will be shown at lcd display.

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CHAPTER 01: INTRODUCTION

1.1. BACKGROUND

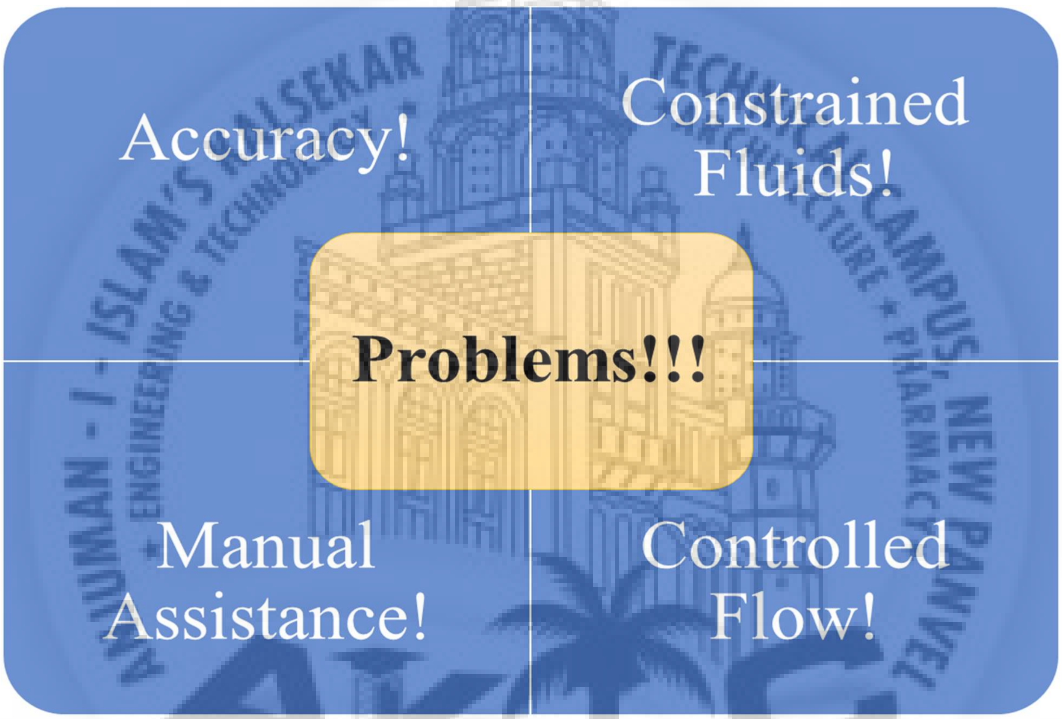
Rotameters is known as variable area flowmeter on which the drop rate in the pressure is constant and the flowrate is the function of the area of constriction. The market for rotameters is more demanding and competitive each passing day and this requires constant technological innovation of companies in that sector. The manufacturer who is competing in the market wants its product to be manufactured at effective cost and better accuracy. The set-up of the rotameter should be effective and take less time to get accurate readings.

Modification of the rotameter and its basic components parameters such as weight of float, variable area, and attachment of various types of sensors such as ultrasonic, I.R sensors, hall effect sensor etc leads to gives out the preferable hype in accuracy domain of rotameters. Use of modern methods such as ultrasonic sensors enable the improvements in rotameters by measuring the accurate displacement of float which gives out astounding accuracy rate in terms of digital output.

Glass tube rotameter is a type of rotameter which gives out manual reading in the Industrial domain. So, to get rid of the manual reading and less accurate GTR setup into an affordable digitalize meter the correct selection of sensors generates the optimum conditions during the manufacturing of rotameter and becomes the main exigency of the rotameter manufacturing industry.

1.2. PROBLEM DEFINATION

The Glass tube rotameter is a type of rotameter which gives out manual reading in the Industrial domain. So, to get rid of the manual reading and less accurate GTR setup into an affordable digitalize meter the correct selection of sensors generates the optimum conditions during the manufacturing of rotameter and becomes the main exigency of the rotameter manufacturing industry.



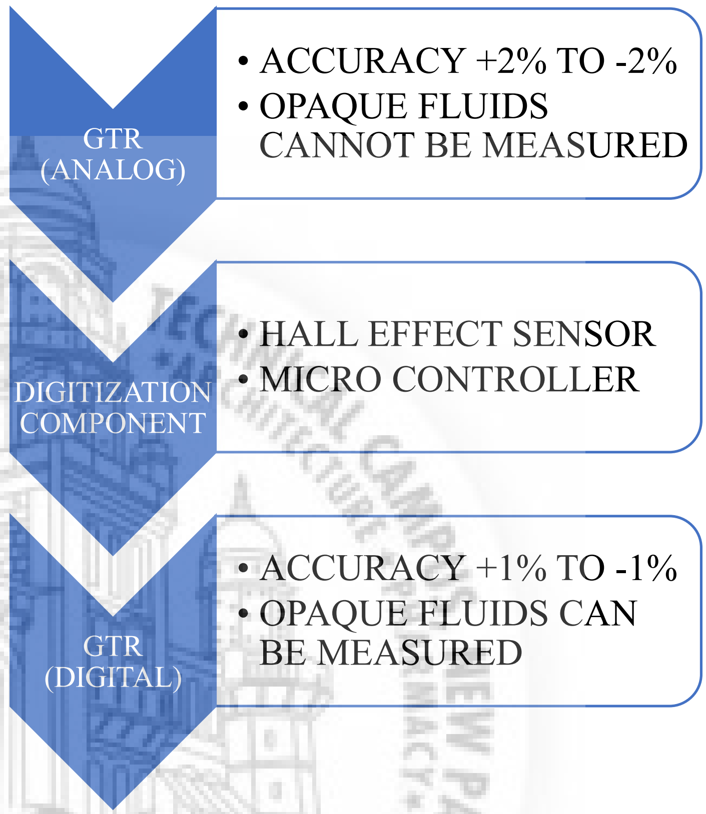
1.2.1: Problem definition

Also, it's really had limitation when it comes to the type of fluid which can be passed through it and gets a reliable reading as it is only suitable for transparent fluid.

1.3. OBJECTIVES

Here are some of the objectives that we wish to achieve successfully with the help of the project.

1. Accuracy of the device will be improved drastically.
2. There will be a full control on the flow of the fluid even without manual assistance.
3. The process of operating the device will be automated.
4. The restrictions of only measuring the transparent fluid will be solved efficiently.



1.3.1: Objectives of the project

1.4. SCOPE OF STUDY

Flow meters with digital displays and measurement methods have been standard in most industries. Digital flow meters take the data the mechanism is capturing and translate it into easy-to-read quantities that are much more reliable than traditional rotameter-style flow meters.

You can find almost every type of flow meter with a digital display. At the least, these meters are easier to read, but they can also provide improved accuracy with more complex interior workings. Because they have exterior power, they rely less on the pressure and temperature of fluid. This makes the readings they provide more reliable in applications that require precision.

We can add a pH sensor, temperature sensor, and turbidity sensor to check the quality of water. We can also use the ultrasonic sensor to check the level of water in the tank. If the water level is low then the notification will be sent to users. By using a solenoid valve, we can turn on/off the water supply from any place. Also, we can predict water usage using machine learning algorithms. It can also be possible to notify the user if the water is not good enough for drinking.

CHAPTER 02: LITERATURE SURVEY

i. **Michal Urbanski** [1] conducted research on the Hall effect sensor as a converter for single and multi-jet water meters. The research was carried out on industrial single and multi-jet water meter. The analysis of magnetic field simulations based on finite elements method and studies of magnetic field distribution provide guidelines for utilization of Hall effect sensor in flowmeters applications in order to improve sensing abilities, such as resolution and sensitivity.

ii. **Ria Sood** [2] conducted research on Hall Effect sensor attached to G1/2 water flow sensor is a transducer which examines the rotations of rotor and passes the pulse train which is in the form of electrical signal as a frequency input to the microcontroller that is programmed to convert it to flow rate. Sensor consists of multiple bladed, free spinning, and permeable metal rotor. The selection of a microcontroller plays very important role in any embedded system. According to the need of the system a microcontroller is chosen. Here in this system in order to design a low-cost automatic water flow meter Atmel AT89S52 microcontroller is used. He had designed and developed a low-cost water flow meter mainly for irrigation purposes to deliver only the correct amount of water as per requirement to the irrigation fields.

iii. **William Banko** [3] conducted research on, the fluid flow meter of the invention comprises a fluid tight housing including an inlet and an outlet, including at least one slot, the slot for receiving fluid from the inlet and communicating it to the outlet, a magnetic piston slidably positioned within the liner for movement in response to the flow of fluid from the inlet through the slot, and transducer means mounted on the housing in substantially side-by-side relation to the piston for producing an electrical signal corresponding to the position of the piston in the cylinder. Fluid entering through the inlet displaces the pies ton thereby uncovering the slots. The fluid then passes through the bypass passages and the apertures exiting at the outlet end. The differential pressure between the upstream side of the piston and the downstream side by there of controls the movement of the piston as a function of flow.

iv. **Lars O. Rosaen** [4] invented a Fluid Flow Indicator Including A Hall Effect Transducer, relates to fluid flow monitors, and more particularly, to a fluid flow rate indicating assembly. Flowing fluid impinges on the member, causing it to move. Often, the member is resiliently biased against such motion, so that movement of the member is indicative of the rate of fluid flow. Biasing means commonly employed include gravity or springs. Alternatively, the member can be a rotor, which is mounted on an axle having an end which passes through the housing, and which is connected to a tachometer.

v. **J. Wunderlich** [5] carried out experiment on spin-Hall effect in a two-dimensional spin-orbit coupled semiconductor system Predictions of the SHE was reported, within different physical contexts, in several seminal studies and currently its microscopic origins are subject of an intense theoretical debate. Its co-planar geometry and the strong spin-orbit (SO) coupling in the embedded two-dimensional hole gas (2DHG), whose ultra-small thickness debate. Its induced self-field effects, are well suited for inducing and detecting.

CHAPTER 03: SPECIFICATION

3.1. MAIN COMPONENTS LIST

Sr. No	Component Name
1	Glass Tube Rotameter
2	Arduino Uno
3	Needle Valve
4	Motor
5	Hall Effect Sensor
6	2x16 LCD
7	Motor Driver

Table 3.1: components list

3.2. MAIN COMPONENTS OF GTR

1. Glass Tube

Glass tube the following setup consists of a variable area glass tube as the name suggests they have gradually increasing area from bottom to top for proper flow of the fluid, the bottom and top diameter, height and thickness depends upon the range of flow measurement that needs to be carried out by the rotameter it has a fixed standard size.

3.2.1: Glass tube

<table>
<tr><th>Serial number</th><th>Parameters</th><th>Standard size available</th></tr>
<tr><td>1</td><td>Thickness</td><td rowspan="4">SDG30, SDG40, SDG50 SDG60, SDG70 SDG80 SDG90</td></tr>
<tr><td>2</td><td>Length / Height</td></tr>
<tr><td>3</td><td>Bottom Diameter</td></tr>
<tr><td>4</td><td>Top Diameter</td></tr>
</table>

Table 3.2.1: Glass tube standards

2. Float

The next in the component list comes the Centre float, it is a solid piece of metal that comes in various shapes but generally in half-cylinder and half cone shape. It is made up of material like SS316 and SS316L some exceptional fluids like dangerous chemicals material like PTFE [Polytetrafluoroethylene] and PVC [Polyvinyl chloride]. There is an orifice at both the ends of the tube which regulates the flow.

3.2.2: Float

Serial number	Parameters	Comment
1	Shape	**Half cylinder half cone & sphere are commonly used**
2	Materials	**SS316 & SS316L for normal fluids and for highly reactive chemicals like cl2 PTFE is used**
3	Size	**Standardized according to the flow rate, glass tube, and fluid flowing.**

Table 3.2.2: Float standards

3.3. ARDUINO

The Arduino Uno is one kind of microcontroller board based on ATmega328, and Uno is an Italian term which means one. Arduino Uno is named for marking the upcoming release of microcontroller board namely Arduino Uno Board 1.0. This board includes digital I/O pins-14, a power jack, analog i/ps-6, ceramic resonator-A16 MHz, a USB connection, an RST button, and an ICSP header. All these can support the microcontroller for further operation by connecting this board to the computer. The power supply of this board can be done with the help of an AC to DC adapter, a USB cable, otherwise a battery. This article discusses what is an Arduino Uno microcontroller, pin configuration, Arduino Uno specifications or features, and applications.

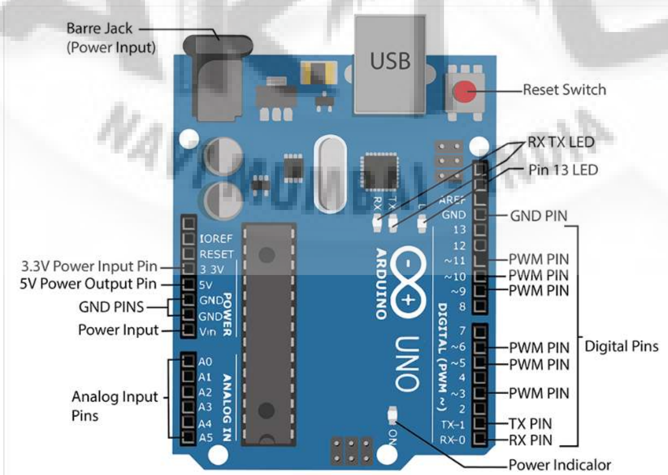
3.3.1: Arduino UNO

FEATURES:

- The operating voltage is 5V
- The recommended input voltage will range from 7v to 12V
- The input voltage ranges from 6v to 20V
- Digital input/output pins are 14
- Analog i/p pins are 6
- DC Current for each input/output pin is 40 mA
- DC Current for 3.3V Pin is 50 mA
- Flash Memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK Speed is 16 MHz

APPLICATION IN DIGITIZATION OF GLASS TUBE ROTAMETER:

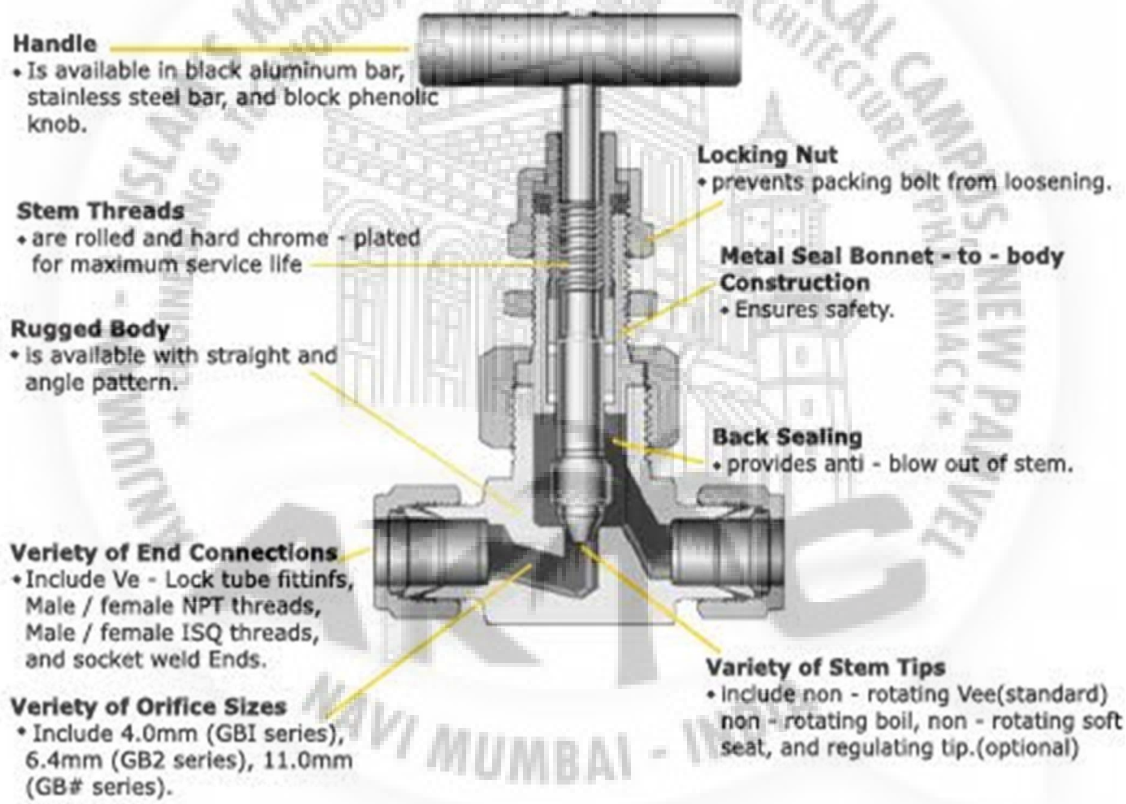
- Controls valve Opening and Closing.
- Controls DC MOTOR.
- Controls switch and Flow Indicated Devices.



3.2.2: Arduino UNO details

3.4. NEEDLE VALVE

A needle valve is used to accurately control flow rates of clean gasses or fluids. The adjustments are gradual and smooth for controlling the flow rate; however, they can also be used as a reliable shut-off valve. However, they are generally only used for low flow rates and have a relatively large pressure drop from the inlet to the outlet. Common port sizes for needle valves range from 1/8" up to 2". The most common application is to control the flow of a gas, like a propane needle valve does.



3.4.1: Needle valve

Needle valves are similar to a globe valve in design with the biggest difference is the sharp needle like a disk. Needle valves are designed to give very accurate control of flow in small diameter piping systems. They get their name from their sharp-pointed conical disc and matching seat.

WHY WE USED NEEDLE VALVE

- A needle valve is a type of valve having a small port and a threaded, needle-shaped plunger. It allows precise regulation of flow, although it is generally only capable of relatively low flow rates.
- needle valve uses a tapered pin to gradually open a space for fine control of flow. The flow can be controlled and regulated with the use of a spindle.
- A needle valve has a relatively small orifice with a long, tapered seat, and a needle-shaped plunger on the end of a screw, which exactly fits the seat.
- As the screw is turned and the plunger retracted, flow between the seat and the plunger is possible; however, until the plunger is completely retracted, the fluid flow is significantly impeded.
- Since it takes many turns of the fine-threaded screw to retract the plunger, precise regulation of the flow rate is possible.
- The virtue of the needle valve is from the vernier effect of the ratio between the needle’s length and its diameter, or the difference in diameter between needle and seat.
- A long travel axially (the control input) makes for a very small and precise change radially (affecting the resultant flow).
- Hence Needle valves may also be used in vacuum systems, when a precise control of gas flow is required, at low pressure, such as when filling gas-filled vacuum tubes, gas lasers and similar devices.

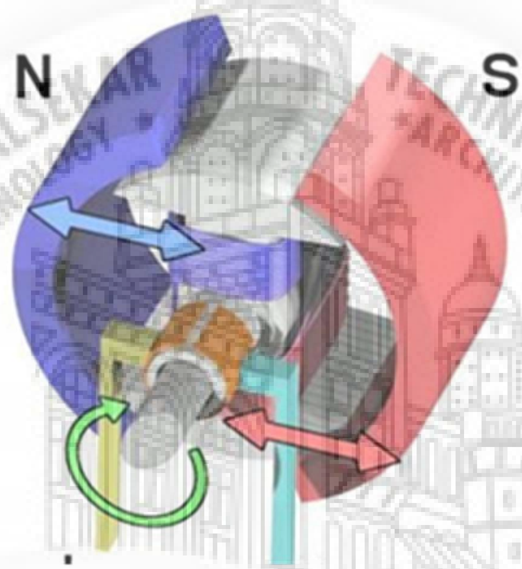
OTHER ADVANTAGES

- **Robustness**: Stainless steel needle valves are the top choice in industry because of their robustness. They are resistant to both hot and cold temperatures.
- **Corrosion-Free:** One of the most amazing qualities of stainless-steel needle valve is its resistance against rust.

- **Resistance Against High-Pressure:** These needle valves can endure constant pressure and vibrations efficiently
- **Variety of Designs:** A wide variety of designs in stainless steel needle valves are available to fit the needs of different industries.
- **Leakage Proof:** Another major benefit of using stainless steel needle valves is a leakage-free hydraulic system, even under high temperatures and pressures.

3.5. MOTOR

DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.



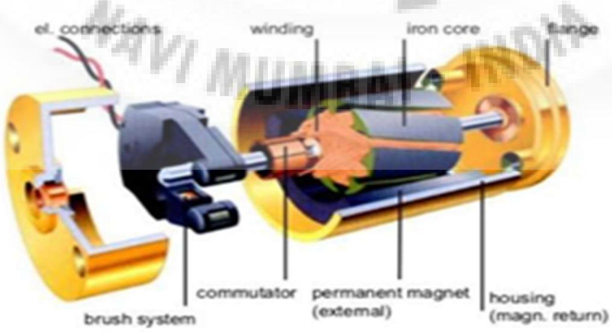
3.5.1: DC motor coil working

Workings of a brushed electric motor with a two-pole rotor (armature) and permanent magnet stator. "N" and "S" designate polarities on the inside axis faces of the magnets; the outside faces have opposite polarities. The + and - signs show where the DC current is applied to the commutator which supplies current to the armature coils.

The Pennsylvania Railroad's class DD1 locomotive running gear was a semi-permanently coupled pairing of third rail direct current electric locomotive motors built for the railroad's initial New York-area electrification when steam locomotives were banned in the city (locomotive cab removed here).

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

3.5.2: High torque DC motor

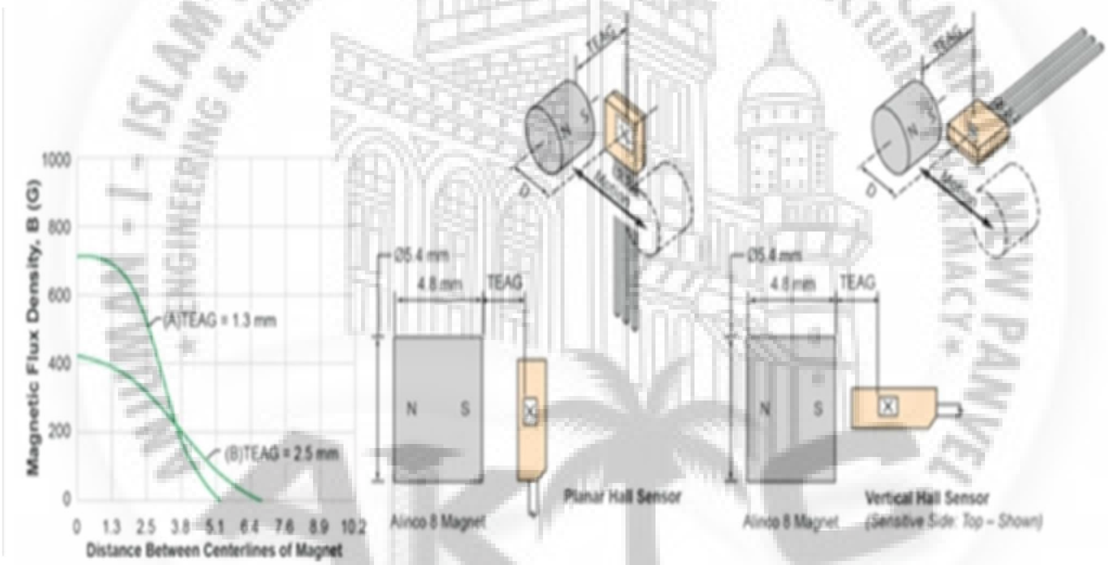


3.5.3: Internal of a DC motor

3.6. HALL EFFECT SENSOR

The sensor has a small turbine inside that rotates with water flow. The turbine rotates a small magnet. The Hall-Effect sensor outside the casing, picks up the magnetic field as the magnet rotates, and converts this into a pulse each time it rotates. The output voltage signal is a nearly 50% duty cycle pulse of the same voltage as the input pulse.

While each sensor has an internal filter to protect the turbine, we don't recommend using these with overly dirty water that has particles, as the filter will get plugged up and restrict water flow.



3.6.1: Working of a hall effect sensor

Features:

- Compact, Easy to Install
- High Sealing Performance
- High Quality Hall Effect Sensor
- RoHS Compliant

3.6.2: ½” Hall effect flow sensor

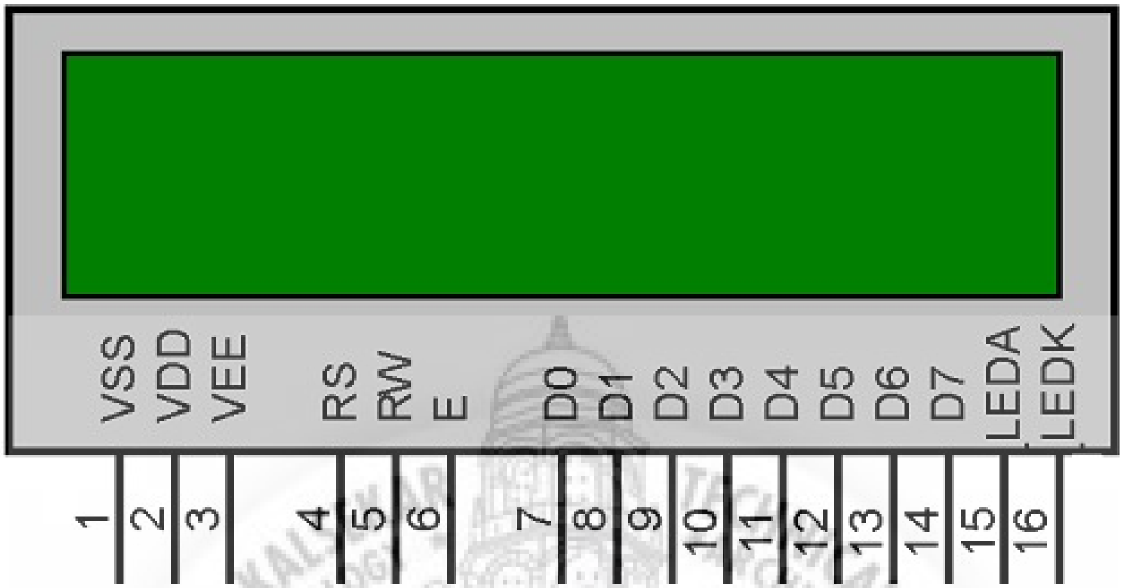
Specifications:

- Water pressure resistance: = >2MPa
- Operating Temperature: = -20~85C
- Insulation resistance: = >100MΩ
- Characteristics of Flow pulse: f=(4.8*Q) Q=L/Min

3.7. 2x16 LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCD's are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCD's can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCD's to give them their characteristic appearance.

3.7.1: 2x16 LCD



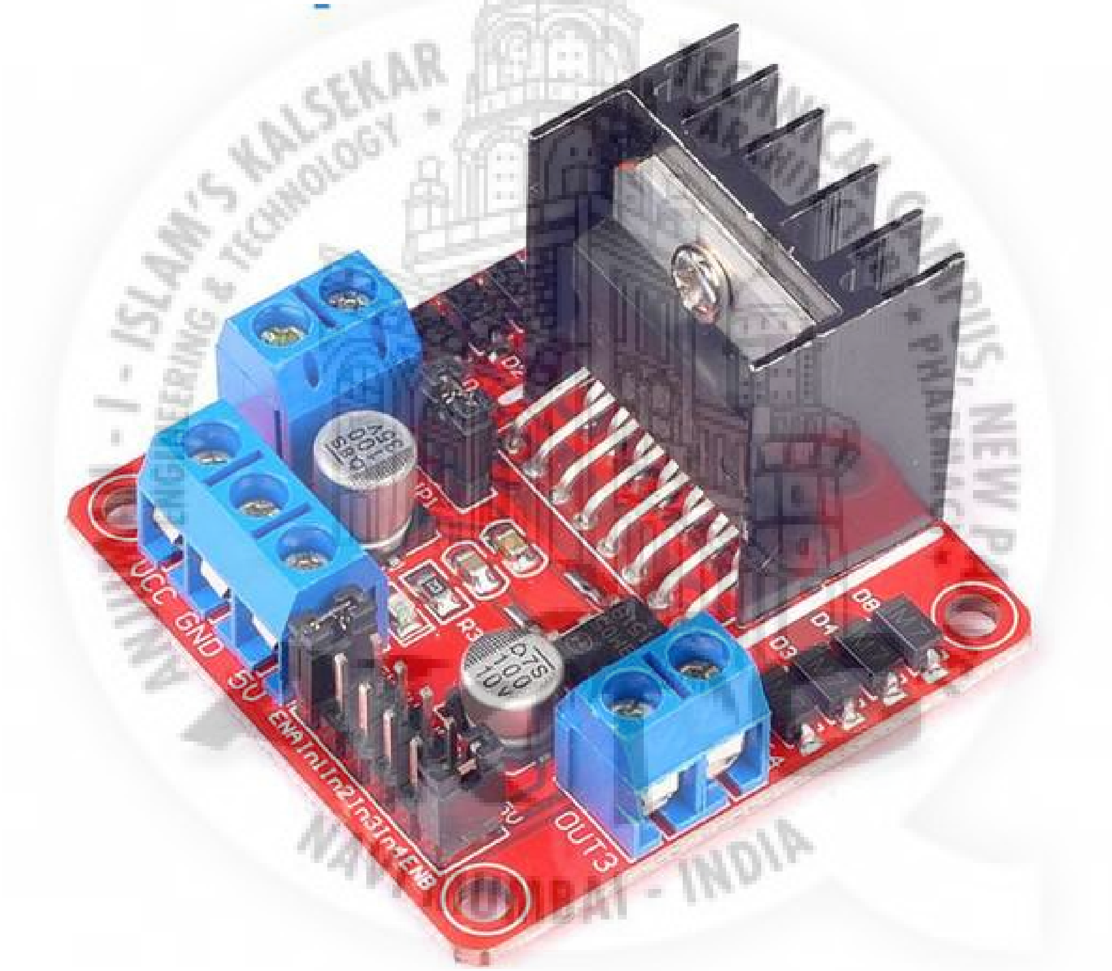
3.7.2: 2x16 LCD pin layout

Advantages

- Very compact, thin and light, especially in comparison with bulky, heavy CRT displays.
- Low power consumption. Depending on the set display brightness and content being displayed, the older CCFT backlit models typically use less than half of the power a CRT monitor of the same size viewing area would use, and the modern LED backlit models typically use 10–25% of the power a CRT monitor would use.
- Little heat emitted during operation, due to low power consumption.
- No geometric distortion.
- The possible ability to have little or no flicker depending on backlight technology.
- Usually no refresh-rate flicker, because the LCD pixels hold their state between refreshes (which are usually done at 200 Hz or faster, regardless of the input refresh rate).
- Sharp image with no bleeding or smearing when operated at native resolution.

3.8. MOTOR DRIVER

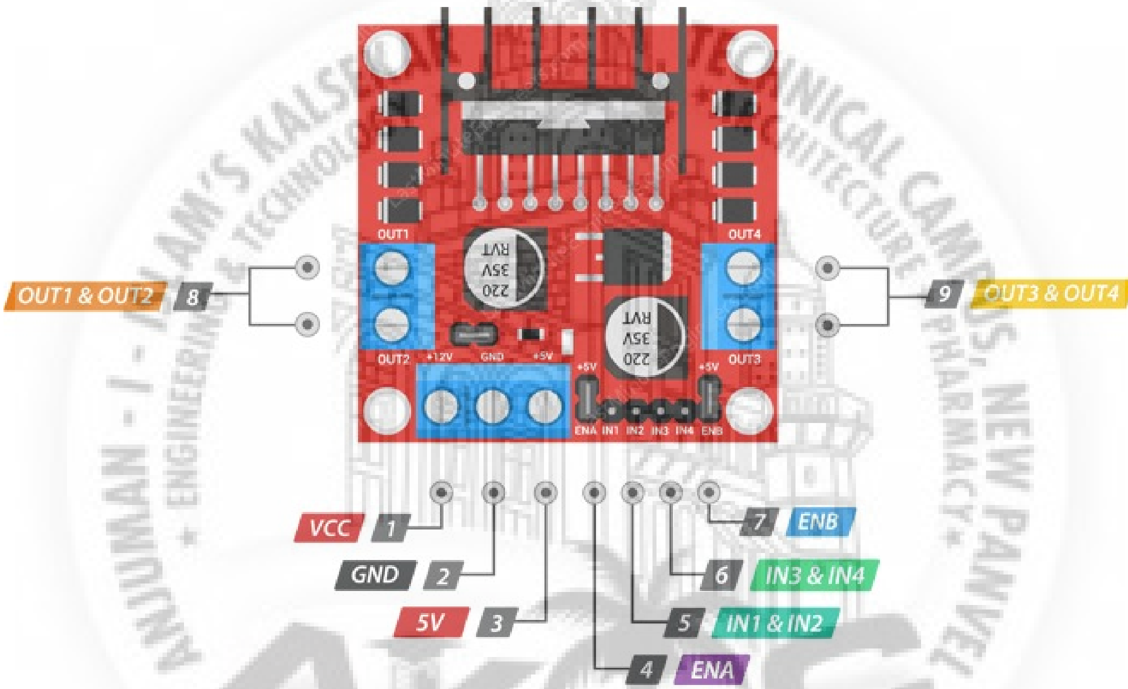
Motor drive, or simply known as drive, describes equipment used to control the speed of machinery. Many industrial processes such as assembly lines must operate at different speeds for different products. Where process conditions demand adjustment of flow from a pump or fan, varying the speed of the drive may save energy compared with other techniques for flow control.



3.8.1: L298N DC motor driver

Line regenerative variable frequency drives, showing capacitors (top cylinders) and inductors attached which filter the regenerated power.

Where speeds may be selected from several different pre-set ranges, usually the drive is said to be adjustable speed. If the output speed can be changed without steps over a range, the drive is usually referred to as variable speed. Adjustable and variable speed drives may be purely mechanical (termed variators), electromechanical, hydraulic, or electronic.



3.8.2: L298N pin layout

L298 Module Features & Specifications:

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V

- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

Applications of L298N Module

- Drive DC motors.
- Drive stepping motors
- In Robotics

3.9. GLASS TUBE ROTAMETER [GTR]

A rotameter is a device that measures the volumetric flow rate of fluid in a closed tube. It belongs to a class of meters called variable area meters, which measure flow rate by allowing the cross-sectional area the fluid travels through to vary, causing a measurable effect.

A rotameter consists of a tapered tube, typically made of glass with a 'float' (a shaped weight, made either of anodized aluminum or a ceramic), inside that is pushed up by the drag force of the flow and pulled down by gravity. The drag force for a given fluid and float cross section is a function of flow speed squared only, see drag equation.

A higher volumetric flow rate through a given area increases flow speed and drag force, so the float will be pushed upwards. However, as the inside of the rotameter is cone shaped (widens), the area around the float through which the medium flows increases, the flow speed and drag force decrease until there is mechanical equilibrium with the float's weight.

3.9.1: GTR

Floats are made in many different shapes, with spheres and ellipsoids being the most common. The float may be diagonally grooved and partially colored so that it rotates axially as the fluid passes. This shows if the float is stuck since it will only rotate if it is free. Readings are usually taken at the top of the widest part of the float; the center for an ellipsoid, or the top for a cylinder. Some manufacturers use a different standard. The "float" must not float in the fluid: it has to have a higher density than the fluid, otherwise it will float to the top even if there is no flow.

The mechanical nature of the measuring principle provides a flow measurement device that does not require any electrical power. If the tube is made of metal, the float position is transferred to an external indicator via a magnetic coupling. This capability has considerably expanded the range of applications for the variable area flowmeter, since the measurement can observe remotely from the process or used for automatic control.

3.9.2: GTR SD20

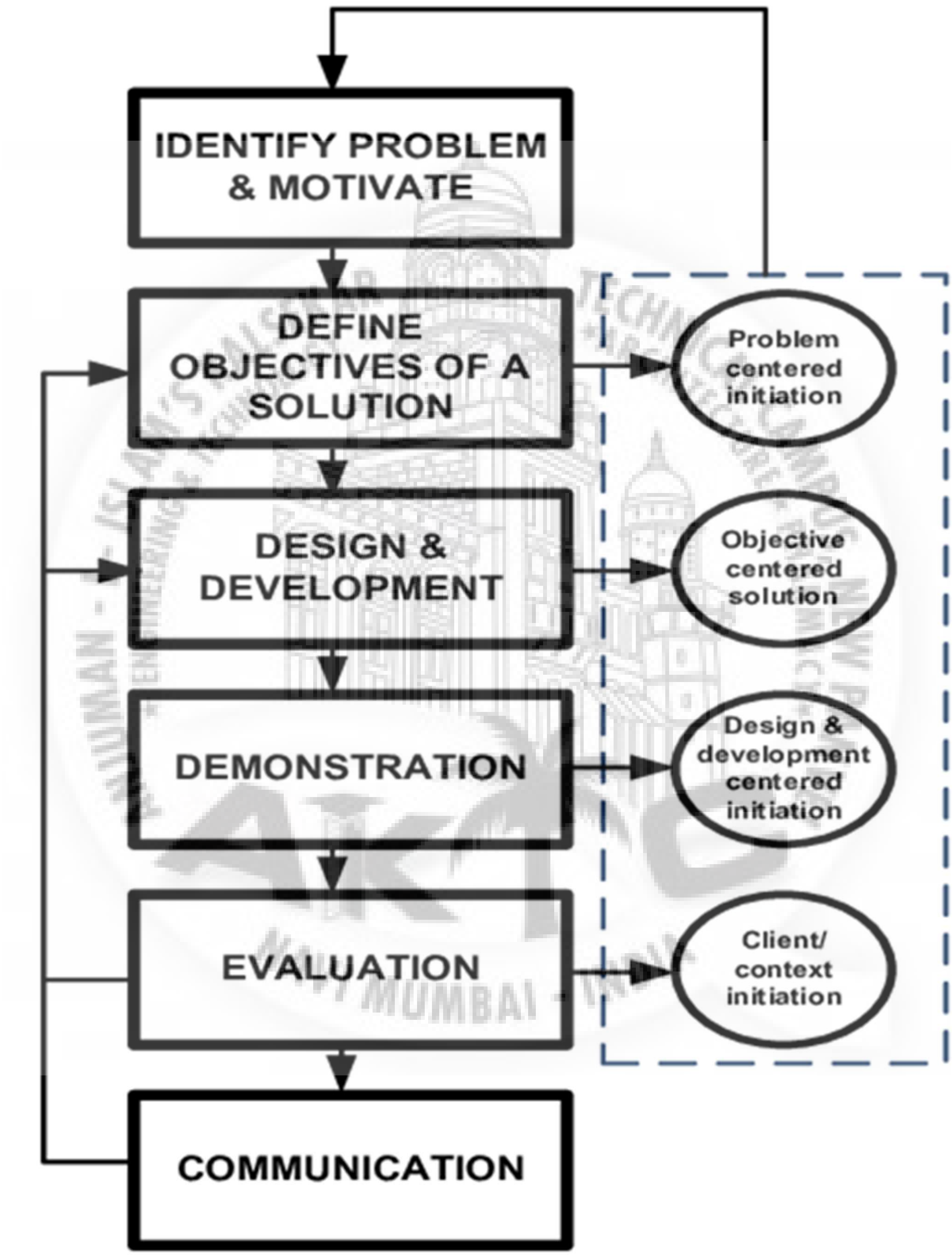
Fluid	: Liquids & Gases
Density / Sp. Gravity	: Up to 1.85
Viscosity	: Up to 220 cp
Design Temperature	: Up to 100°C
Design Pressure	: Up to 5 Kg/cm²
Measuring Range	: 0.6 to 160 LPH of Water/Liquid 10 to 5000 NLPH of Air/Gas at NTP
Line Size	: Up to 1″ NB
Available Materials	: SS304/SS304L/SS316/SS316L/PTFE/Monel/Hastalloy
Connection	: Flanged to ASA/BS/DIN/ Triclover Standard Screwed to BSP/NPT(M/F)
Accuracy	: ±2% of FSD & ±1.5% on request

CHAPTER 04: COST OF THE PROJECT

Sr. No	Items List	Qty	Amount (RS)
1	Glass Tube Rotameter [GTR]	1	5000
2	Arduino UNO	1	500
3	DC Motor (High Torque)	1	500
4	L298N DC Motor Driver	1	200
5	2x16 LCD	1	150
6	½" Hall Effect Flow Sensor	1	300
7	PVC Pipe	1	100
8	Hose Nipple	5	150
9	Other Small Essential	-	500
	Total Cost of Device		7400
	Amount Used During Trial & Error Run		2600
	Total Cost of the Project		10000

Table 4.1: Cost of the project

CHAPTER 05: METHODOLOGY



5.1: Methodology chart

A. Identify problem and motivate:

Our main aim was is to convert any mechanical device into digital one, for this we explore all the flow measuring devices for conversion. By our observation we came to know that glass tube rotameter is the only device which needed digitization. As we know GTR (glass tube rotameter) Give reading on linear scale engraved on its glass tube which has possibility of parallax error and it cannot be integrated with any electronic system.

So, we decided that if by any means we can obtain GTR analog reading digitally. By doing this it will make rotameter far more accurate compare to analog one and it can also open N number of possibilities for GTR to be integrated with any electronic smart system. This was our main motivation to convert analog GTR into digitized GTR.

B. Define objectives of solution:

Our main objective was to obtain analog reading of GTR digitally on a lcd screen. But by doing digitization of GTR we can also get following other advantages like improved accuracy Control over flow rate of fluid

C. Design and development:

First, we decided to use ultrasonic sensor to track the position of float of rotameter, by tracking the position of float we can easily measure the flow rate of fluid. but we had some difficulties for placement of the sensor also we didn't get required size sensor so we dropped that idea.

After that we thought that working principle of LVDT can be used for our project, were float of a rotameter can act as a core of lvdt, and deflection of core can generate EMF current, and this EMF can generate voltage at the output of the winding. And this voltage can be calibrated in terms of flow rate. But there are some difficulties with lvdt method such permeability of core, distance between winding and core, number of winding, casing material etc. Due these difficulties we dropped lvdt idea.

Finally, we decided to use hall effect sensor (Turbine flow meter) at the inlet of the rotameter. A turbine flow meter is a volume sensing device. As liquid or gas passes through the turbine housing, it causes the freely suspended turbine blades to rotate. The velocity of the turbine rotor is directly proportional to the velocity of the fluid passing through the flow meter.

Detail working and construction of our setup with the use of hall effect sensor explained in "construction & working" section.

D. Demonstration:

After difficult design & development and coding, we calibrated our setup according to rotameter to which we are going to connect to our setup. After several rounds of calibration, we successfully calibrated our setup with rotameter.

After calibration we demonstrated our project to company seniors and to our project guide. After demonstration our company seniors and project guide agreed to our results and green flagged our project.

After the green flagged our project, we demonstrated our projects in several national and state level competition, and successfully managed to secure runner up position in "National level paper presentation ' competition held at Bharati vidya peeth collage of engineering, Kharghar 20 September 2019.

E. Evaluation:

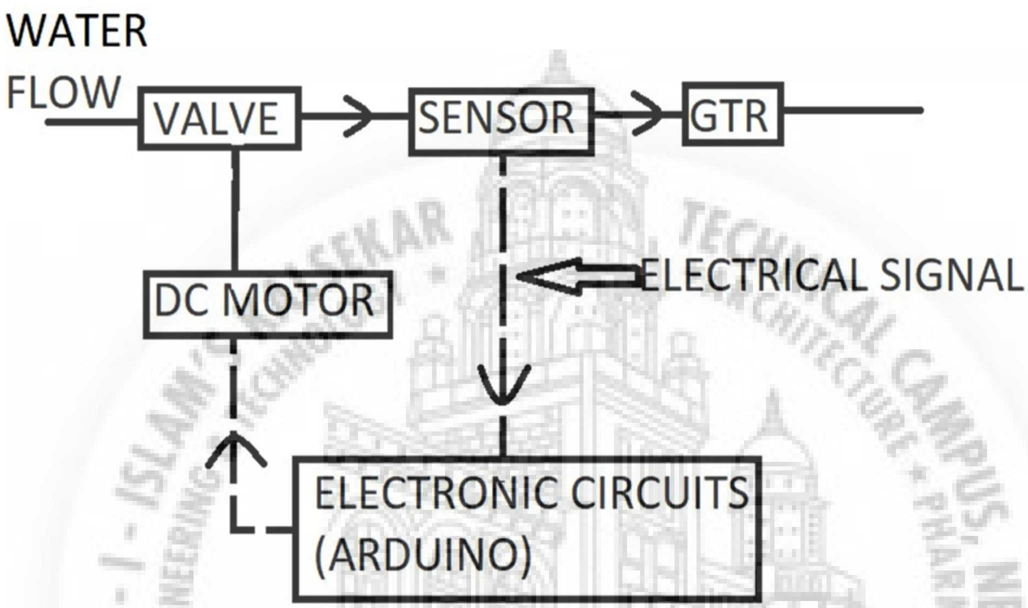
We compared obtained results/ reading with actual reading and evaluated that we managed to increase accuracy of measuring flow rate with some extra benefit such as precious control over flow rate, integration with electronic system.

That me we successfully converted mechanical system in mechatronics domain.

F. **Communication**:

Excellent communication is a critical component of project success. In fact, according to the Project Management Institute (PMI), most project failures are due to communication issues. Project communication management ensures that does not happen. It consists of three processes that help make sure the right messages are sent, received, and understood by the right people. Project communication management is one of the ten key knowledge areas in the PMBOK (Project Management Book of Knowledge). The processes included in this area have changed over the years, but in the current version, there are three primary project communication management processes.

CHAPTER 06: SOFTWARE INTERFACE & CODING



6.1: Software interface line diagram

The **Arduino Integrated Development Environment (IDE)** is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

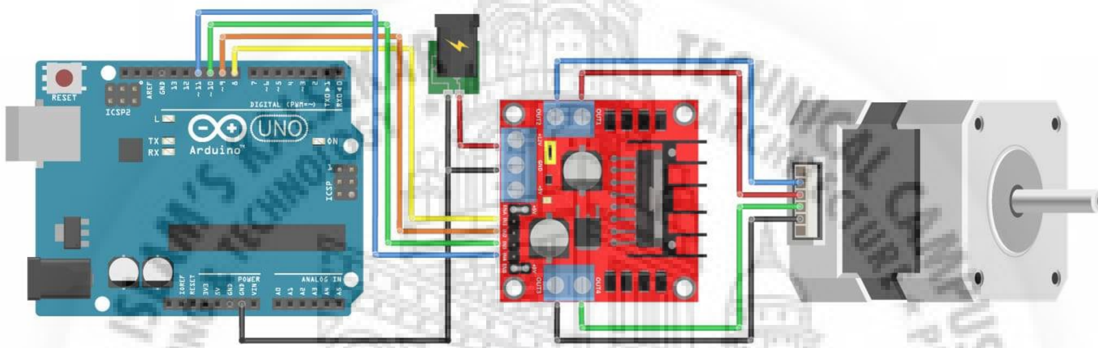
The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

Arduino Pro IDE	
Developer(s)	Arduino Software
Preview release	v0.0.2 / 28 October 2019; 11 months ago.
Repository	• github.com/Arduino/Arduino
Written in	C, C++
Operating system	Windows, macOS, Linux
Platform	IA-32, x86-64, ARM
Type	Integrated development environment
License	LGPL or GPL license
Website	blog.arduino.cc/2019/10/18/arduino-pro-ide-alpha-preview-with-advanced-features/

Table 6.1: Software details

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers.

In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features.



6.2: Motor, Driver & Arduino interface

Description

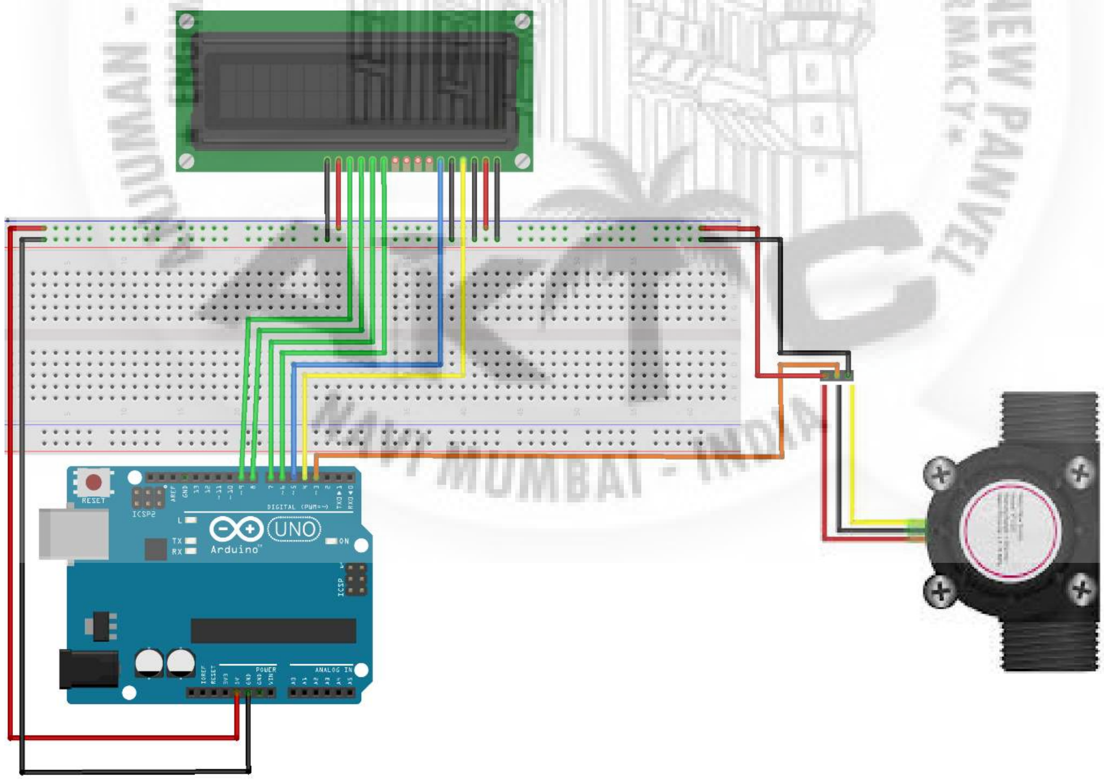
- As mentioned above L298N contains two pairs output which are connected to a pair of DC motors.
- The positive of battery is connected to the Power Input of the L298N module and negative is connected to GND.
- The 5V pin of the driver is connected to the Vin pin of the Arduino to power the Arduino board.
- Input 1 and Input 2 pins are used to control the direction of Motor 1 is connected to pin 13, pin 12 of the Arduino respectively.
- Input 3 and Input 4 pins are used to control the direction of Motor 2 is connected to pin 11, pin 10 of the Arduino respectively.

- Enable A and Enable B are connected to the pin 9 and pin 3 of Arduino, which are used to control the speed of motors using PWM.

Individual Program

```
// Motor A connections
int enA = 9;
int in1 = 13;
int in2 = 12;
// Motor B connections
int enB = 3;
int in3 = 11;
int in4 = 10;

void setup() {
    pinMode(enA, OUTPUT);
    pinMode(enB, OUTPUT);
    pinMode(in1, OUTPUT);
    pinMode(in2, OUTPUT);
    pinMode(in3, OUTPUT);
    pinMode(in4, OUTPUT);

    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
    digitalWrite(in3, LOW);
    digitalWrite(in4, LOW);
}

void loop() {
    directionControl();
    delay(1000);
    speedControl();
    delay(1000);
}
void directionControl() {
    // Set motors to maximum speed
    // PWM value ranges from 0 to 255
    analogWrite(enA, 255);
    analogWrite(enB, 255);

    // Turn on motor A & B
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
    digitalWrite(in3, HIGH);
    digitalWrite(in4, LOW);
    delay(2000);

    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);
    delay(2000);

    // Turn off motors
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
```

```
    digitalWrite(in3, LOW);
    digitalWrite(in4, LOW);
}
void speedControl() {
    // Turn on motors
    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);

    for (int i = 0; i < 256; i++) {
        analogWrite(enA, i);
        analogWrite(enB, i);
        delay(20);
    }

    for (int i = 255; i >= 0; --i) {
        analogWrite(enA, i);
        analogWrite(enB, i);
        delay(20);
    }

    // Now turn off motors
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
    digitalWrite(in3, LOW);
    digitalWrite(in4, LOW);
}
```



6.3: Arduino, Flow Sensor & LCD interface

Circuit Design

Connect the Red and Black wires of the YF-S201 Water Flow Sensor to +5V and GND. Since I will be using the Interrupt feature of the Arduino, only Digital I/O Pins 2 and 3 are possible to connect to the Output of the Water Flow Sensor. In this project, I have connected the Output of the Water Flow Sensor (Yellow Wire) to Digital I/O Pin 2 of Arduino UNO.

Individual Program

```
/*
YF- S201 Water Flow Sensor
Water Flow Sensor output processed to read in litres/hour
Adaptation Courtesy: www.hobbytronics.co.uk
*/
volatile int flow_frequency; // Measures flow sensor pulses
unsigned int l_hour; // Calculated litres/hour
unsigned char flowsensor = 2; // Sensor Input
unsigned long currentTime;
unsigned long cloopTime;
void flow () // Interrupt function
{
   flow_frequency++;
}
void setup()
{
   pinMode(flowsensor, INPUT);
   digitalWrite(flowsensor, HIGH); // Optional Internal Pull-Up
   Serial.begin(9600);
   attachInterrupt(0, flow, RISING); // Setup Interrupt
   sei(); // Enable interrupts
   currentTime = millis();
   cloopTime = currentTime;
}
void loop ()
{
   currentTime = millis();
   // Every second, calculate and print litres/hour
   if(currentTime >= (cloopTime + 1000))
   {
```

```
      cloopTime = currentTime; // Updates cloopTime
      // Pulse frequency (Hz) = 7.5Q, Q is flow rate in L/min.
      l_hour = (flow_frequency * 60 / 7.5); // (Pulse frequency x 60 min) / 7.5Q = flowrate
in L/hour
      flow_frequency = 0; // Reset Counter
      Serial.print(l_hour, DEC); // Print litres/hour
      Serial.println(" L/hour");
   }
}
```

6.4: Testing the code

FINAL INTERFACE PROGRAM

```
#include <stdio.h>

 #include <LiquidCrystal.h>


LiquidCrystal lcd(7, 6, 5, 4, 3, 8);

volatile int flow_frequency; // Measures flow sensor pulses

float l_min; // Calculated litres/min

unsigned char flowsensor = 2; // Sensor Input

unsigned long currentTime;

unsigned long cloopTime;

const int input = 2;

void flow () // Interrupt function

{

   flow_frequency++;

}

float val=3;

 float SET=round(val);

 // define pin used

 const int In1 = 9;

 const int In2 = 10;

 const int ENA = 11;
```

```
int SPEED = 150;

int Switch_1 , Switch_2 ;

float variable ;


void setup()

{


   pinMode(flowsensor, INPUT);

  digitalWrite(flowsensor, HIGH); // Optional Internal Pull-Up

  Serial.begin(9600);

  attachInterrupt(0, flow, RISING); // Setup Interrupt

  sei(); // Enable interrupts

  currentTime = millis();

  cloopTime = currentTime;


Serial.begin(9600);

lcd.begin(16, 2);

lcd.clear();

lcd.setCursor(0,0);

lcd.print("Water Flow Meter");

lcd.setCursor(0,1);

lcd.print("****************");
```

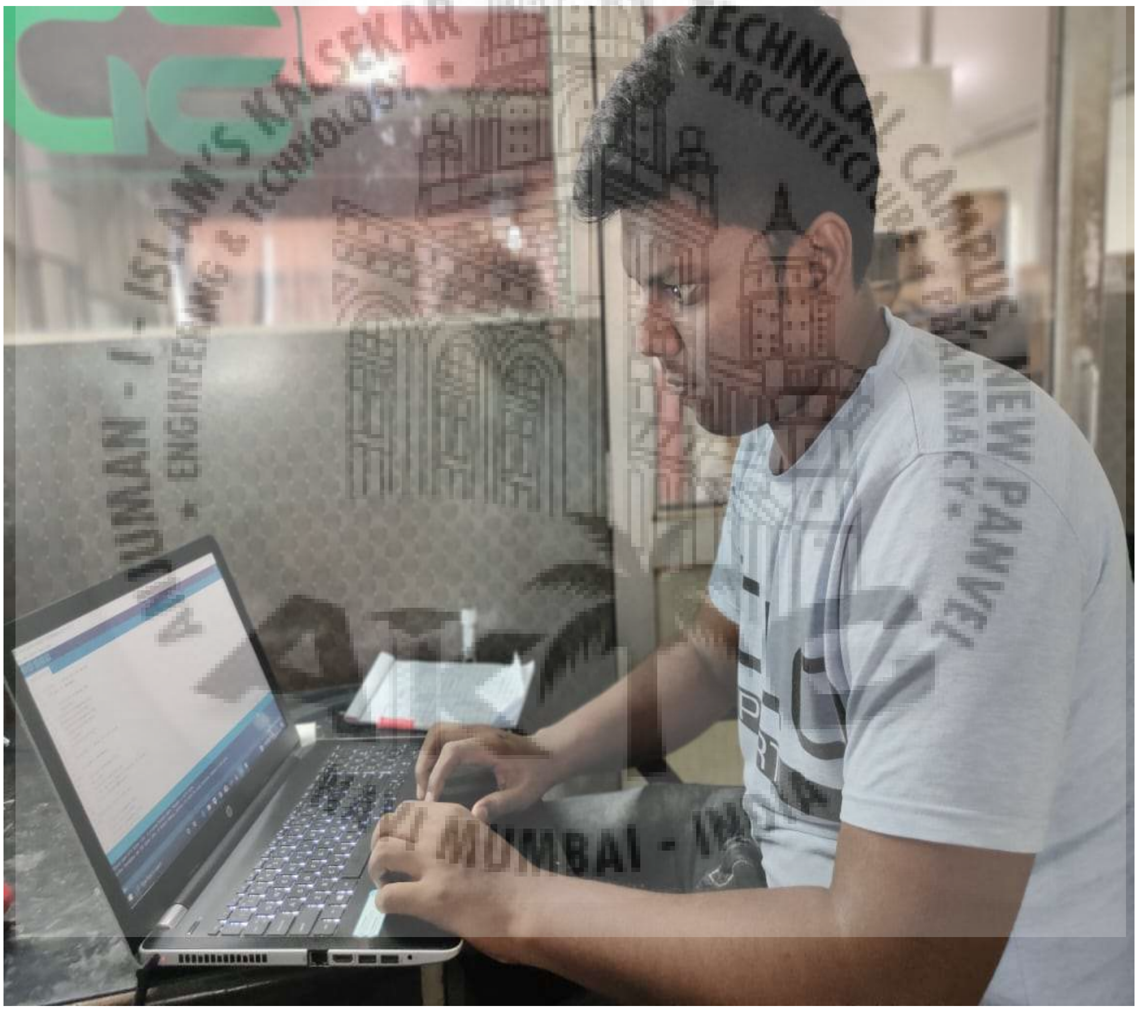
```
delay(2000);

pinMode(input,INPUT);


// set the two pins as outputs

  pinMode(In1,OUTPUT);

  pinMode(In2,OUTPUT);

  pinMode(ENA,OUTPUT);

  analogWrite(ENA,SPEED);

variable = SET;


pinMode(13,INPUT_PULLUP);

pinMode(12,INPUT_PULLUP);


 }

void loop()

{

int k=round(l_min);


Switch_1 = digitalRead(13);

Switch_2 = digitalRead(12);


if((Switch_1 == LOW)&&(Switch_2 == HIGH))
```

```
{
  variable = variable + 0.5;
  delay(20);
digitalWrite(11,HIGH);
digitalWrite(12,HIGH);
  }
if((Switch_2 == LOW)&&(Switch_1 == HIGH))
{
  variable = variable - 0.5;
  delay(20);
digitalWrite(11,HIGH);
digitalWrite(12,HIGH);
  }
if((Switch_1 == LOW) && (Switch_2 == LOW))
{
  variable = SET;
  delay(20);
digitalWrite(11,HIGH);
digitalWrite(12,HIGH);
  }


currentTime = millis();
```

```
// Every second, calculate and print litres/hour
if(currentTime >= (cloopTime + 1000))
{
  cloopTime = currentTime; // Updates cloopTime
  // Pulse frequency (Hz) = 7.5Q, Q is flow rate in L/min.
  l_min = (flow_frequency / 6.23 ); // (Pulse frequency) / 7.5Q = flowrate
in L/min
  flow_frequency = 0; // Reset Counter
  Serial.print(l_min); // Print litres/hour
  Serial.println(" L/min");

lcd.clear();
lcd.setCursor(0,0);
lcd.print("VEL:");
lcd.setCursor(6,0);
lcd.print(l_min);
lcd.setCursor(0,1);
lcd.print("SET:0.00");
lcd.print(variable);
lcd.print(" LPM");
}
```

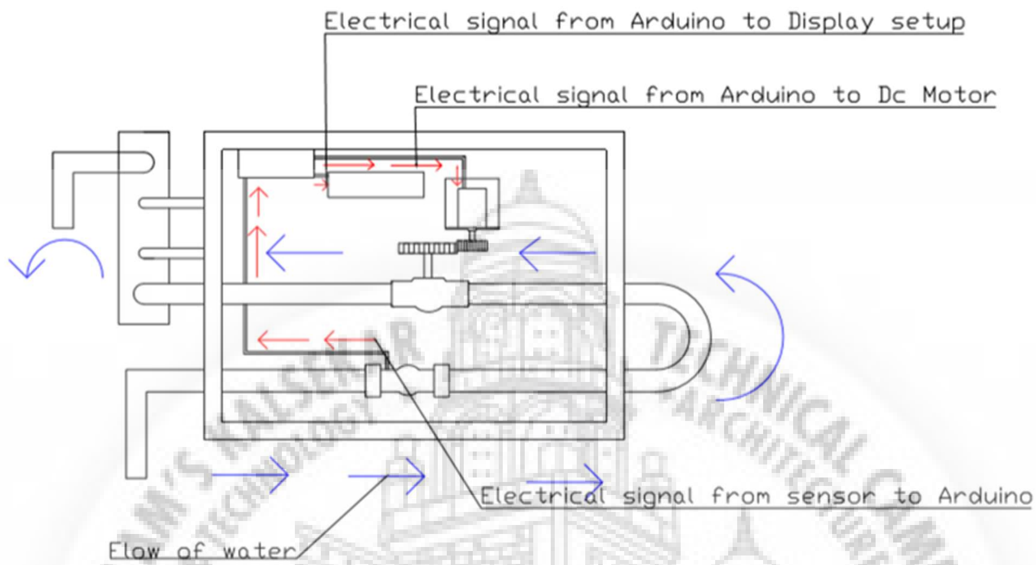
```
if(k < variable)
{
  digitalWrite(In1,LOW);
  digitalWrite(In2,HIGH);
  delay(50);
  Serial.print("open");
}
delay(50); // delay for one second
  if(k == variable)
    {
     digitalWrite(In1,LOW);
  digitalWrite(In2,LOW);
  delay(50);

  Serial.print("stop");
  }
  delay(50); // delay for one second

   if(k > variable)
 {
   digitalWrite(In1,HIGH);
```

```
  digitalWrite(In2,LOW);

  delay(50);

  Serial.print("close");

}

delay(50);

}
```



6.5: finding errors in code

CHAPTER 07: ASSEMBLY LINE



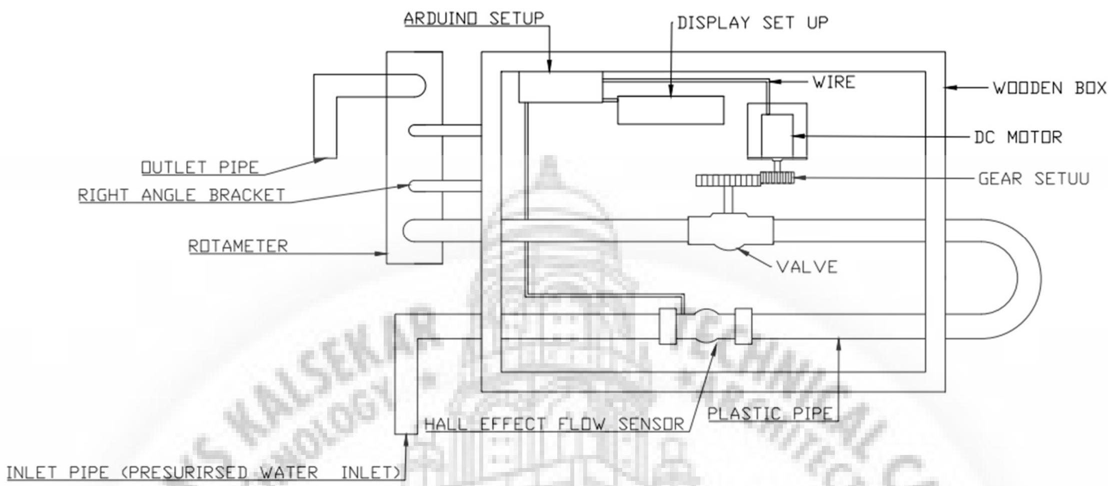
7.1: Final Assembly

As the above diagram shows the flow of a water and electric signal in the model. Here's is the brief explanation how's model work with flow of water and electrical signal.

- As the actual flow is seen by both digitally on display and analog on rotameter, and we can a set what amount of flow in lpm we required by using button setup, and it is seen on the display (2*16), consider we are selecting X lpm by button set up.
- As the pressurised water from the tank, enters in the model by inlet pipe of the model. From the inlet pipe waters flow through hall effect water sensor, and the sensor sense the flow in lpm and sends the electrical signal to the Arduino setup.
- And the Arduino setup gives electrical signal to display, the actual and set lpm is shown on the display digitally.

- And then the water flows through needle valve, at the top of the valve there is a gear mounted, the gear mounted on valve is meshed with other gear mounted on dc motor as shown in fig, and we can open and close the valve by dc motor.
- Dc motor receives the signal from Arduino, consider sensor sense "Arduino, consider Arduino will compare the lpm of set value "X" lpm with actual lpm "actual "X" is lesser than "Y" Lamothe Arduino sends the electrical signal to dc motor to rotate clockwise, the clockwise rotation of the dc motor is transferred through gear setup and it will closed the valve, it will close the valve until "Y" lpm="X lpm.
- If actual lpm is equal to set value, "Y" lpm="X" lpm, then Arduino send null signal to dc motors, means no movement is required.
- if "Y" is lesser than "X" lpm, then Arduino sends the electrical signal to dc motor to rotate anticlockwise, the anticlockwise rotation of the dc motor is transferred through gear setup and it will open the valve, it will open the valve until "Y" lpm="X" lpm.
- As the control flow is transfer to rotameter, it shows the lpm in analog and the outlet of rotameter is connected to tank and the cycle is complete.

CHAPTER 08: FABRICATION



8.2: Final layout

Fabrication part is meant to be very crucial as many factors of the project depends upon it. The fabrication of the casing required the following points to be fulfilled, the first was it should accommodate all the necessary equipment inside it without any congestion. The second thing was it should be compact enough to be fitted and carried wherever required with ease. The dimension of the cutout was an important part as rest of the parts totally depends on it.

8.2: Marking dimensions for casing

8.3: Fabricating the casing

8.4: Checking the fit

CHAPTER 09: CALIBRATION

Scientific Devices (Bombay) Pvt. Ltd.
An ISO9001-2015 Company

Office No. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sector 3,
Opp. Ghansoli Railway Station, Ghansoli (E), Navi Mumbai - 400701,
Maharashtra, INDIA. Tel. : +91-2549 1407, 2549 1408, 2549 1409, 2549 2779,
2549 2780, 2535 5092, 2535 3530, 2535 3505
Email : sdbpl@vsnl.com / sales@ scientificdevices.org
Web : www.scientificdevices.org

IAF ISO CE

Type Approved for Ships, High Speed & Light Craft

TEST & CALIBRATION REPORT

REF. NO.: SDBPL/TR1/1903217/2020-2021
DATE : 12/03/2020
P.O.NO. : VERBAL DATE.: 30/01/2020
W.O.NO. : 1903217 DATE.: 30/01/2020
CLIENT : KALSEKAR DEGREE COLLEGE.

ITEM : LOW FLOW ROTAMETER
QTY. : 1 NO.
IS NO. : 20012518
TAG NO : E53500020002
PRODUCT CODE : STRC

OPERATING CONDITIONS :		MATERIAL :	
FLUID/OPT.DENSITY/OPT. VISCOSITY/OPT.TEMP/OPT.PRESSURE =	WATER/1/1 CP/AMBIENT/ 18 KG/CM2	METERING TUBE :	BOROSILICATE GLASS
		FLOAT :	SS316 (GUIDED)
		WETTED PARTS/END FITTING :	SS304
		GLAND PACKING :	NEOPRENE
FLOW RANGE :	0 - 12 LPM	SCALE	ENGRAVED
STATE:	LIQUID	W.E.	720

PHYSICAL DETAILS :			
F/F OR C/C DISTANCE :	110 MM	SIZE&CONNECTION :	¼" BSP(F)
MODELNO/DESIGN PRESS. :	ST-22E / 22 KG/CM²	DIRECTION OF FLOW :	REAR

TEST CONDUCTED :		OBSERVATION	REMARKS
DIMENSIONAL CHECK :	OK	± 2MM	ACCEPTABLE
HYDRO TEST :	28 KG/CM²	NO LEAK	ACCEPTABLE

REMARKS : Above instruments has been tested by calibrated pressure guage bearing Sr.no. 5171-L and its Recalibration due on 10/09/2020.

CALIBRATION REPORT :

S.R.NO.	ROTAMETER READING IN LPM	WATER EQUIVALENT IN LPM	ACTUAL FLOW IN LPM TAG NO. : E53500020002 IS N.20012518					
1)	12	12.000	12.160					
2)	10	10.000	10.120					
3)	8	8.000	8.100					
4)	6	6.000	6.060					
5)	4	4.000	4.050					
6)	2	2.000	2.020					
7)	1	1.000	1.010					

REMARKS : A) Accuracy within ±2% of FSD
B) Calibration method confirms to ISA R.P.16.6
C) Above flowmeter has been calibrated by Borosil standard calibrated jar Class 'A' certified.
D) This certificate is valid for a period of 12 month from the date of calibration.

For SCIENTIFIC DEVICES(BOM) PVT. LTD.

SIGN. DATE : 12/03/2020

9.1: ISO certified calibration test report

The above certification clearly certifies the authenticity and accuracy of the calibrated device. The calibration process followed a simple process of calibrating the GTR which we are using with the master GTR.

The calibration process involves the following steps.

- Aligning the GTR we are using with the master GTR in series combination.
- Allowing water to pass through them.
- Set the flow on a certain level say 1 LPM on the master and mark the same position of the float on the glass as 1 LPM on the new GTR.
- Similarly, gradually increase the flow from 0 to the upper limit and mark down the flow on the GTR.

After the calibration of GTR we calibrated our flow sensor to the newly calibrated GTR. The process was same but in the place of master GTR we setup the newly calibrated GTR and on the other hand we placed the water flow sensor.

9.2: Sensor calibration

9.3: Sensor recalibration with valve

9.4: Calibration with final setup

CHAPTER 10: RESULT

After all the calculations and calibration following result was obtained:

S.R. NO.	Rotameter Reading in LPM	Digital Reading Shown on LCD in LPM
1	12	12.16
2	10	10.12
3	8	8.1
4	6	6.06
5	4	4.05
6	2	2.02
7	1	1.01

Table 10.1: Comparing reading on GTR and LCD

As the above tables shows the different flow in lpm for the same flow, one side there is analog reading shown by rotameter and other side there is digital reading shown in lcd sense by hall effect sensor as the reading shown in lcd sensed by hall effect sensor there is slightly difference in the reading shown in rotameter for same flow.

CHAPTER 11: CONCLUSION

I hereby conclude the project report of **"DIGITIZATION OF GLASS TUBE ROTAMETER [GTR]"**. The report aims to achieve complete reference for the project's development and design cycle. This development is a flow measuring device who thereby can be called as a successor of an existing flow measuring device that is GTR. The device offers a digital display to check the reading. It also provides live control buttons to change the required flow of the fluid in the live time. The main objective of the project has been achieved that is digitization. Apart from that following objectives were accomplished;

- **Digital reading** was obtained.
- The device provides us the **improved accuracy**.
- Automation in **controlled flow** is achieved.
- The device is **easy to operate** and does not need a skilled worker.
- There is no constant need of manual assistance.
- Flow rate of opaque fluids can also be measured with the same accuracy.
- The device produced is very **cost effective** comparatively with the product existing in the market.

CHAPTER 12: FUTURE SCOPE

flow meters with digital displays and measurement methods have been standard in most industries. Digital flow meters take the data the mechanism is capturing and translate it into easy-to-read quantities that are much more reliable than traditional rotameter-style flow meters.

You can find almost every type of flow meter with a digital display. At the least, these meters are easier to read, but they can also provide improved accuracy with more complex interior workings. Because they have exterior power, they rely less on the pressure and temperature of fluid. This makes the readings they provide more reliable in applications that require precision.

We can add a pH sensor, temperature sensor, and turbidity sensor to check the quality of water. We can also use the ultrasonic sensor to check the level of water in the tank. If the water level is low then the notification will be sent to users. By using a solenoid valve, we can turn on/off the water supply from any place. Also, we can predict water usage using machine learning algorithms. It can also be possible to notify the user if the water is not good enough for drinking.

CHAPTER 13: REFERENCE

[1] **Michal Urbanski**, "Investigation of Flow in a Rotameter "Article · July 1992.

[2] **Ria Sood,** thesis of "Prediction and Performance of Rotameter Using CFD.

[3] **William Banko,** conducted research on, the fluid flow meter of the invention comprises a fluid tight housing including an inlet and an outlet, including at least one slot Volume 5, Issue 6, June 2015.

[4] **Lars O. Rosaen,** invented a Fluid Flow Indicator Including A Hall Effect Transducer, relates to fluid flow monitors, and more particularly, to a fluid flow rate indicating assembly, pg.549-561 (2016).

[5] **William Banko,** conducted research on, the fluid flow meter of the invention comprises a fluid tight housing including an inlet and an outlet, including at least one slot, the slot for receiving fluid from the inlet and communicating it to the outlet, pg.59-61 (2014).