A Minor Project Report on

"AquaFlowControl Pro"

Bachelor of Engineering in

Mechanical Engineering

Submitted by

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CERTIFICATE

This is to certify that Capstone Project entitled **"AquaFlowControl Pro"** submitted by **Team B5 to** the **KLE Technological University**, Hubli-580031, towards partial fulfillment for the award of the degree of Bachelor of Engineering is a bona-fide record of work carried out by him/her under our supervision. The contents of project report, in full or in parts, have not been submitted to any other institute or university for award of any degree or diploma.

Prof. Gururaj Fattepur

Guide

Dr. B. B. Kotturshettar

Head of department

ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without mentioning the people who made it possible and whose guidance and encouragement has made our efforts successful.

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Student signatures

(Team B5)

Course: Minor Project

Course code: 18EMEW303

Semester: Six

Credits: 6

Team size: Six in a team

Team criteria: Team members can be from different divisions, Minimum of one diploma student in a team and selection of one student from other branches is optional.

Theme: Precision Agriculture, Hospital Automation, Factory Automation, Social Issues or Any other Mechatronic Product.

PHASE 1-7

Team -5

Phase wise Contents:

1. Refined problem statement		*(Tick mark the cell once each activity is completed)*
1.1	Identifying end users (Customers)	
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Phase 1

1 Refined problem statement :- Smart water management system.

1.1 Identifying end users :-

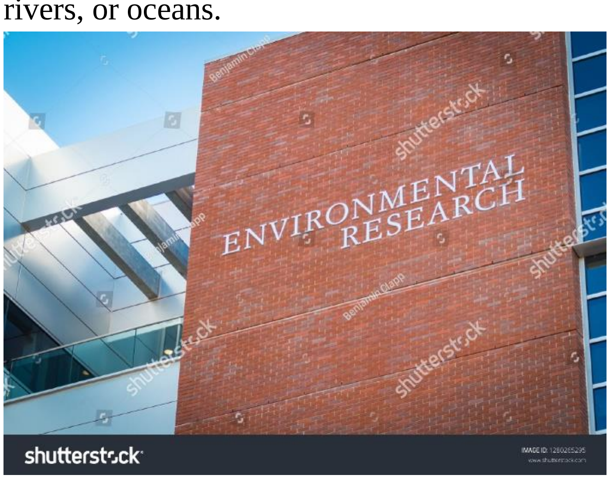
•Residential customers: Homeowners or renters may use water level sensors to monitor their water usage and identify opportunities to conserve water and save money on utility bills.

•Commercial customers: Businesses that rely on water for their operations, such as restaurants or manufacturing facilities, may use water level sensors to track their water usage and identify opportunities to optimize their processes.

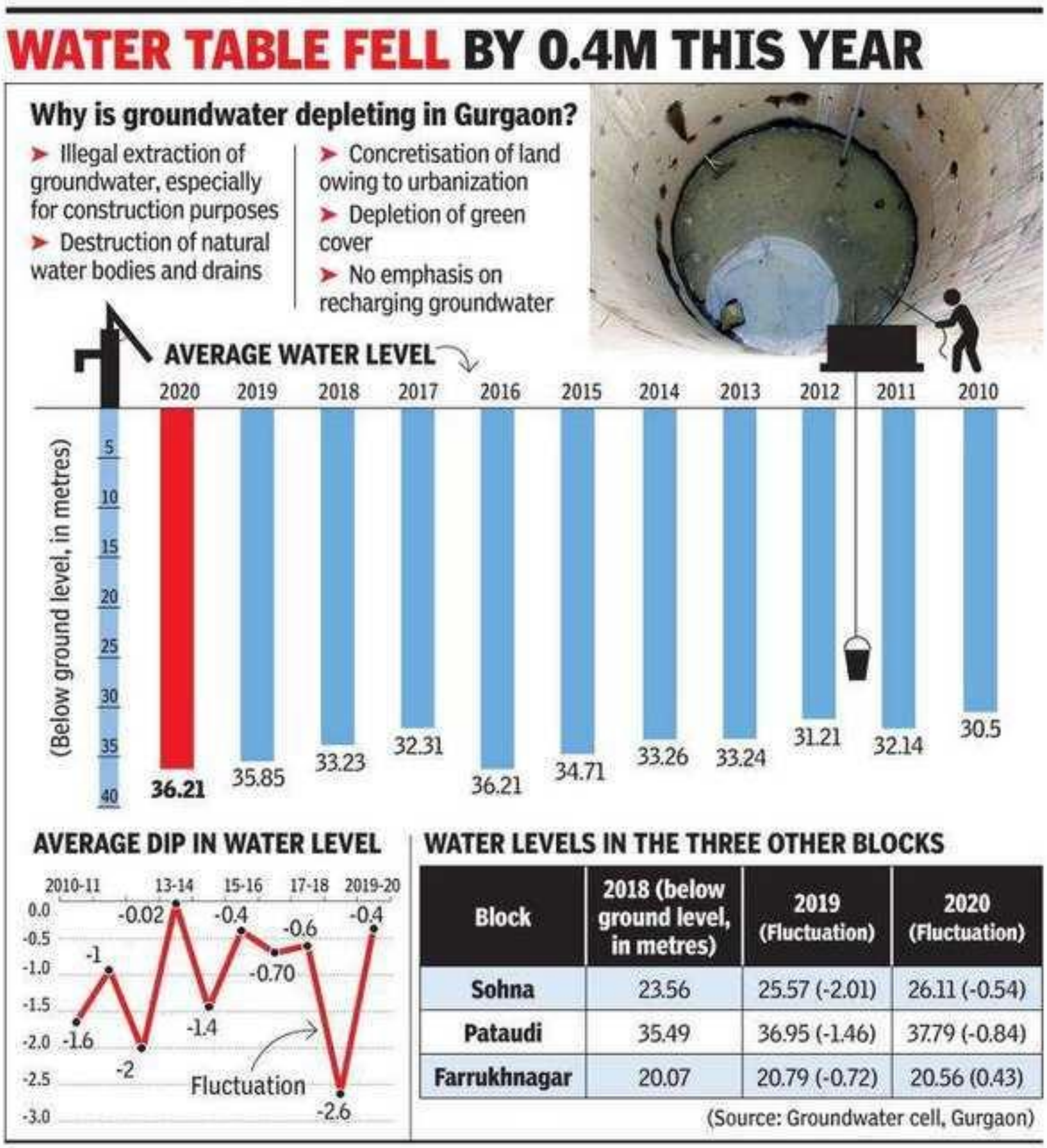
•Municipalities: Local governments may use water level sensors to monitor water usage in their communities, detect leaks or other issues in the water supply system, and enforce water conservation policies.

•Agriculture industry: Farmers or agricultural businesses may use water level sensors to monitor their irrigation systems and optimize water usage in their fields.

•Environmental researchers: Scientists and researchers may use water level sensors to collect data on water usage and environmental conditions in natural bodies of water, such as lakes, rivers, or oceans.



- In metropolitian cities the ground water table is depleting at an alarming rate, to cater the ever increasing population and hence there will be cap on the amount of water being used for each household in the near future.



Block	2018 (below ground level, in metres)	2019 (Fluctuation)	2020 (Fluctuation)
Sohna	23.56	25.57 (-2.01)	26.11 (-0.54)
Pataudi	35.49	36.95 (-1.46)	37.79 (-0.84)
Farrukhnagar	20.07	20.79 (-0.72)	20.56 (0.43)

1.2 Identify customer needs

1. Accurate measurement: Customers may want a water level sensor that accurately measures the volume of water being used to ensure that they are not being overcharged for their water usage.
2. Convenience: Customers may want a water level sensor that is easy to use and does not require a lot of maintenance. They may also prefer a sensor that is easy to install and can be used with different types of water storage tanks.
3. Energy efficiency: Customers may want a water level sensor that is energy-efficient and does not require a lot of power to operate.
4. Cost-effective: Customers may want a water level sensor that is affordable and provides value for their money.
5. Safety: Customers may want a water level sensor that is safe to use and does not pose any hazards, such as electrical shocks or fires.
6. Compatibility: Customers may want a water level sensor that is compatible with their existing water supply system and can work with different types of pipes and tanks.
7. Durability: Customers may want a water level sensor that is durable and can withstand different weather conditions and water quality.
8. Customization: Customers may want a water level sensor that can be customized to meet their specific needs and preferences.
9. Timely alerts: Customers may want a water level sensor that provides timely alerts when the water level is running low or when the maximum quantity has been reached. This helps to avoid wastage and to ensure that there is always enough water available when needed.
10. Easy integration: Customers may want a water level sensor that can be easily integrated with their existing water management systems to provide real-time data on water usage and to enable them to track and analyze water consumption patterns.

1.3Analyzing the needs

Question/Prompt	Customer Statement	Interpreted Need/ Expectations
Typical uses	I want accurate measurement of the total water used	Making the product as accurate as possible
	I want the product to cutoff the water supply when maximum level is used	Installing a solenoid valve
	I don't want to check the water used manually	Make the product IoT based
Likes-current methods followed(traditional techniques)	Traditional methods use a meter based product	A meter based product is more reliable as it is mechanical and not electronic
	Traditional devices may be compatible with existing water systems	Compatibility is easier, making them easier to integrate into an existing setup without requiring major changes.
Dislikes-current methods followed(traditional techniques)	Traditional methods are often prone to errors and inaccuracies, which can lead to incorrect readings and calculations	Inaccuracy is the most major con of using a traditional meter based method
	It is labor intensive	Traditional methods often require manual labor, such as taking readings and measurements, which can be time-consuming and costly
	It is High maintenance	Traditional methods may require regular calibration and maintenance to ensure accuracy and reliability
	Limited scalability	Traditional methods may not be easily scalable, meaning that they may not be able to accommodate larger or more complex water systems
Suggested Improvements	Making a water level measurement device which is IoT based and cuts off the water supply after the prescribed maximum water limit is used	

1.4 Requirements List

Requirements
Accuracy: The water level sensor must be able to measure the volume of water used with an accuracy of at least ±1% of the total volume.
Maximum quantity setting: The water level sensor must be able to set the maximum quantity of water that can be used, with a minimum resolution of 1 liter.
Automatic cut-off: The water level sensor must have a mechanism for automatically cutting off the water supply when the maximum quantity has been reached, with a response time of less than 5 seconds.
Compatibility: The water level sensor must be compatible with different types of water storage tanks and pipes, with a range of pipe diameters from 0.5 inches to 2 inches.
Installation: The water level sensor must be easy to install, with a plug-and-play design that does not require extensive technical expertise or complex wiring.
Energy efficiency: The water level sensor must consume minimal power to operate, with a maximum power consumption of 100 watt.
Low maintenance: The water level sensor must be low-maintenance, with a minimum lifespan of 5 years and no need for frequent calibration or replacement of parts.
Durability: The water level sensor must be durable and able to withstand different weather conditions and water quality, with an IP65 or higher rating.
Safety: The water level sensor must be safe to use, with a maximum voltage of 24 volts DC and protection against electrical hazards such as short circuits and overvoltage.
Timely alerts: The water level sensor must be able to provide timely alerts when the water level is running low or when the maximum quantity has been reached, with a minimum update frequency of once every 5 seconds.
Customization: The water level sensor must be customizable to meet specific customer needs and preferences, with a software interface for adjusting settings such as the maximum quantity and alert thresholds.
Real-time monitoring: The water level sensor must be able to provide real-time data on water usage and consumption patterns, with a minimum data rate of once every minute.
Cost-effectiveness: The water level sensor must be affordable and provide value for money.

Here's a yes or no questionnaire for common households using a municipality meter based water supply:-

NOTE :- MARK ✓ For YES | MARK ✕ For NO

1. Do you frequently run out of water unexpectedly? (Yes/No)
2. Do you want to reduce your water bills by monitoring and controlling your water usage? (Yes/No)
3. Do you have a water storage tank or a need to manage water usage for a specific purpose? (Yes/No)
4. Do you want to prevent overuse or wastage of water? (Yes/No)
5. Do you want to automate the process of monitoring and controlling your water usage? (Yes/No)
6. Do you want to be alerted when the water level is low or when the maximum quantity has been reached? (Yes/No)
7. Do you want to customize the maximum quantity setting based on your specific needs? (Yes/No)
8. Do you want to reduce your environmental impact by conserving water? (Yes/No)
9. Do you want to make sure that you are not exceeding any water usage regulations or restrictions in your area? (Yes/No)
10. Do you want a simple, easy-to-use solution for managing your water usage? (Yes/No)

1. ನೀವು ಅಪಾರವಾಗಿ ನೀರಿನಿಂದ ಕೊನೆಗೆ ಬಿಟ್ಟುಕೊಳ್ಳುವುದು ಸಾಧಾರಣವಾಗಿದೆಯೇ? (ಹೌದು / ಇಲ್ಲ)
2. ನೀರಿನ ಬಿಲ್ಲುಗಳನ್ನು ಕಡಿಮೆಮಾಡಲು ನೀವು ನೀರಿನ ಬಳಕೆಯನ್ನು ಮಾನಿಟರ್ ಮಾಡಿ ನಿಯಂತ್ರಿಸಲು ಬಯಸುವಿರಾ? (ಹೌದು / ಇಲ್ಲ)
3. ನೀವು ನೀರಿನ ಸಂಗ್ರಹಣ ಟ್ಯಾಂಕ್ ಹೊಂದಿರುವುದು ಅಥವಾ ನಿರ್ದಿಷ್ಟ ಉದ್ದೇಶಕ್ಕಾಗಿ ನೀರಿನ ಬಳಕೆಯನ್ನು ನಿರ್ವಹಿಸಬೇಕಿದ್ದೀರಾ? (ಹೌದು / ಇಲ್ಲ)
4. ನೀರಿನ ಅತಿ ಬಳಕೆಯನ್ನು ತಡೆಗಟ್ಟಲು ಬಯಸುವಿರಾ? (ಹೌದು / ಇಲ್ಲ)
5. ನೀರಿನ ಬಳಕೆಯನ್ನು ಸ್ವಯಂಚಾಲಿತವಾಗಿ ಮಾನಿಟರ್ ಮಾಡುವ ಪ್ರಕ್ರಿಯೆಯನ್ನು ಸುಲಭವಾಗಿ ಮಾಡಲು ಬಯಸುವಿರ? (ಹೌದು / ಇಲ್ಲ)

Survey:

Conducting Survey In Nikunj Apartment

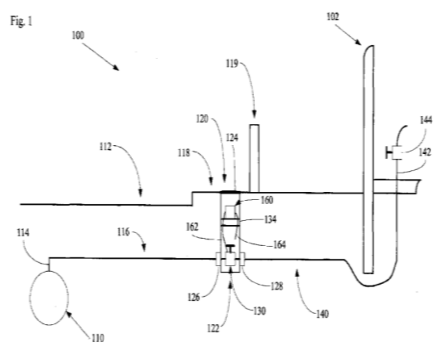
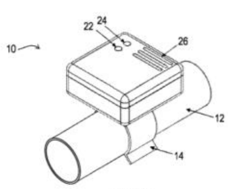
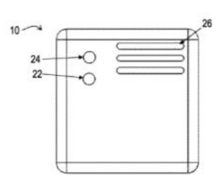
Phase 2

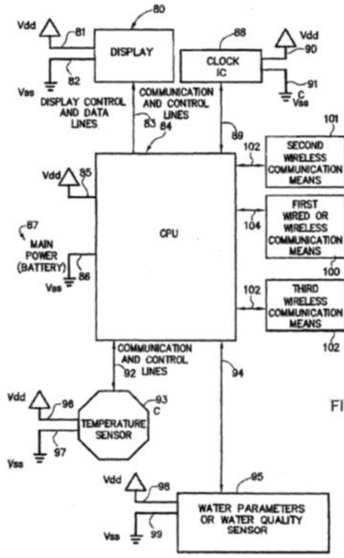
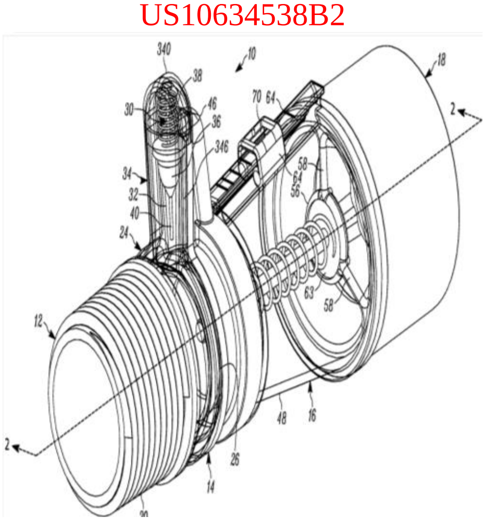
Product Benchmarking -- 2.1 Studying and exploring competitive products

Products	Specifications	Cost	Advantage	Limitations	Availability
	1. Manufacture Water Sparks 2. Country of Origin India 3. Number of Memory Sticks 1 4. Item Weight 300 g 5. Product Dimensions10 x 7 x 6 cm; 300 Grams 6. Item part number DFM 01 7. Item Height 6 Centimeters 8. Item Width 7 Centimeters 9. Are batteries included? Yes	₹5,320	Digital Screen	Cost Not IoT Integrated No-real Time data of consumption No-Warning System	In Stock On AMAZON
	1. Brand Rymac 2. Manufacturer Venus Createch Solutions 3. Country of Origin India 4. Number of Memory Sticks 1 5. Item Weight 240 g 6. Package Dimensions- 11 x 9.2 x 6.8 cm; 240 Grams 7. Batteries 2 AAA batteries required. (included) 8. Item part number RYDLFM 9. Are batteries included?-Yes	₹4,920	Digital Screen	Cost Not IoT Integrated No-real Time data of consumption No-Warning System	In Stock On AMAZON

	1. Manufacturer-Restmo 2. Item model number O-WM-1 3. Product Dimensions-3.56 x 19.05 x 5.59 cm; 110.56 Grams 4. ASIN-B08XZTP66F 5. Item Weight110 g 6. Item Dimensions-LxWxH 36 x 190 x 56 Millimeters	₹7,500	Digital Screen	Cost Not IoT Integrated No-real Time data of consumption No-Warning System	In Stock On AMAZON
	1. Brand-Shanrya 2. Manufacturer-Shanrya 3. Country of Origin-China 4. ASIN-B09MG2SQVT	₹5,886	Easy Install	Cost Not IoT Integrated No-real Time data of consumption No-Warning System Not Digital	In Stock On AMAZON
	1. Brand-JAPSIN 2. Manufacturer-JAPSIN 3. Colour-Blue 4. Item Weight 1 kg 60 g 5. Package Dimensions 17.6 x 10.8 x 9.4 cm; 1.06 Kilograms 6. Are batteries included? No	₹3,500	Easy Install	Cost Not IoT Integrated No-real Time data of consumption No-Warning System Not Digital	In Stock On AMAZON

2.2 Patent search

Patent	Information
WO2016124931A1 	A location is including an installation associated with a site.At the site is a a house. A water main forms part of a water distribution network and is buried approximately Im below the surface of a road. A ferrule extends from an upper part of the water main pipe and is in fluid communication with a first portionof a service pipe at depth of typically approximately 0.75m and which extends from the water main to underneath a pavement An outside stop-tap or meter chamber is provided below pavement and includes a pilotable cover, which can be opened to provide access to the interior of the chamber A first connector is provided on an upstream side of the chamber and a second connector is provided on a downstream side of the chamber. A stop-tap or stop-tap and meter assembly is provided within the chamber and in fluidic communication with the first and second connectors. An insulating member ,for example in the form of a piece of polystyrene, extends across the interior of the chamber and acts to insulate the lower part of the chamber from the environment above. A temperature logging device is located on the insulating member and includes a first temperature sensor.Optionally the temperature logging device may also include a second temperature sensor .The temperature of a part of a water supply system between a water main and a site is recorded as a function of time. The recorded temperature as a function of time is analysed to determine a property indicative of the water consumption at the site.
GB2546126B  Figure 1 	The present invention generally relates to a water flow detector for detecting a flow in a building water supply system comprising a pipe, and to a method for detecting a flow in such a building water supply system. In an embodiment, a method of providing water consumption feedback to a user of such a building water supply system uses the water flow detector and/or the method for detecting a flow.

US20160076909A1  FIG. 3	The present invention is a water use and/or a water energy use monitoring apparatus that is affixed to the hot and cold water supply piping for continuously (or on demand) monitoring displaying the water and water energy (hot vs. ambient) use within a residential or commercial building. A first wire or wireless means is incorporated to communicate with a remote display for viewing by the owner of a commercial building or occupier/resident of a home. A second optional wire or wireless means can be incorporated that can be monitored by civil, commercial, governmental or municipal operators or agencies, using a remote display and/or recorder means or by a secure wire or wireless communication network (e.g. cell phone, smart phone or other similar technology communication means). A third wireless means communicates water parameter data utilizing typical cell tower technology and/or mesh network technology. The water use monitor apparatus includes a power generation, a microprocessor, temperature and water flow sensors, optional water quality sensors, timing circuits, wireless circuitry, and a display means. A wired or wireless means is designed to electronically communicate water use, water energy use and/or water quality information to a remotely located display apparatus or typical cell phone, smart phones, or similar apparatus for convenient observation by a commercial, operator or occupier, resident, municipal or government agency.
US10634538B2 	Flow sensors are provided that can provide both leak detection and flow monitoring. The flow monitoring enables a determination whether there are blockages or leaks in a fluid system during normal operation of the system. The leak detection enables detection of leaks when the system is shut off. The flow sensors can use a frusto-conical flow guide to provide a more compact flow sensor. For instance, one could unintentionally spike buried irrigation conduits with a shovel or other tool or machine during lawn care. Further, fluid systems can develop blockage in the lines and the components which will cause an undesired amount of fluid to be delivered through system. With an irrigation system, this could result in insufficient water being delivered to the vegetation. Overall, the damage or interference with proper flow in a fluid system can result in damage and additional cost.

2.3 Literature survey

Literature details	Gathered Information
Saireddy, M. & Shanthi, S.. (2022). Real-time water flow sensor using GSM module and IoT. AIP Conference Proceedings. 2519. 030060. 10.1063/5.0119985	According to today's scenario water is an important source of nature's gift to humans and animals. Without water life is not possible in this earth. Survey says that earth is surrounded by one third of water. But most of the water is salt water. The drinking water is just 4 percent. So this ample amount of water has to be saved. But all humans are consuming excess amount of water nowadays which is a threat to life of all species in this earth. It all affects human in some ways. In the present scenario one no has time to protect our water from being used excess. In all of this excess water consumption has a greater impact towards environment. The 3 % of the death rate is due to the lack of availability of water. So we should provide a good source of water to all the people in the world. In this proposed system we are going to design an E water meter with a help of water flow sensor. These sensors play a major role in this technology. A water flow sensor is placed in the main water pipe which will help in measuring the actual water that is been used by the consumer. These sensors are connected by using microcontroller with the help of GSM network. When the sensor senses the flow of water inside the water pipe the sensed data is transmitted to the controller. If the water consumption is above the threshold value it will automatically intimates the user with the help of GSM. Automatic billing system can also be implemented for future use in order to save the enormous consumption of water.
Harikumar, Harija & George, Boby & Tangirala, Arun. (2021). A Cantilever-Based Flow Sensor for Domestic and Agricultural Water Supply System. IEEE Sensors Journal. PP. 1-1. 10.1109/JSEN.2021.3121306.	Most of the existing flow sensors are expensive and limited in their capabilities for sensing bidirectional flow. Low-cost and accurate flow sensors with bidirectional sensing capability have numerous applications in the residential and irrigation sectors. Evaluation of a low-cost, cantilever-based sensor, suitable for measuring

	flow rates under turbulent flow conditions is presented in this article. Such sensors are reported for micro-fluidic applications but its potential application in large diameter pipes under turbulent flow has not been studied yet. A cantilever formed using a thin stainless-steel strip is used as the sensing element in the proposed sensor. One of the ends of the cantilever is firmly fitted to the inner wall of the pipe, and it bends or deflects towards the direction of the flow as a function of the flow rate. To experimentally evaluate the sensor in detail, the mean deflection angle of the cantilever is measured using a camera, and an image processing algorithm. In practice, the angle can be sensed using simpler methods. The performance of the prototype sensor has been evaluated after building an appropriate regression model. The results are subsequently expressed in terms of the mean flow velocity, thereby providing its potential utility in pipes of other dimensions. The shape of the mean flow velocity with respect to the mean angle of deflection characteristic of the proposed sensor matched well with the theoretical deflection computed. The sensor developed has given an accuracy of 3 % of full scale, for flow rates in the range of 2–15.5 m The proposed sensing mechanism can realize cost-effective, simple, and reliable flow sensors. Such sensors will find applications in residential and industrial domains.
Faishol, Muhammad & Ismail, Munaf & Hapsari, Jenny. (2022). Design and Build a Water Pump Protection Tool Using IOT (Internet Of Things) Based Water Flow Sensor. Journal of Applied Science and Technology. 2. 16. 10.30659/jast.2.02.16-27.	Water is often taken with the help of a pump to remove water from the well to be filled into the reservoir.However, often during the dry season, many pumping machines are damaged because the pump is on but thewater in the well (source) is empty and no one knows it, so the pump engine does not turn off, therefore it cancause the pump to fail. be damaged. This study designed a system that can monitor the flow of water using theBlynk application. Monitoring is carried out using a smartphone with a NodeMCU ESP8266 microcontrollerconnected to the internet

	network. The sensor used is a water flow sensor to detect the flow of water. The Blynkapplication is used by the user as a data display for the NodeMCU ESP8266 microcontroller which is integratedinto the internet network. The results of the research water flow sensor has worked well on the water pump.After testing the distance, the distance is detected indefinitely provided that the microcontroller and the blynk application are connected to the internet network, and do not experience internet network trouble.
Jarrah, Asem & Aljabarin, Nader. (2022). Magnetic Coupling of Two Coils Due to Flow of Pure Water Inside Them – Double Coil Volumetric Flow Sensor. Advances in Science and Technology Research Journal. 16. 47-53. 10.12913/22998624/147973.	In this work a simple new type of flow sensors was developed; the double coil flow sensor. In this sensor two coils are magnetically coupled due to the flow of pure water inside them. The first coil, the primary coil, was supplied by AC voltage in the frequency range 0.5-1 MHz which is the coupling range of frequency for water. The voltage in the second coil, was found to be directly proportional with the volumetric flow rate of the water flowing inside the coils. The two coils can only be coupled in the laminar flow region. In the turbulent region, due to the turbulent chaos and fluctuation the two coils cannot be effectively coupled, and therefore the sensor cannot be used. The temperature of the water was found to have a negligible effect on the coupling, which add a good advantage to the simplicity of the double coil sensor. The working fluid used in this work was pure water. Other fluids are believed to be working as well, most probably at different frequency range, and this will be the subject of future work.

Phase 3

2. Design Specifications

3.1 Brainstorming

Keywords	
1. Water	16. Interruption
2. Flow	17. Data
3. Sensor	18. Performance
4. Volume	19. Container
5. Measurement	20. Shape
6. Automatic	21. Opacity
7. Cutoff	22. Contaminants
8. Maximum	23. Debris
9. Quantity	24. Temperature
10. Engineering	25. Humidity
11. Precision	26. Installation
12. Accuracy	27. Cost
13. Calibration	28. Household
14. Maintenance	29. Business
15. Power	30. Application

3.2 OFMC Chart

Keywords	Objectives	Functions	Means	Constraints
Accuracy	✓			
Efficiency	✓			
Precision	✓			
Reliability	✓			
Cost-effectiveness	✓			
Maintenance	✓			
User-friendly	✓			
Calibration	✓			
Real-time monitoring	✓			
Monitoring		✓		
Logging		✓		
Interfacing		✓		
Displaying		✓		
Storing		✓		
Cutting-off		✓		
Communicating		✓		
Sensor technology			✓	
Flow metering			✓	
Control algorithms			✓	

Actuator design			✓	
Programming logic			✓	
Wireless communication			✓	
Data analytics			✓	
Power management			✓	
Cost				✓
Size				✓
Temperature				✓
Viscosity				✓
Pressure				✓
Compatibility				✓
Latency				✓
Corrosion				✓
Contamination				✓

3.3 Objectives

Accuracy
Efficiency
Reliability
Cost-effectiveness
Maintenance
User-friendly
Calibration
Real-time monitoring

3.4 Constraints

Cost
Size
Temperature
Viscosity
Pressure
Compatibility
Latency
Corrosion
Contamination

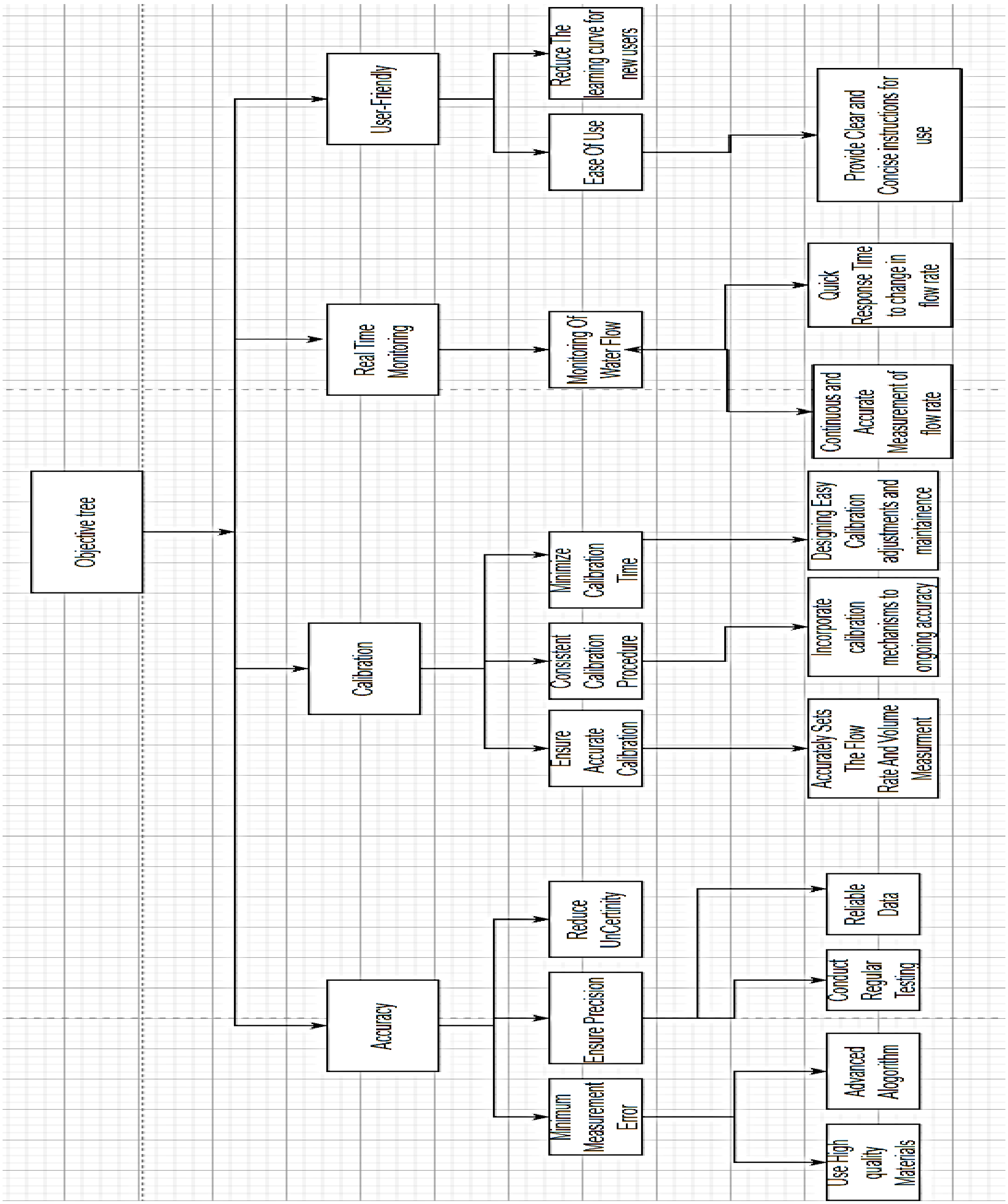
3.5 Objective tree (affinity diagram)

O#	Objectives	First level objectives	Second level objectives
1	Accuracy	Achieve high accuracy Minimize measurement errors Ensure reliable readings Enhance precision Reduce uncertainty	Select appropriate sensing technology Optimize calibration process Use high-quality materials and components Implement advanced signal processing algorithms Reduce environmental and external factors that can affect accuracy Ensure proper installation and maintenance Conduct regular testing and verification Provide accurate and reliable data outputs Meet or exceed industry standards and regulations Continuously improve accuracy through research and development
2	Efficiency	Maximize efficiency Optimize resource utilization Reduce energy consumption Improve response time Increase throughput	Design a sensor with low power requirements Minimize pressure drop and flow disturbance Implement fast and accurate data processing Reduce mechanical losses and friction Use materials with high thermal conductivity and low heat capacity Optimize system control and automation Implement self-cleaning mechanisms to reduce maintenance needs Design for easy installation and operation Ensure compatibility with existing infrastructure and devices

3	Reliability	Ensure high reliability Maximize system uptime Minimize failures and downtime Increase operational availability Enhance system durability	Use high-quality materials and components Implement redundancy measures Conduct thorough testing and verification Implement proactive maintenance procedures Provide clear and concise system documentation Ensure compatibility with existing systems and infrastructure Design for ease of repair and replacement Monitor and analyze system performance Implement fault detection and correction mechanisms Continuously improve reliability through research and development.
4	Cost-effectiveness	Achieve high cost-effectiveness Minimize overall system cost Increase system efficiency Enhance system performance while minimizing costs Optimize return on investment	Use cost-effective sensing technology and components Optimize system design to minimize cost and complexity Implement efficient manufacturing processes Use energy-efficient components and systems Conduct life-cycle cost analysis to identify cost-saving opportunities Optimize maintenance and repair procedures to reduce downtime and costs Design for ease of installation and integration Minimize waste and environmental impact Use economies of scale to reduce component and manufacturing costs Continuously improve cost-effectiveness through research and development.

5	Maintenance	Minimize maintenance requirements Maximize sensor uptime Ensure easy maintenance and repair	Use durable and reliable materials Design for easy cleaning and maintenance Implement effective diagnostics and troubleshooting capabilities Provide accessible and replaceable components for quick repairs Incorporate self-cleaning mechanisms to reduce maintenance needs.
6	User-friendly	Ensure ease of use for all users Maximize user satisfaction with the device Reduce the learning curve for new users	Incorporate intuitive and user-friendly interfaces Provide clear and concise instructions for use Design for ergonomics and ease of handling Incorporate visual indicators for system status Provide customizable settings for user preferences Include user-friendly error messages to aid troubleshooting Implement automatic self-calibration to minimize user input.
7	Real-time monitoring	Real-time monitoring of water flow	Continuous and accurate measurement of water flow rate Quick response time to changes in flow rate Integration with data logging and recording systems Real-time alerts and notifications for abnormal flow rate Compatibility with remote monitoring and control systems
8	Calibration	Ensure accurate calibration Establish consistent calibration procedures Minimize calibration time and effort	Develop a calibration procedure that accurately sets the flow rate and volume measurements Incorporate calibration verification mechanisms to ensure ongoing accuracy Design a system that enables easy calibration adjustments and maintenance

Objective tree:



3.6 Design Specifications:

Si.	Engineering Specifications	Units
1	Flow range	0-100 liters/minute
2	Accuracy	+/- 1% of reading
3	Resolution	0.1 liters/minute
4	Maximum working pressure	10 bar
5	Working temperature	10 to 50 degrees Celsius
6	Power supply	12-24 V DC
7	Output signal	4-20 mA or 0-10 V DC
8	Response time	<100 ms
9	Protection class	IP65
10	Communication interface	RS485, 10Mb/s-100Kb/s

3.7 Competitive Benchmarking:

Sl.no	Metric	Units	Competitive Products		
			DIGITEN Water Liquid Flow Rate	Water Sparks Digital Flow Mete	JAPSIN
1	Item Weight	gms	280	300	690
2	Flow Rate	LPM	10-120	10-100	1-30
3	Inlet size	inch	1 Male End	1.5Male End	1 Male End
4	Outlet size	inch	1 Male End	1.5Male End	1 Male End
5	Voltage	Volts	12	8	12-20

Phase 4

4.1 Concept Generation

Defining Functions

Si.	Functions
1	**Measurement: This function measures the volume of water that has passed through the sensor. It uses a flow meter to detect the amount of water flowing through the system.**
2	**Control : This function controls the flow of water through the system. When the maximum quantity of water is reached, it sends a signal to shut off the supply of water.**
3	**Logging : This function logs the volume of water used over time**
4	**Shut off function: This function shuts off the water supply when the maximum quantity of water has been reached. It ensures that no excess water is used and helps to conserve water**
5	**Real-time monitoring function: This function enables the user to monitor water usage in real-time through a web or mobile app**
6	**Historical data function: This function stores historical data on water usage and enables the user to analyze usage patterns over time.**

4.2 Morphological Chart

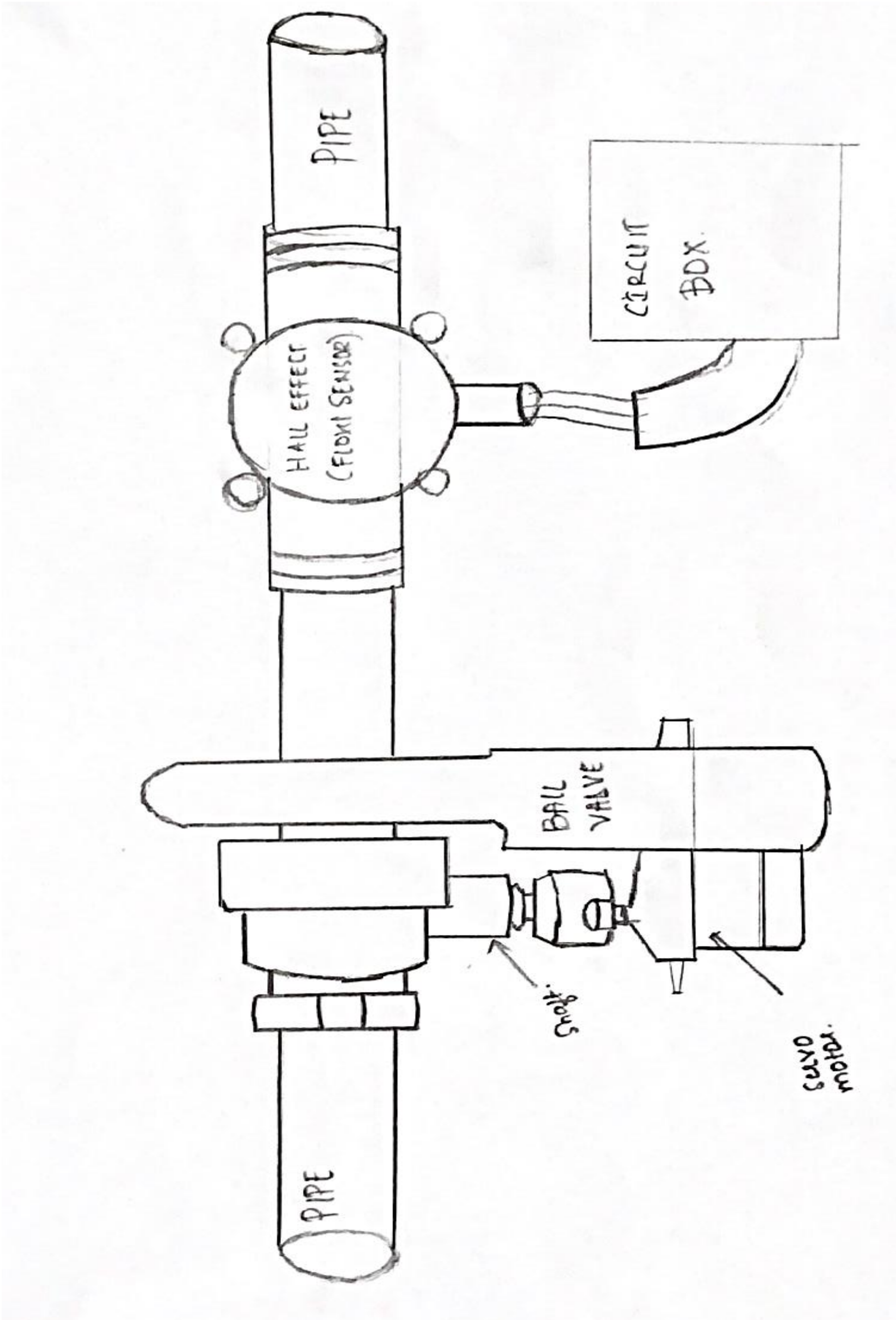
Functions ▼	Means ▶	**Means 1**	**Means 2**	**Means 3**	**Means 4**
Automatic Shut off		Ball Valve	Gate Valve	Solenoid Valve	Butterfly Valve
Measurement sensor		Hall Effect Sensor	Ultrasonic Flow Sensor	Turbine Flow Sensor	Vortex Flow Sensor
Connectivity		Wi-Fi	Ethernet	Bluetooth	Cellular Network
Power Supply		DC Power	AC Power	Rechargeable Battery	Solar
Motor		Servo Motor	Stepper Motor	DC Motor	Shunt Motor

4.3 Generating design alternatives

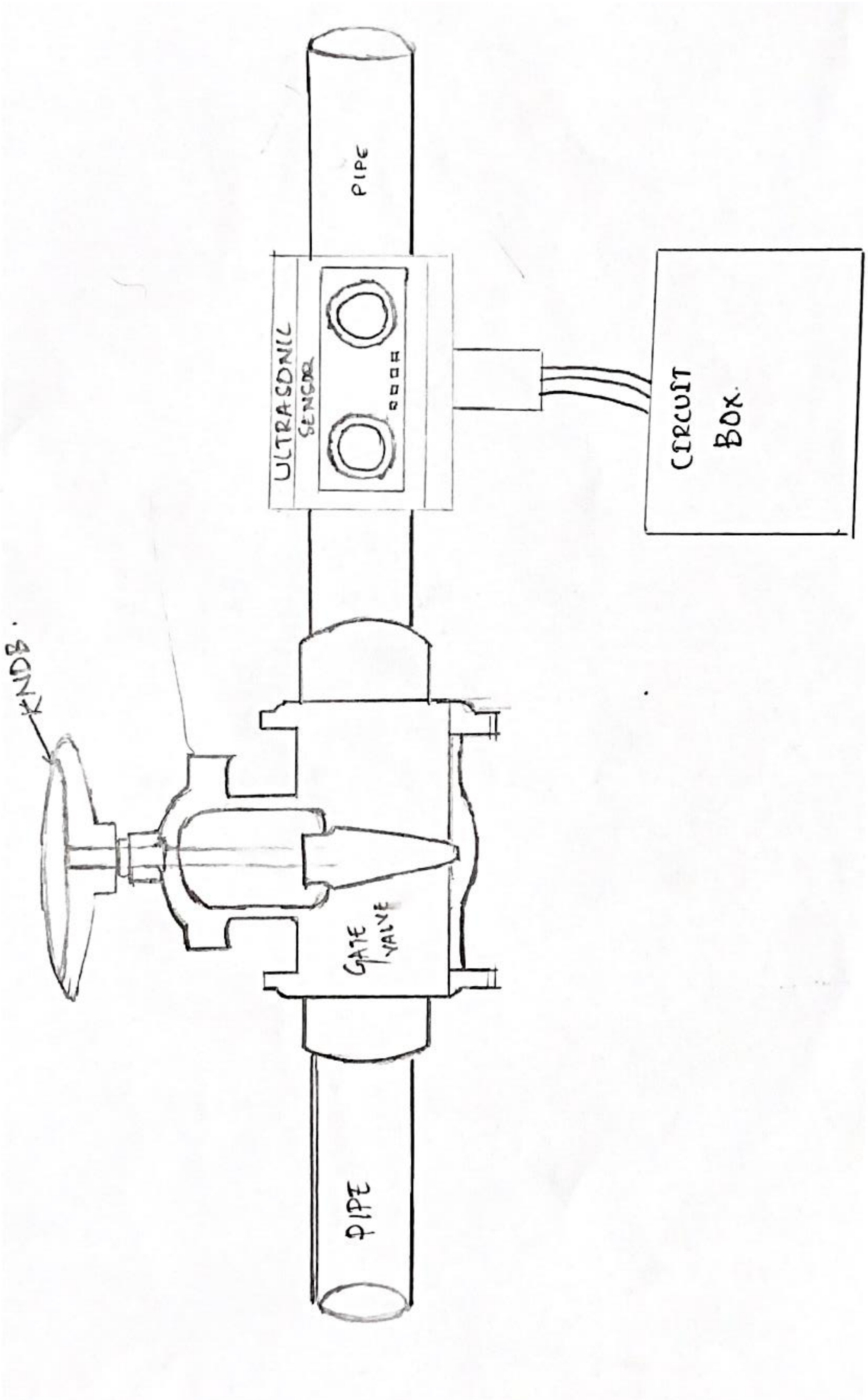
Identified Design Alternatives:

Si.	**Design Alternatives**
1	**Water Flow Sensor and Conservation with Hall Effect sensor and ball valve**
2	**Water Flow Sensor and Conservation with Ultrasonic flow sensor and gate valve**
3	**Water Flow Sensor and Conservation with Turbine flow sensor and solenoid valve**
4	**Water Flow Sensor and Conservation with Vertex Flow Sensor and Butterfly valve**

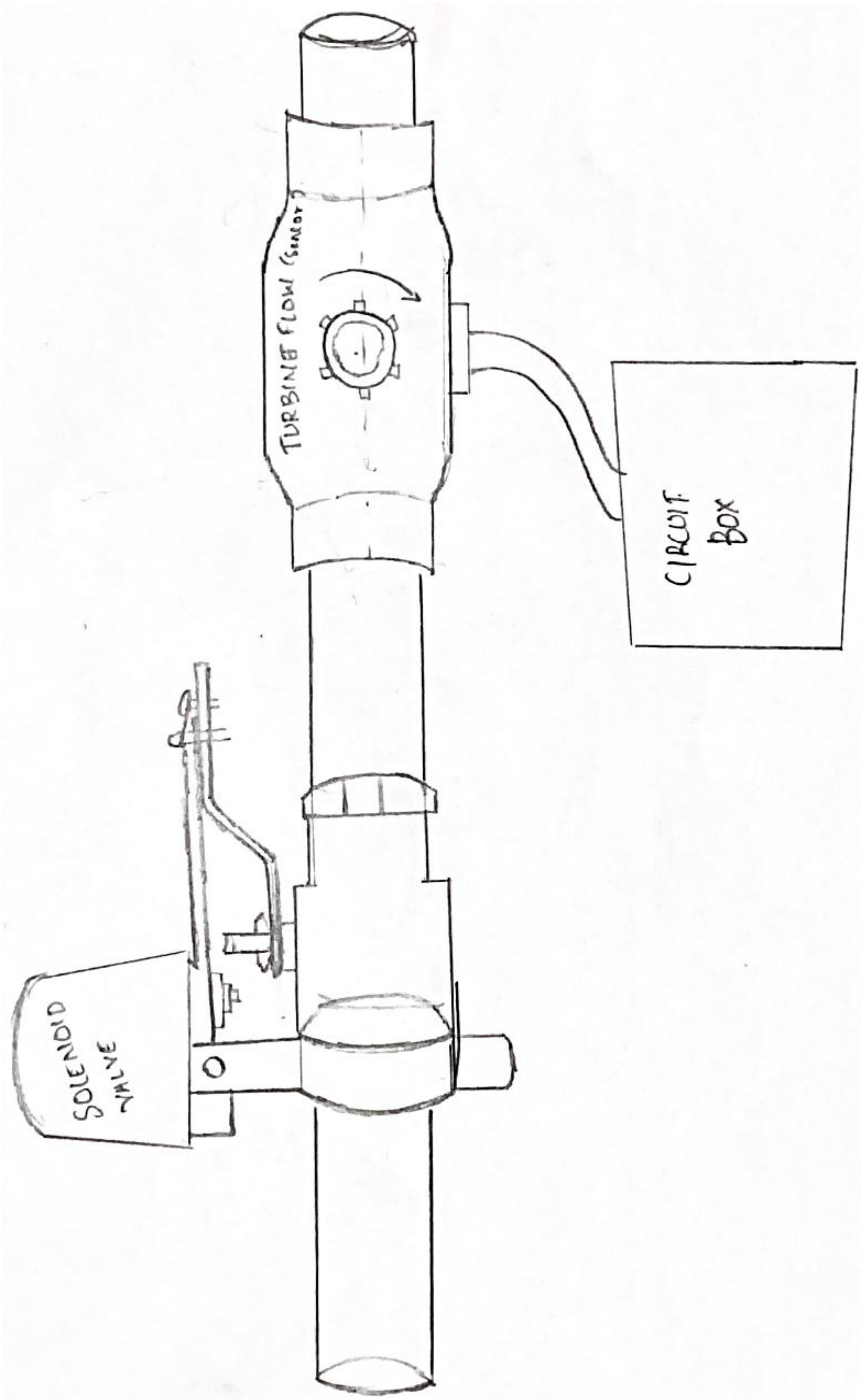
Design 1:


PIPE
CIRCUIT BOX.
HALL EFFECT (FLOW SENSOR)
BALL VALVE
Shaft.
PIPE

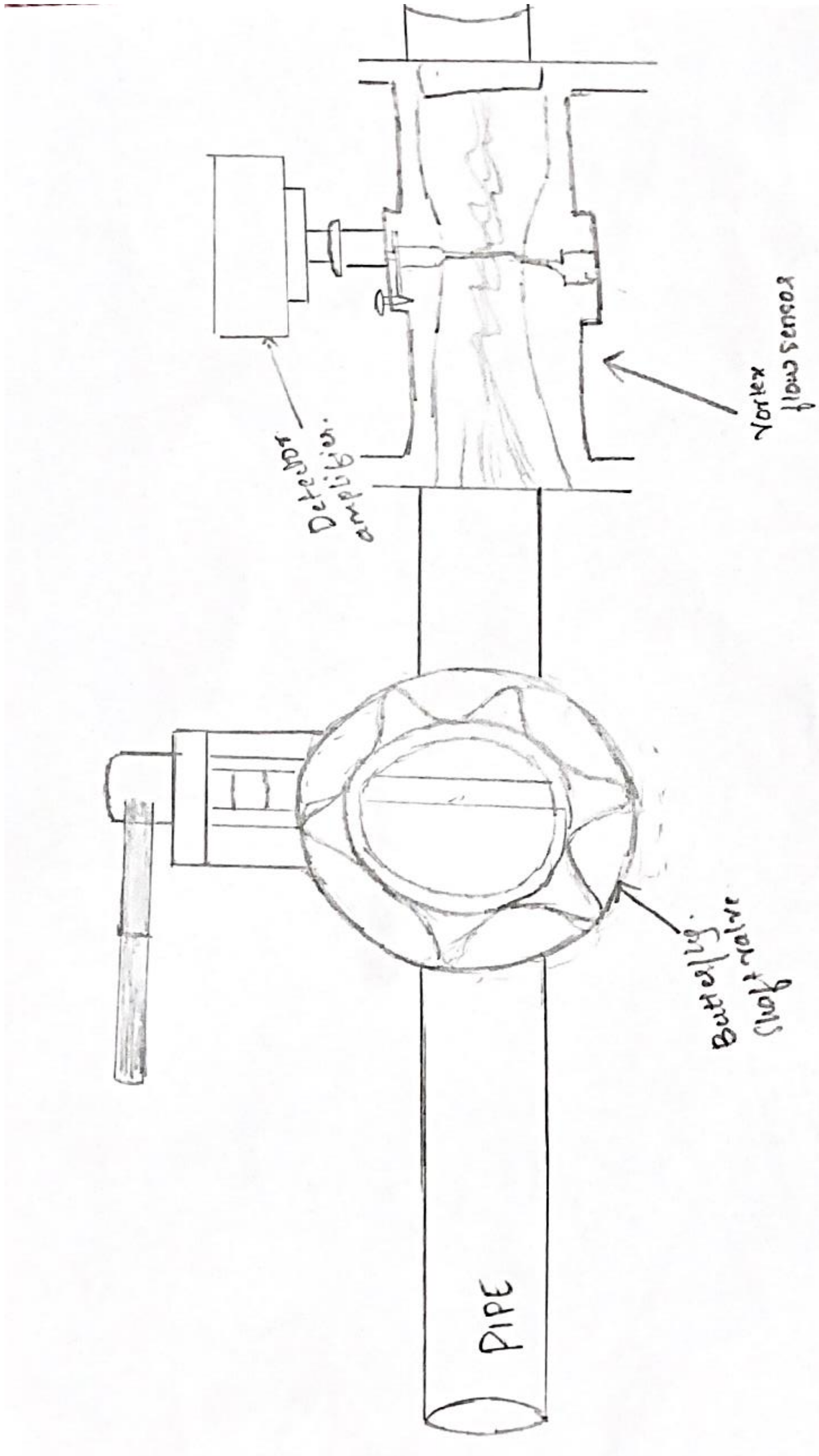
Design 2:



Design 3:



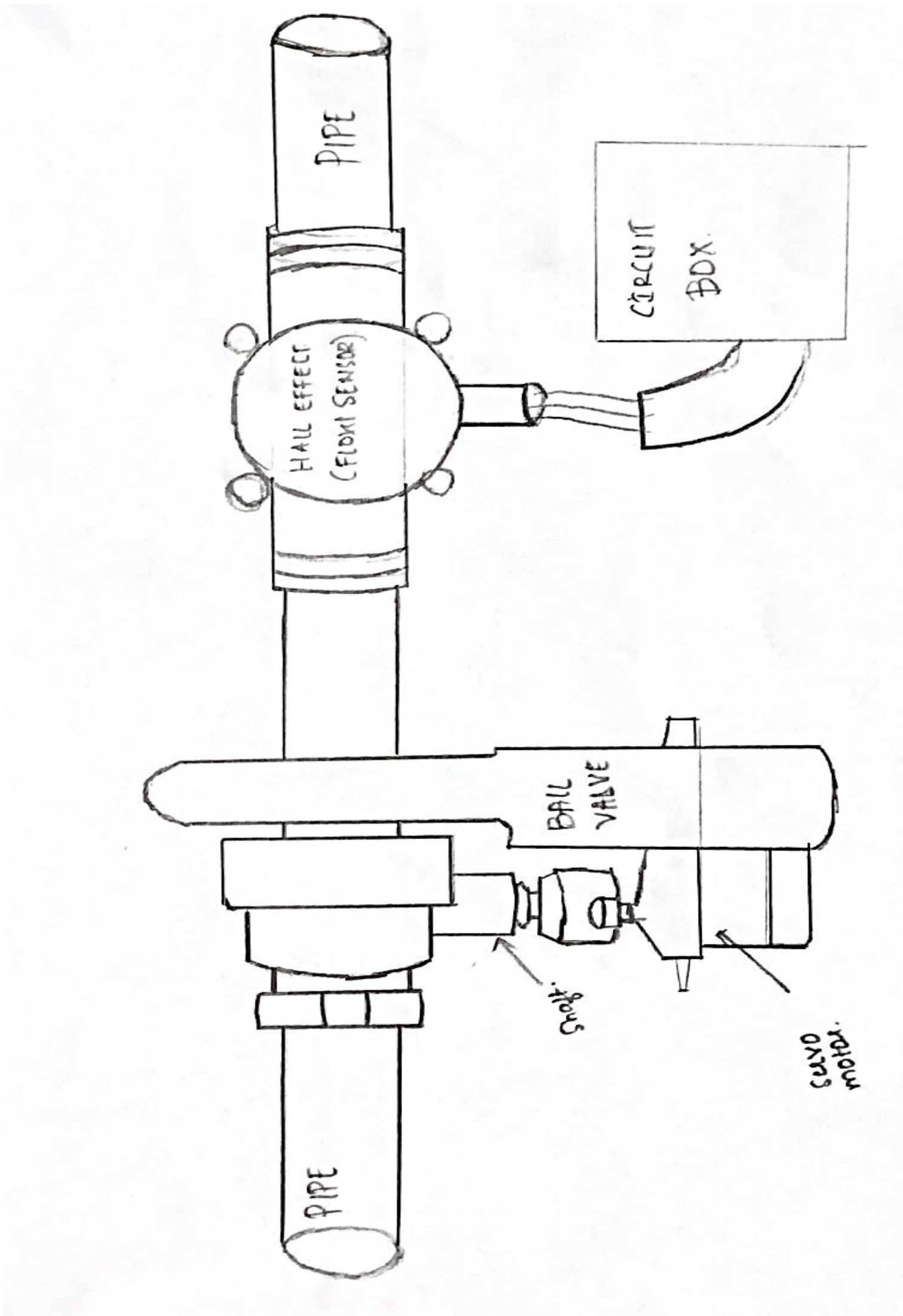
Design 4:


Detector amplifier
Vortex flow sensor
Butterfly shaft valve
PIPE

4.4 Selecting Design Alternative (Using Phugh Chart)

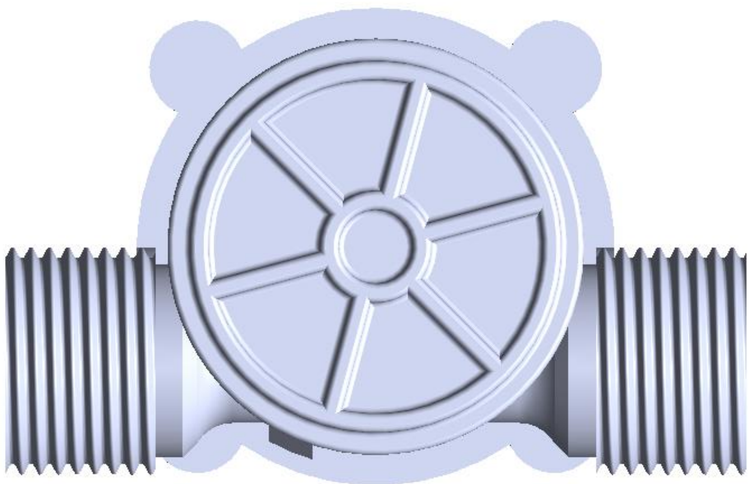
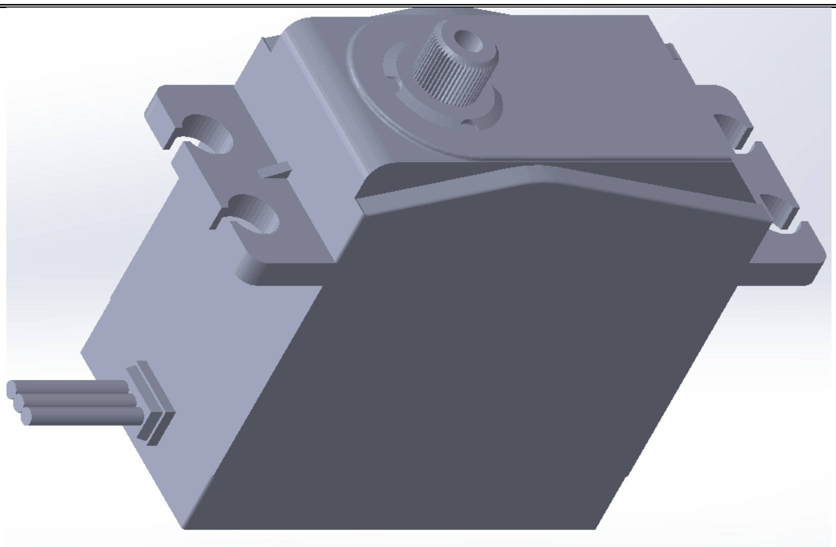
Requirements	Weight	Design1	Design2	Design3	Design4	Reference
Accuracy	10	+	-	+	+	0
Real Time Monitoring	9	+	0	0	0	0
Durability	8	0	0	0	0	0
Ease Of Installation	7	-	+	-	0	0
Cost Effective	7	+	-	-	-	0
Low maintenance	6	+	0	-	0	0
Easy Integration	5	0	+	+	+	0
Pluses		4	2	2	2	
Sames		2	3	2	4	
Minuses		1	2	3	1	
Overall Total		3	0	-1	1	
Yes / No		Yes	No	No	No	

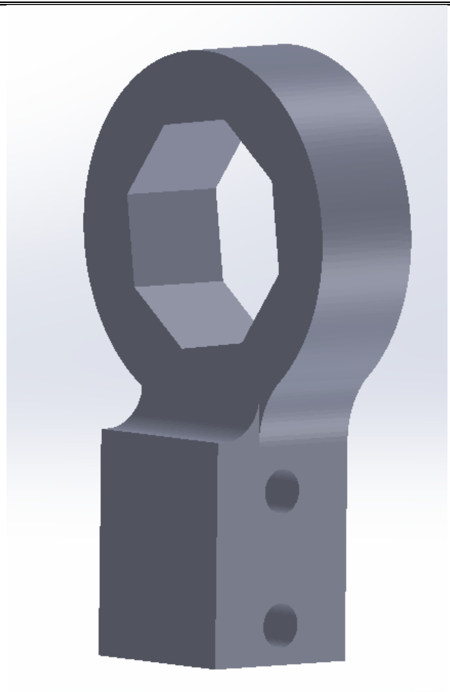
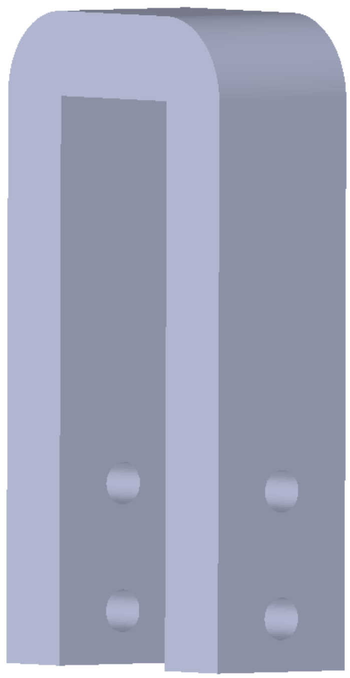
Selected Design Alternative: Water Flow Sensor and Conservation with Hall Effect sensor and ball valve i.e **Design 1**

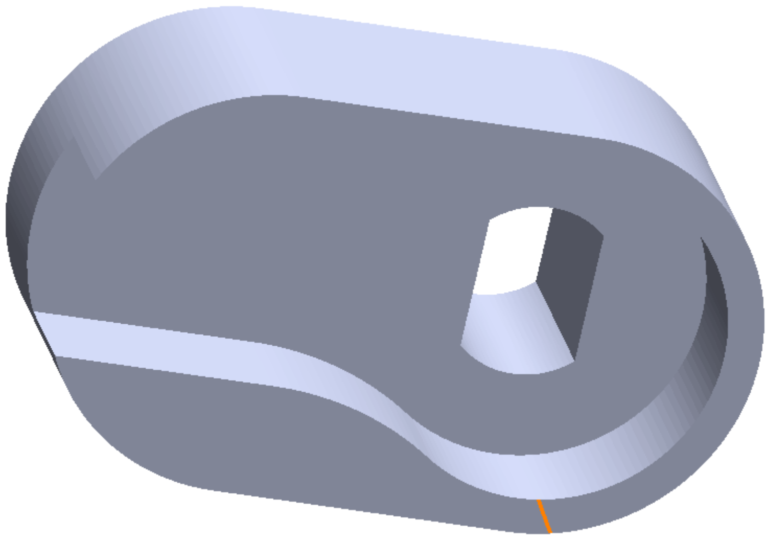
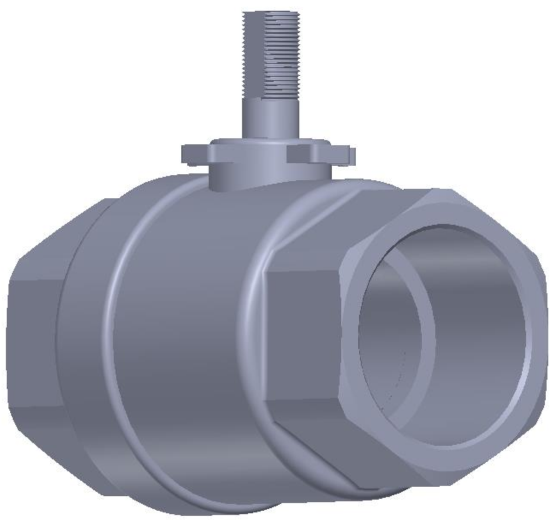


Phase 5

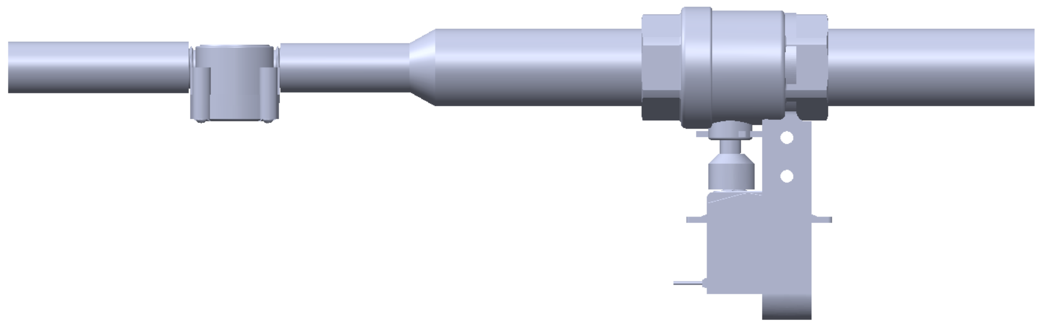
5.1 3D Model

FLOW SENSOR

Servo motor (25 KG)


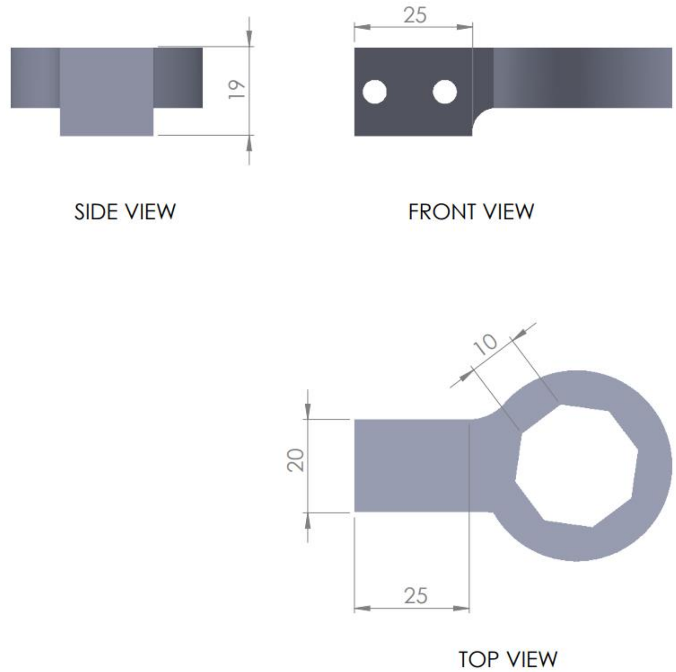
Hex Mount

Servo Bracket


Shaft Adapter

Ball Valve


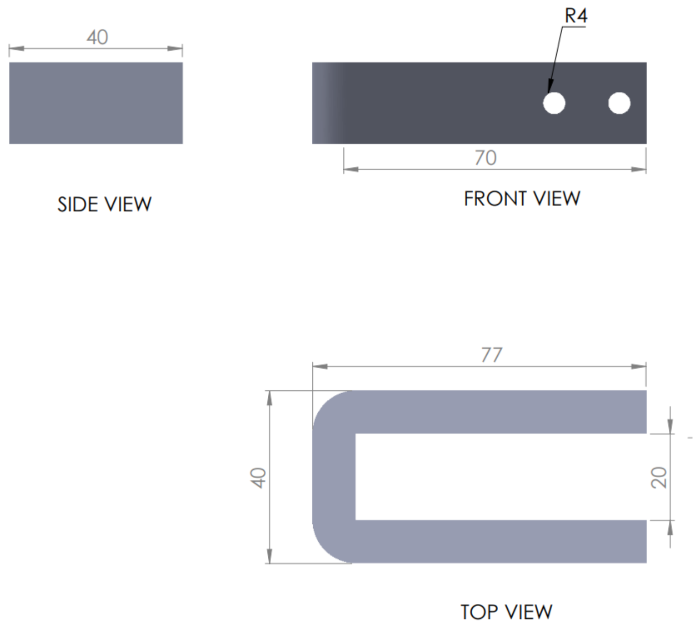
5.2 Assembly models

Assembly Model


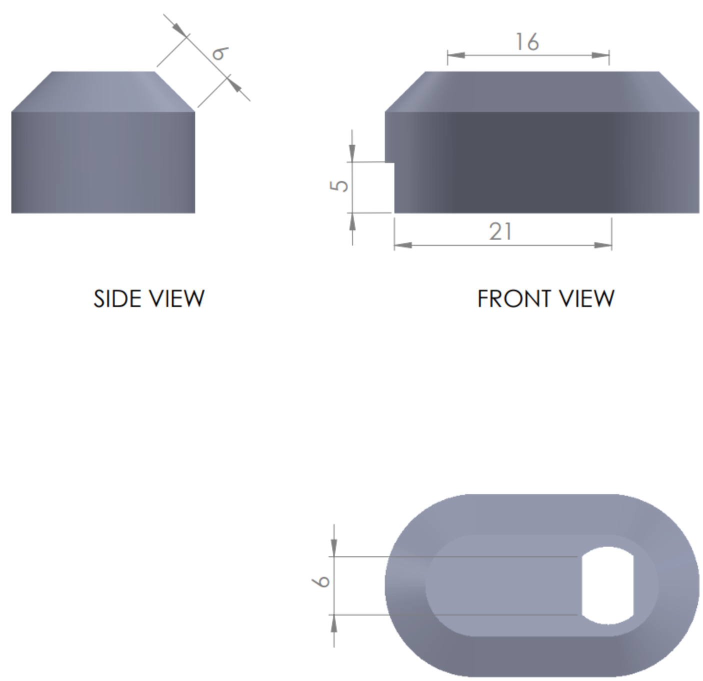
5.3 2D Drawings

HEX MOUNT


SERVO BRACKET



SHAFT ADAPTER



6 Analysis of critical parts and Prototype Planning

6.1 Raw materials required for Prototyping:

#	Material	Properties /Reason for selecting the material	Part Name
1	PVC	Cost Effective , Light Weight And Corrosion Resistant	PVC PIPE

6.2 Bill of Materials

Si No	Part Name	Quantity	Material Specification
1	YFS-201	1	Flow Range: 0-30 liters per minute (l/min) , Accuracy: ±2%
2	ESP-32	1	Operating Voltage: 2.2V to 3.6V , Wireless Connectivity: Wi-Fi (802.11 b/g/n) , Digital I/O Pins: 34
3	25Kg Servo Motor	1	Torque: 25 kg-cm or 25 Nm , Voltage: 12V
4	OLED 0.96	1	Resolution: Typically 128x64 pixels , Size: 0.96 inches
5	12v Adapter	1	Voltage Output: 12V, Input Voltage: 100-240V

6.3 Flow Chart:

Prepare tentative flow chart of series of operation to be followed for prototyping:

- **PLA+ Material for 3d-Printing**

↓

- **3d -Printer**

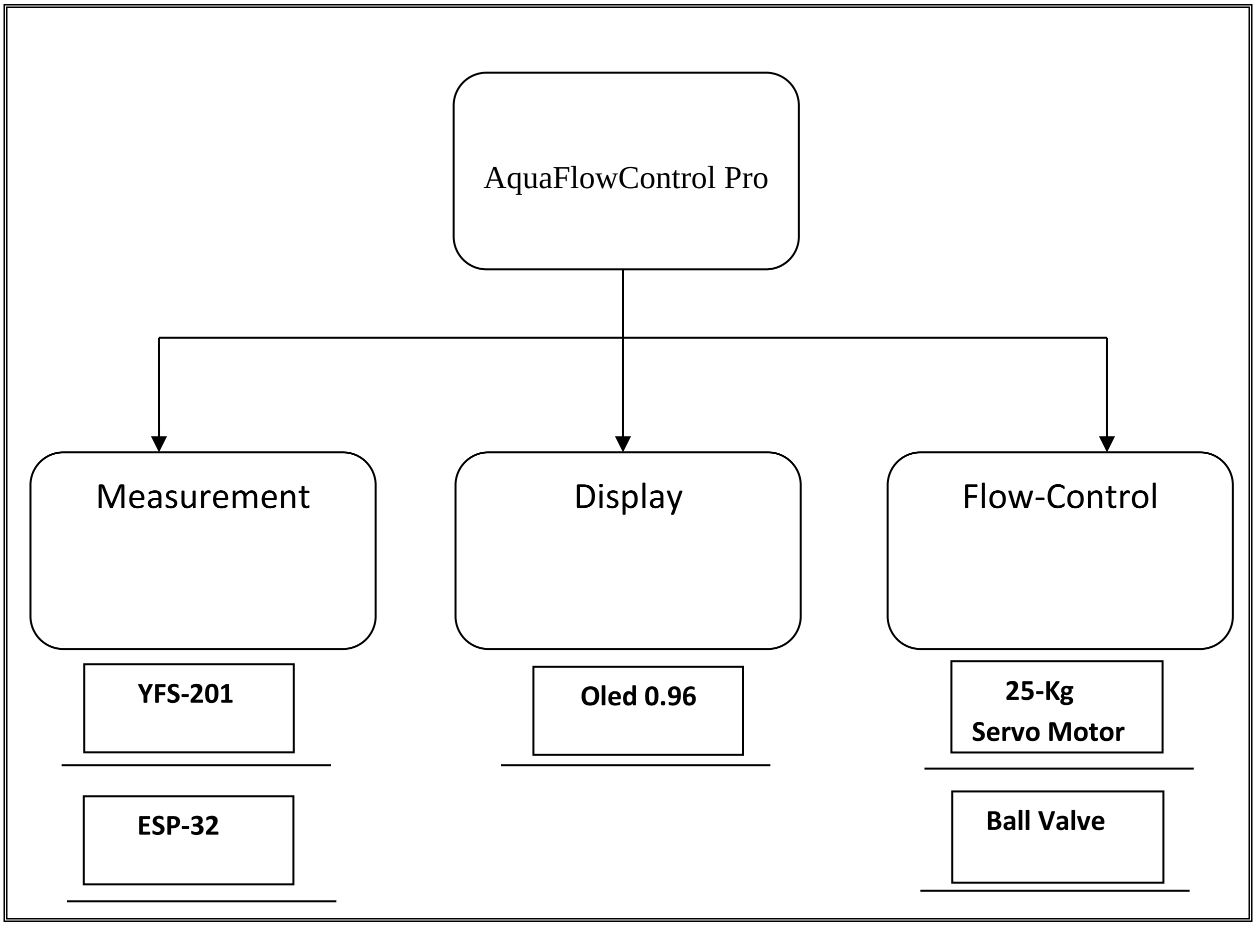
↓

- **Assembly Of Hex Mount , Shaft Adapter and Servo Bracket**

↓

- **Servo Motor is placed in servo bracket , shaft adapter connects servo motor to the ball valve and Hex Mount for pipe connections**

6.4 Sub-Assembly Planning:



Sub Assembly #	**Brought out Parts**	**Manufactured Parts**
	YFS-201	-
	ESP-32	-
Display	Oled 0.96	-
Flow-Control	25kg Servo Motor	Hex Mount
	Ball Valve	Servo Bracket
	-	Shaft Adapter

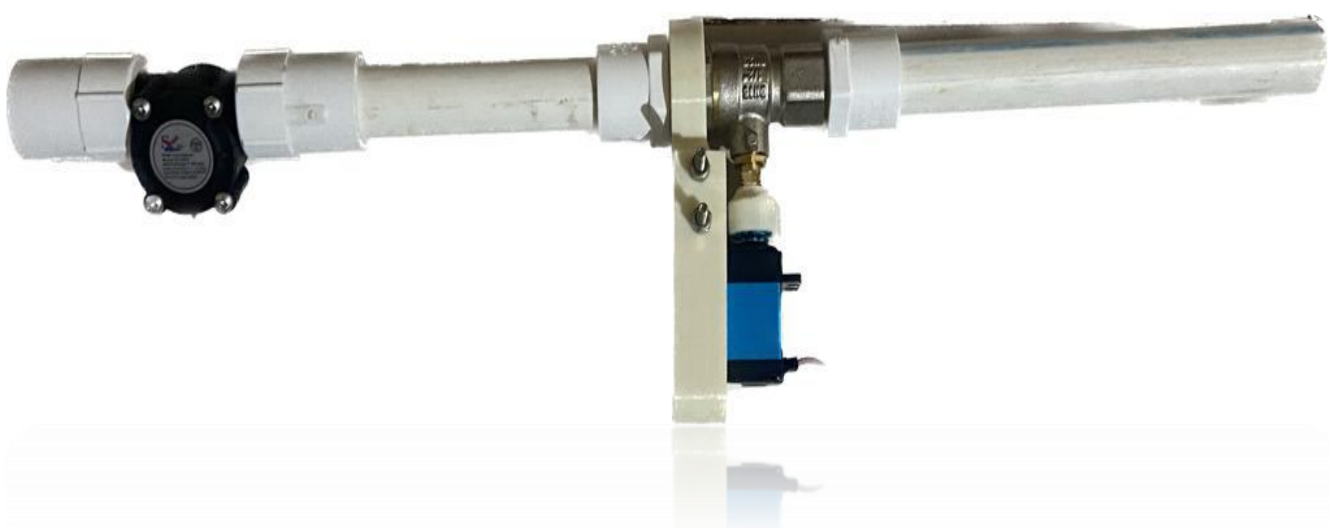
7. Final Impressions

7.1 Final Cost Estimation

Product Expenses			
SI	**Part Name**	**Qty.**	**Total Cost**
1	**ESP-32**	**1**	**550**
2	**YFS-201**	**1**	**310**
3	**Oled 0.96**	**1**	**300**
4	**25Kg Servo Motor**	**1**	**1550**
5	**PVC pipe**	**1**	**100**
6	**Ball Valve**	**1**	**350**
7	**12V Adapter**	**1**	**250**
		Total Parts Expenses Rs.	**3410**
Labor Expenses			
SI	**Task Name**	**Hours**	**Total Cost**
1	**3D-Printing**	**3**	**500**
		Total Labor Expenses Rs.	**500**

The estimated total expenses is the sum of parts and labor expenses of Rs: **3910**

7.2 Final Prototype Pictures



7.3 Conclusions

In conclusion, the prototyping system consisting of a water level sensor (YFS-201), ESP32 microcontroller, servo motor for ball valve control, and an OLED display provides a solution for measuring the rate of flow of water, displaying the rate and volume of water on the OLED screen, and closing the ball valve after reaching the maximum set quantity of water.

The system operates by continuously reading the water level from the YFS-201 sensor and calculating the flow rate and volume of water based on the sensor readings. The calculated values are then displayed on the OLED display, allowing real-time monitoring of the water flow characteristics.

Once the maximum set quantity of water is reached, the system triggers the servo motor to close the ball valve, effectively stopping the water flow. This ensures that the desired quantity of water is not exceeded and provides control over the water usage.