SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

A PROJECT REPORT ON

"WATER FLOW DETECTION SYSTEM"

SUBMITTED TOWARDS THE

PARTIAL FULFILLMENT OF THE REQUIREMENTS

OF CIA of TY BACHELOR OF TECHNOLOGY IN

COMPUTER ENGINEERING

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(TY B.Tech Computer Engineering)

UNDER THE GUIDANCE OF

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DEPARTMENT OF COMPUTER ENGINEERING

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING, KOPARGAON

(An Autonomous Institute)

2022-23

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SANJIVANI COLLEGE OF ENGINEERING, KOPARGAON

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DEPARTMENT OF COMPUTER ENGINEERING

CERTIFICATE

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is a bonafide work carried out by students under the supervision of Dr. A.B.Pawar and it is submitted towards the partial fulfillment of the requirement of CIA of TY Bachelor of Technology (Computer Engineering). During the academic year 2022-23

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Abstract

The water flow detection system is a crucial component in monitoring and managing water resources efficiently. This abstract provides an overview of the system's key features, its role in water management, and its potential benefits.The water flow detection system is designed to accurately measure flow rates, detect anomalies, and monitor water consumption. By employing various sensor technologies, such as ultrasonic, laser-based, or electromagnetic flow sensors, the system ensures precise measurements and reduced maintenance requirements. It integrates with IoT infrastructure, enabling real-time data transmission and remote monitoring, thus facilitating proactive decision-making and timely interventions.

The system's future scope lies in advancements such as artificial intelligence and machine learning algorithms, which enable data analysis to detect irregularities and predict maintenance needs. Integration with smart grids and smart home systems enhances energy optimization and personalized consumption monitoring. Moreover, the system's adaptability to different water distribution networks, scalability, and potential for water quality monitoring further enhance its efficacy.

Overall, the water flow detection system plays a vital role in water resource management, conservation, and infrastructure maintenance. Its accurate measurements, anomaly detection capabilities, and integration with emerging technologies promise improved efficiency, reduced water loss, and optimized resource allocation. Implementing the system's future scope considerations will contribute to the development of intelligent and sustainable water management practices.

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1. Project Summary

The University Campus has a complex water supply system that supplies water to various buildings, offices, and facilities. To this end, a water flow detection system is being developed that can accurately measure water flow and provide real-time monitoring and alerts for any anomalies or deviations from the predicted flow. It should also be easy to install and maintain, and it should provide clear and intuitive visualization and reporting of collected data.

In summary, the water flow detection system is the basic equipment to detect the water overflow in the container as well as the leak or drip in the pipeline. This helps prevent water wastage.

The project included the design, assembly, installation, testing, and maintenance of the system to ensure its proper functioning.

1.1. Background

There are important reasons why a water flow sensing system should be used here:

Water scarcity: Many parts of the world are experiencing water shortages, making it difficult to provide water. enough water to meet the needs of the population. .This has led to greater emphasis on water conservation and efficient use of water resources.

Aging Infrastructure: Many cities and towns have aging water infrastructure, including piping and distribution systems, which can lead to leaks, ruptures, and reduced water flow. This can cause significant property damage and waste of water resources.

Climate change: Climate change is causing increased variability in precipitation patterns, resulting in droughts and floods in some regions. This further highlights the importance of effective water resource management and the need for early detection of water flow problems.

Industrial Applications: In industrial applications, water flow is critical to the proper functioning of equipment and processes. A sudden drop in water flow could indicate a problem with the equipment, causing a safety hazard and potential damage to the installation.

Bylaws: Many municipalities and regulatory bodies have bylaws in place to encourage efficient use of water resources and reduce water waste.

This has led to an increased demand for water flow detection systems that meet regulatory requirements.

1.2. Problem Statement

This project aims to develop a system that can detect water flow and quickly identify any drop in flow that may indicate a leak, equipment problem, or any other issue that requires attention. The system will use sensors and data analysis algorithms to monitor water flow in real time and issue an alert when the flow drops below a certain threshold. By detecting flow problems early, the system will help prevent property damage, reduce water waste, improve safety and meet regulatory requirements.

Water flow is an important issue because it is essential for the efficient and responsible use of water resources. Water is a finite resource and there are growing concerns about water scarcity, especially in regions where water demand is high and supply is limited. Water flow is an essential aspect of water resource management as it is necessary to supply water to homes, businesses, and industries.

However, problems such as leaks, ruptures, and reduced flow rates can lead to serious water waste and property damage, as well as safety hazards in industrial applications. Not only is it a waste of valuable resources, but it can also be costly in terms of maintenance and potential environmental impact. A water flow detection system is important because it detects and alerts the user to a drop in water velocity, indicating potential problems that require attention. By detecting flow problems early, the system can help prevent property damage, reduce water waste, improve safety and meet regulatory requirements. This is particularly important in regions with limited water resources, where every drop counts and must be used efficiently.

The Water Flow Detection System is important because it can help conserve water, prevent property damage, and reduce costs associated with wasted water. By detecting and alerting users to low water flows, the system enables rapid repairs and maintenance, ensuring efficient and responsible use of water resources.

1.3. Objective

The objectives of a college water flow detection system may include:

- **Early detection of leaks:** The system should be able to detect leaks in the water supply system at an early stage to prevent water damage to the college's infrastructure and property.

- **Reduction of water waste:** The system should be designed to detect and alert users of water waste and encourage them to reduce their water consumption.

- **Conservation of resources:** The system should be designed to conserve water resources by detecting and alerting users of water leaks, thus preventing water loss.

- **Safety:** The system should help ensure the safety of college students and staff by preventing water damage and reducing the risk of slips and falls.

- **Cost savings:** The system should help the college save on water bills and repair costs by detecting and repairing leaks before they cause significant damage.

- **Environmental sustainability:** The system should promote environmental sustainability by reducing water waste and conserving resources.

1.4. Technology / Research gap

A water flow detection system is a piece of equipment that may be used to track and detect water flow in pipes or water distribution systems. Water consumption monitoring, and water flow management are all possible with the system.

Application:

The water flow detecting system is useful in a broad number of locations and industries, including:

- **Residential properties**: The system may be used in residential properties to track water use.

- **Commercial buildings:** The technology may be used to track water use in commercial buildings.

- The device may be used in industrial settings to monitor water flow.

- **Agriculture:** The system may be used in agricultural settings to track water use.

- **Municipal water systems:** The system can be used in municipal water systems to monitor water flow.

- **Municipal water systems**: The system may be used to monitor water flow in municipal water systems.

Innovation:

The water flow detecting system may make use of several cutting-edge technologies, including:

Ultrasonic sensors:

These devices employ sound waves to identify water movement in pipelines Sensors that utilize magnetic properties to monitor the flow of water in pipes are known as magnetic sensors. Sensors that measure pressure in order to determine flow include pressure sensors.

USP:

The capacity to track water use in real-time is a water flow detection system's unique selling proposition. The system may deliver accurate and trustworthy data to assist customers conserve water and avoid water damage by using cutting-edge sensors and technology.

Research Gap:

In general, some potential cutting-edge components of a water flow sensing system may be:

- **Advanced Sensors:** The sensors that water flow detection systems use to monitor water flow are a crucial area where they may vary. Advanced systems may employ several sensors to measure flow from various angles or places in a pipeline, or they may use very sensitive sensors that can detect extremely minute changes in water flow.

- **Real-Time Monitoring:** Real-Time monitoring of water flow is another possible innovation that enables earlier identification of leaks or other irregularities. For customers to monitor water flow statistics on their smartphones or other devices and get alerts, the system may need to be integrated with cloud-based software or an app.

- **Predictive analytics** may be used by some water flow detection systems to find patterns or trends in water flow data that might point to possible concerns before they become serious ones. In order to find connections or abnormalities, this might include analysing huge amounts of data using machine learning techniques.

- **Automatic Shut-Off:**

  A function that can be activated in the case of a leak or Another problem is another possible innovation. This could lessen the need for physical intervention and help stop additional harm.

- It is crucial to compare various water flow detection systems and consider aspects like accuracy, consistency, cost, and usefulness. While some products or reports may excel in only one or two of these categories, others may focus more on all of them. Others may excel in all areas. Furthermore, some systems could be more appropriate for various settings or uses, such as domestic vs industrial use.

1.5. Deliverables

A water flow detecting system's deliverables may change based on the particular project needs. Yet, the following are some potential deliverables of a water flow sensing system:

Sensors: For the system to monitor water flow, sensors are needed. These sensors, which may be mechanical or electronic, oversee giving precise readings.

Control Unit: The control unit would be in charge of analysing the information gathered from the sensors and making judgements in light of that information. The control unit could work independently or in conjunction with other systems.

Alarm/Alert System: In the event of anomalous water flow, consumers must be notified by an alarm or alert system. These may involve alarms that are audible or visible, or automatic processes like closing.

Data logging: To analyse data in the future and keep track of any changes in water flow patterns, the system would need to collect data over time. Both a local system and a cloud-based one might store this.

User Interface: To interact with the system, a user interface is necessary. A web-based user interface or a mobile app may be examples of this.

Installation and Maintenance Documentation: To ensure the system's correct operation, extensive installation and maintenance documentation is required. User manuals, instructional materials, and troubleshooting instructions may fall under this category.

Technical Support: To help users with any system-related problems that could occur, technical support would be needed. In addition to on-site assistance, if necessary, this might also involve phone or email support.

1.6. Resources and Budget

A water flow detection system's budget and resource requirements vary depending on the system's size, the sensors it uses, the amount of automation needed, and the difficulty of the installation procedure. The main materials and expenses for a typical water flow sensing system are listed below.

- **Sensors: -**

  Water flow sensor -
  A device used to detect the flow rate of a liquid, specifically water, is a water flow sensor. It is frequently used in industrial, commercial, and residential applications to track and manage water usage, find leaks, and guarantee that water systems are functioning properly.
  Price: 400

- **Control unit:**

  Arduino uno-
  Arduino Uno is an open-source microcontroller board based on the ATmega328P microcontroller chip. It was developed by Arduino.cc and released in 2010. The board is designed to be a simple and affordable way for hobbyists, students, and professionals to create digital devices and interactive projects.

- **Alert System: -**
  Buzzer-
  A buzzer is an electronic component that produces sound when an electrical current is passed through it. It is essentially a type of speaker that is designed to produce a single, simple tone, and is often used to provide audible feedback in electronic circuits and devices.
  Price-₹96.

- **Connection: -**

<u>Jumping wires-</u>

Jumper wires are an important component in building circuits using Arduino boards, as they allow you to easily connect sensors, actuators, and other components to the board.

Price- ₹105.

<u>Arduino cable-</u>

An Arduino USB cable connects an Arduino board to a computer through a USB connection. It powers the Arduino and transfers data between it and the PC.

Price: -₹29.

- **User Interface: -**

LCD Display - Price- ₹400.

1.7. Project Plan with Milestone

Sr.No.	Milestone	Activity	Duration in Week
1	Set project specifications and objectives	• Specify the project's scope • Determine the system's aims and objectives. • Choose the necessary sensors and tools. • Create a spending plan for the project.	1st
2	Schedule the project.	• Make a thorough project plan with deadlines and milestones. • List the duties and materials needed for each milestone. • Set the project team's parameters and delegate tasks.	2nd
3	Acquire tools and sensors	• Purchase the necessary tools and sensors. • Coordination of installation and delivery	3rd

4	Install devices and sensors.	• Place sensors and data loggers in the proper places. • Set up and test the data recorders and sensors. • Construct a control system and software.	4th
5	Conduct preliminary tests	• Gather and examine sensor data • Check the software and control unit. • Resolve any problems and enhance the system.	5th
6	Make the system configuration final	• Correct the system's calibration and settings. • Check the system's precision and dependability • Set alarm and notification preferences.	5th
7	Documentation and user training	• Educate system users and operators on how to maintain and operate the system • Create operational manuals and user guides. • Perform a thorough evaluation of the project.	6th
8	completing the project	• Complete the project's documentation. • Give the user control over the system. • Do an assessment and evaluation of the project.	6th

1.8. Category of New Technology/Product

Sr. No.	Category	Details
1	**New-to-the-world Products/Technology**	A fresh innovation that opens a brand-new market for water management techniques. It is a device that detects and tracks water flow in pipes or pipelines using sensors and data analytics, which may help stop water waste, find leaks, and optimize water consumption to cut expenses. This product category, which is not commonly offered on the market, is seen as a novel and creative approach to managing water resources.
2	**New-to-the-firm Products/Technology (New Product Lines)**	In this case, the firm is offering a new product line that involves the development, manufacturing, and marketing of water flow detection systems. The product is not new to the market, but it is new to the firm and represents a new business opportunity for the company to expand its product offerings and gain a competitive advantage in the water management industry.
3	**Additions to existing Product Lines**	If the firm already offers water management systems but does not have a specific product for detecting and monitoring the flow of water. In this case, the water flow detection system would be considered a line extension to the existing product line. The new technology would complement the existing products and provide additional benefits to customers, such as improved water usage optimization, leak detection, and cost savings. The firm would leverage its existing customer base to promote the new product and increase sales by offering a more comprehensive range of water management solutions.
4	**Improvements and Revisions to existing Products**	If the firm already has a similar product in the market, but the new technology represents a significant improvement in terms of accuracy, efficiency, or ease of use.
5	**Repositioning**	The water flow detection system was originally developed for industrial or commercial applications, but the firm decided to reposition it as a solution for residential water management, then it would be considered a repositioning product.
6	**Cost Reductions**	Finally, cost reductions complete the six categories of new products. Cost reductions refer to new products that simply replace existing products in the line, providing the customer similar performance but at a lower cost

2. Requirement Analysis

The requirements required for water flow detection in the water pump of Sanjivani College of Engineering are:

- **Sensors: -**

In the sensor we are using the two sensors: water flow sensor and the water float sensor.

Water Flow Sensor:

A water flow sensor is a device that is used to measure the flow rate of water in a pipeline or other water system. The sensor typically includes a paddle wheel, turbine or other type of impeller that rotates as water flows through the system. The rotation of the impeller is then detected by the sensor and converted into a signal that can be used to calculate the flow rate.

Water flow sensors are commonly used in a variety of applications, such as monitoring water usage in homes, tracking the flow of water in irrigation systems, and measuring the flow of water in industrial processes. They can also be used in conjunction with other sensors to detect leaks or other problems in water systems. There are several types of water flow sensors available, including mechanical, magnetic, and ultrasonic sensors. Mechanical sensors use a paddle wheel or other rotating element to measure flow, while magnetic sensors use a magnetic field to detect the rotation of a metal rotor. Ultrasonic sensors use sound waves to measure the velocity of the water, which can then be used to calculate the flow rate.

Here we require one water flow sensor.

Water Float Sensor:

A water float sensor is a device that is used to detect the level of liquid in a container or tank. The sensor typically consists of a float that is buoyant in the liquid, and a switch that is activated when the float reaches a certain level.

When the liquid level rises, the float rises with it and activates the switch. This can trigger an alarm or control a pump to maintain a certain level of liquid in the container. Water float sensors are commonly used in applications such as water tanks, aquariums, and swimming pools. They are also used in industrial settings, such as chemical processing plants and oil refineries, to monitor and control the level of liquids in tanks and vessels.

- **Control unit:**

Arduino Uno-

Arduino Uno is a microcontroller board based on the ATmega328P microcontroller. It is a popular choice among hobbyists and professionals alike due to its simplicity, low cost, and versatility. The Arduino Uno board has 14 digital input/output pins, six analog inputs, a 16 MHz quartz crystal oscillator, a USB connection, a power jack, and an ICSP header for programming the board. It can be powered either through the USB connection or an external power supply.

The board can be programmed using the Arduino Integrated Development Environment (IDE), which is a free software tool that allows users to write and upload code to the board. The IDE uses a simplified version of C++ programming language, making it accessible to beginners with little to no programming experience.

Arduino Uno can be used for a wide range of projects, such as controlling LEDs, motors, sensors, and other electronic components. It is also widely used in home automation, robotics, and Internet of Things (IoT) applications

- **Alert System: -**

In the Alert system we use the buzzer. which will notify us in any condition.

Buzzer: -

A buzzer is a type of electronic sound device that produces a continuous or intermittent sound, typically used to alert or indicate something. It usually consists of an electromechanical component, such as a coil or a piezoelectric crystal, that vibrates when an electrical signal is applied to it, producing a sound wave.

Buzzer components can be found in various forms and sizes, ranging from small buzzers that emit a low-level sound to larger ones capable of producing a high-pitched sound.

They are often used in electronic devices such as alarms, timers, and doorbells, where a sound signal is needed to alert the user.

Buzzer components can be controlled using microcontrollers or other electronic circuits. For example, an Arduino board can be used to control a buzzer to produce a tone or a melody. Buzzer components can also be integrated with other sensors, such as temperature sensors or motion sensors, to create custom alarm systems or other alert mechanisms.

- **Connection: -**

Jumping Wires-

Jumping wires, also known as jumper wires or jumper cables, are electrical wires used to make temporary connections between two points on a circuit board or between electronic components. They are often used in prototyping, testing, and repairing electronic circuits. Jumping wires come in various lengths, colours, and gauges, depending on the application and the type of circuit board being used.

Jumping wires can be made from a variety of materials, such as copper or aluminium, and they can be insulated or non-insulated. They can be connected to the circuit board or component using various methods, including soldering, crimping, or using clip-on connectors.

Jumping wires are a convenient and cost-effective solution for making temporary connections when designing or testing electronic circuits. They are often used in combination with breadboards or prototyping boards, which provide a convenient platform for assembling and testing electronic circuits.

Arduino cable-

An Arduino cable usually refers to the USB cable used to connect an Arduino board to a computer or other device. The Arduino board has a USB port that can be used to program and communicate with the board.

The USB cable used for Arduino boards typically has a Type A USB connector on one end and a Type B USB connector on the other end. The Type B USB connector is the one that plugs into the Arduino board.

The USB cable is an important component for working with Arduino boards. It is used to upload code to the board and to communicate with it. The cable provides power to the board and allows the board to be powered from a computer or other USB power source.

When selecting a USB cable for Arduino, it is important to choose a high-quality cable that is reliable and durable. A poor-quality cable can cause issues such as intermittent connections or data transfer errors. It is also important to choose a cable that is the correct length for your application.

- **User Interface: -**

LCD Display: -

An LCD (Liquid Crystal Display) display is a type of electronic display that uses liquid crystals to create images and text. LCD displays are commonly used in a wide range of electronic devices, such as calculators, digital watches, and computer monitors.

Analysis Report:

Our group has visited the water pump near Vaishnavi Canteen of Sanjivani College of Engineering, there we observed water wastage due to the traditional water supply. If the level of water is low, we never come to know about it but we came to know that we can do it by our system. Hence, it is found that the Water Flow Detection System is a smart system applicable to all water containers.

A water flow detection system's budget and resource requirements vary depending on the system's size, the sensors it uses, the amount of automation needed, and the difficulty of the installation procedure. The main materials and expenses for a typical water flow sensing system are listed above. After the successful installation of our project. It will be connected to the laptop through Cable and with help of an algorithm we will detect real-time monitoring of water flow through our system easily.

3. System Architecture Analysis

A complete method for tracking water use and spotting any unusual flow conditions in a building or facility uses water flow sensors and an Arduino Uno mounted on pipes and taps. Here is a detailed illustration of a typical system architecture:

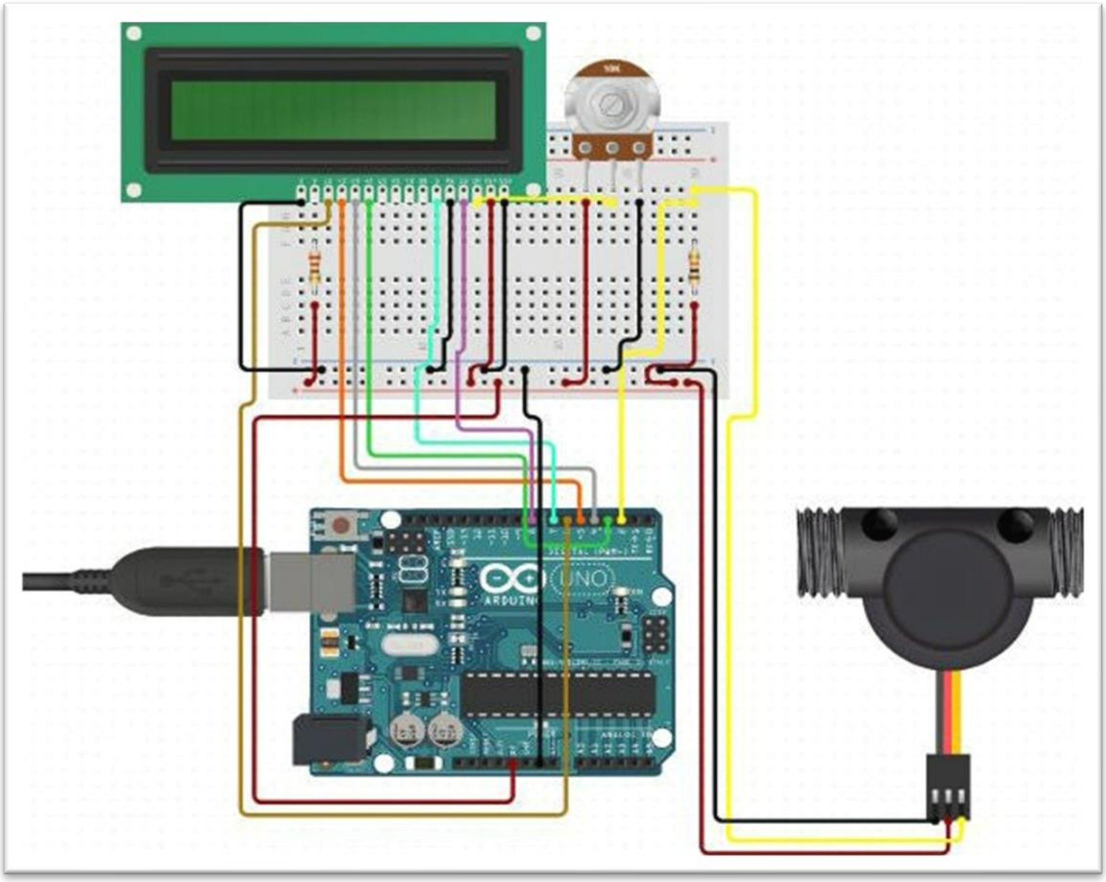

Fig.1 Circuit diagram Of Water flow detection System

- Flow sensors: The system uses taps and flow sensors to detect the rate of water flow at various locations along the pipeline. Depending on the application and accuracy standards, the flow sensors may be electromagnetic, ultrasonic, or mechanical.

- Arduino Uno Board: The flow sensors are attached to the Arduino Uno board, which functions as the system's brain. The board continuously reads and saves data from the flow sensors in its memory.

- Data processing: A software programme analyzes the flow patterns in the data from the flow sensors and computes the flow rate, pressure, and other pertinent parameters. Additionally, the programme can identify anomalous flow conditions such as pipeline or tap leaks or obstructions.

- Alarm Generation: The system will produce an alarm and send it to the operators in charge of running the building or facility if it notices any abnormal flow conditions. Depending on how the system is configured, the alarm may come in the form of an audio-visual alert.

In conclusion, a water flow detection system employing an Arduino Uno and water flow sensors installed on pipes and faucets provides a complete solution for tracking water use and spotting unusual flow circumstances in a building or institution. The system design is rather straightforward and is easily adaptable to meet the needs of certain projects. It can assist in lowering water waste and enhancing the effectiveness of water management in structures and facilities.

Arduino Uno:

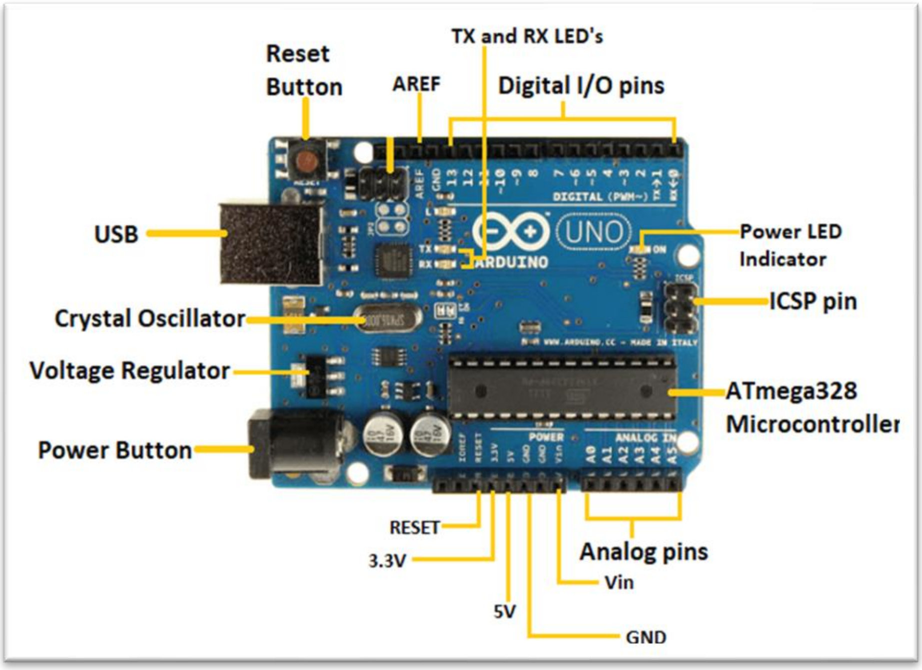

Fig.2 – Arduino Uno

- The ATmega328P microcontroller chip serves as the foundation for the open-source Arduino Uno microcontroller board. It is made to help both pros and beginners build electrical projects.
- The board has 6 analogue inputs, a 16 MHz quartz crystal, 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 digital inputs, a USB port, a power jack, an ICSP header, and a reset button.
- The Arduino Integrated Development Environment (IDE) and programming language can be used to design the board. Even people without prior programming knowledge can quickly learn the C/C++-based programming language. You may develop, build, and upload code to the board using the IDE, a piece of software.

- You may build a broad range of projects using the Arduino Uno, such as robots, weather stations, and home automation systems. The board's compatibility with a variety of shields (add-on boards) also enables you to increase its capability.

Water Flow Detection Sensor:

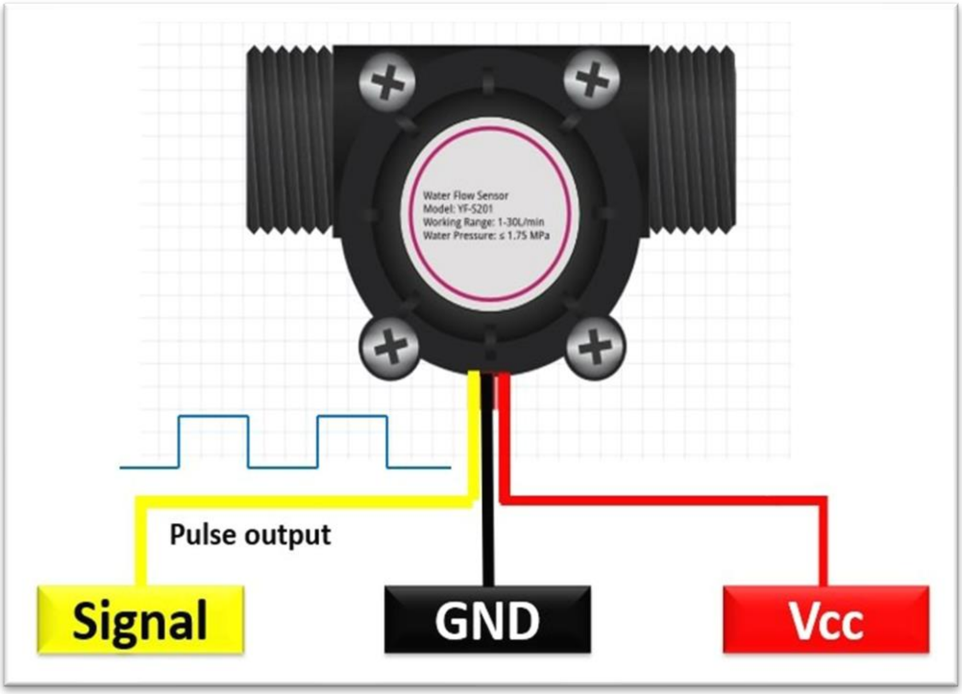

Fig.3- Water Flow Sensor

The rate of water flow in a pipe or other system is measured using an electrical instrument called a water flow detection sensor, sometimes referred to as a flow meter. It is frequently used to track water use, find leaks, and regulate flow in industrial, commercial, and residential plumbing systems.

Applications for water flow detection sensors include irrigation systems, HVAC systems, and water treatment facilities. They are frequently used to keep an eye on how much water is moving through a system and give input to a control system so that it may change the flow rate as necessary.

The maximum flow rate, the sensor's accuracy, the kind of fluid being monitored, and the installation requirements should all be considered when choosing a water flow detection sensor. Some sensors could need a specific kind of pipe or mounting arrangement, but others might be more adaptable.

Overall, water flow detection sensors are a crucial instrument for monitoring and managing water use. They may assist to cut down on waste, increase productivity, and guard against leaks or other problems that could cause harm.

4. Simulation Testing:

In this simulation testing, we evaluate the performance of a water flow detection system that was simulated using Tinker cad. The purpose of the simulation testing was to assess the accuracy and reliability of the system in detecting the flow rate and volume of water through a simulated pipe.

We used Tinker cad to simulate the water flow detection system, which consisted of an Arduino Uno microcontroller and a potentiometer (water flow sensor). The potentiometer was used to measure the flow rate of water through the simulated pipe, and the Arduino Uno was used to process and report the data.

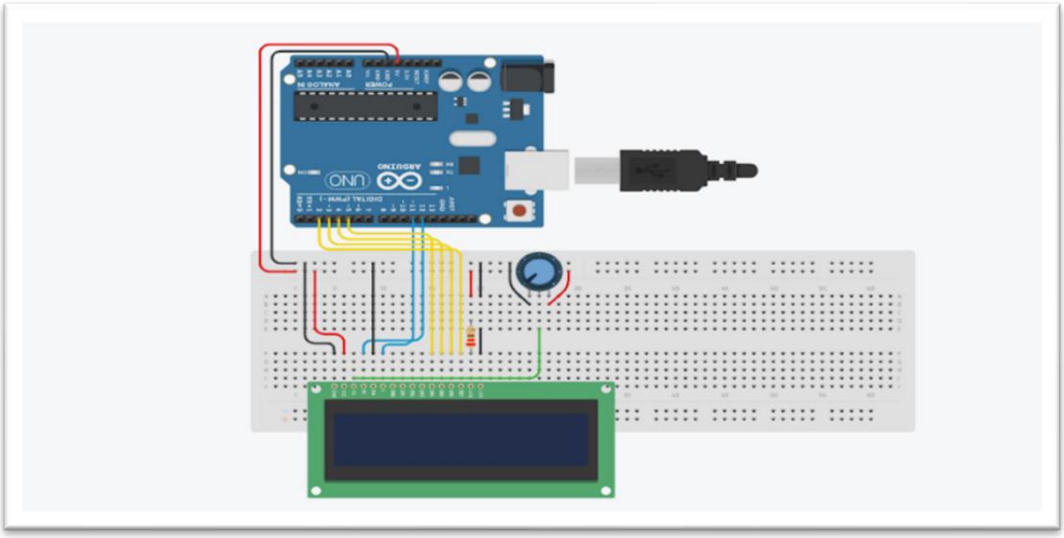

Fig.4- Circuit Dig (During Simulation on Tinker Cad)

We developed a simple code to read the analog output of the potentiometer and convert it to a flow rate and volume. We ran several simulation scenarios to test the accuracy of the system, varying the flow rate and volume of water through the pipe. For each scenario, we recorded the actual flow rate and volume of water, and compared it to the values reported by the simulation.

The results of the simulation testing showed that the water flow detection system simulated in Tinker cad was accurate and reliable.

We concluded that the use of Tinker cad and the selected components, including the Arduino Uno and potentiometer, were effective in simulating a water flow detection system. However, we noted that the simulation had limitations, such as the inability to account for all potential sources of error in the real-world system. Therefore, further testing and validation may be needed to ensure that the simulation accurately represents real-world systems.

The simulation testing demonstrated the accuracy and reliability of the water flow detection system simulated in Tinker cad. This simulation method and component selection could prove useful for further testing and validation of water flow detection systems.

Code:

```
byte statusLed    = 13;
byte sensorInterrupt = 0; // 0 = digital pin 2
byte sensorPin       = 2;
float calibrationFactor = 4.5;
volatile byte pulseCount;
float flowRate;
unsigned int flowMilliLitres;
unsigned long totalMilliLitres;
unsigned long oldTime;
void setup()
{
  Serial.begin(9600);
   pinMode(8, OUTPUT);
  // Set up the status LED line as an output
  pinMode(statusLed, OUTPUT);
  digitalWrite(statusLed, HIGH);  // We have an active-low LED attached
  pinMode(sensorPin, INPUT);
  digitalWrite(sensorPin, HIGH);
  pulseCount        = 0;
  flowRate          = 0.0;
```

```
  flowMilliLitres   = 0;
  totalMilliLitres  = 0;
  oldTime           = 0;
  attachInterrupt(sensorInterrupt, pulseCounter, FALLING);
}

/**
 * Main program loop
 */
void loop ()
{
   if((millis() - oldTime) > 1000)    // Only process counters once per second
  {
    // Disable the interrupt while calculating flow rate and sending the value to
    // the host
    detachInterrupt(sensorInterrupt);
    flowRate = ((1000.0 / (millis() - oldTime)) * pulseCount) / calibrationFactor;
    oldTime = millis();
    flowMilliLitres = (flowRate / 60) * 1000;
    totalMilliLitres += flowMilliLitres;
    unsigned int frac;
    Serial.print("Flow rate: ");
    Serial.print(float(flowRate)); // Print the integer part of the variable
    Serial.print("L/min");
    Serial.print("\t");                       // Print tab space
    if(flowRate > 0.1)
    {
      digitalWrite(8, HIGH);
      delay(3000);
      digitalWrite(8,LOW);
      delay(2000);
```

```
  }
 // Print the cumulative total of liters flowed since starting

  Serial.print("Output Liquid Quantity: ");
  Serial.print(totalMilliLitres);
  Serial.println("mL");
  Serial.print("\t");                                  // Print tab space
  Serial.print(totalMilliLitres/1000);
  Serial.print("");


  // Reset the pulse counter so we can start incrementing again
     pulseCount = 0;

  // Enable the interrupt again now that we've finished sending output
     attachInterrupt(sensorInterrupt, pulseCounter, FALLING);
 }
}
/* Interrupt Service Routine */
void pulseCounter()
{
 // Increment the pulse counter
    pulseCount++;
}
```

Code Explanation:

Variable Declarations:

```
byte statusLed    = 13;
byte sensorInterrupt = 0;
byte sensorPin       = 2;
float calibrationFactor = 4.5;
volatile byte pulseCount;
float flowRate;
unsigned int flowMilliLitres;
unsigned long totalMilliLitres;
unsigned long oldTime;
```

- **statusLed**: This variable represents the pin number (13) connected to the status LED on the Arduino board.
- **sensorInterrupt**: This variable represents the interrupt number (0) associated with the flow sensor. It is connected to digital pin 2.
- **sensorPin**: This variable represents the pin number (2) connected to the flow sensor.
- **calibrationFactor**: This variable is used to convert the pulse count to flow rate. It is set to 4.5 in this case but can be adjusted based on the flow sensor specifications.
- **pulseCount**: This variable keeps track of the number of pulses received from the flow sensor. It is declared as volatile because it is accessed within an interrupt service routine.
- **flowRate**: This variable stores the calculated flow rate in liters per minute.
- **flowMilliLitres**: This variable stores the calculated flow in milliliters.
- **totalMilliLitres**: This variable stores the cumulative total of liquid flow since starting, in milliliters.
- **oldTime**: This variable stores the previous time in milliseconds.

setup() function :

```
void setup() {
  Serial.begin(9600);
  pinMode(8, OUTPUT);
  pinMode(statusLed, OUTPUT);
  digitalWrite(statusLed, HIGH);
  pinMode(sensorPin, INPUT);
  digitalWrite(sensorPin, HIGH);
  pulseCount        = 0;
  flowRate          = 0.0;
  flowMilliLitres   = 0;
  totalMilliLitres  = 0;
  oldTime           = 0;
  attachInterrupt(sensorInterrupt, pulseCounter, FALLING);
}
```

- **Serial.begin(9600)**: Initializes the serial communication at a baud rate of 9600.
- **pinMode(8, OUTPUT)**: Configures pin 8 as an output. This pin is used to control an external device.
- **pinMode(statusLed, OUTPUT)**: Configures the status LED pin (pin 13) as an output.
- **digitalWrite(statusLed, HIGH)**: Turns on the status LED (active-low configuration).
- **pinMode(sensorPin, INPUT)**: Configures the flow sensor pin (pin 2) as an input.
- **digitalWrite(sensorPin, HIGH)**: Enables the internal pull-up resistor on the flow sensor pin. Initializes the variables related to flow measurement.
- **attachInterrupt(sensorInterrupt, pulseCounter, FALLING)**: Attaches an interrupt to the flow sensor pin. When a falling edge is detected, the pulseCounter() function will be called.

loop() function:

```
void loop()
{
   if ((millis() - oldTime) > 1000)
   {
      detachInterrupt(sensorInterrupt);

      flowRate = ((1000.0 / (millis() - oldTime)) * pulseCount) / calibratio

      oldTime = millis();

      flowMilliLitres = (flowRate / 60) * 1000;

      totalMilliLitres += flowMilliLitres;

      unsigned int frac;

      Serial.print("Flow rate: ");
      Serial.print(float(flowRate));
      Serial.print(" L/min");
      Serial.print("\t");
```

- The if statement checks if one second has elapsed since the last measurement by comparing the difference between the **current time (millis())** and the **oldTime** variable. If one second has passed, the code inside the if block is executed.
- **detachInterrupt(sensorInterrupt):** Disables the interrupt to prevent further pulse counting while calculating the flow rate and updating the measurements.
- **The flow rate is calculated using the formula**:

  *(1000.0 / (millis() - oldTime)) * pulseCount / calibrationFactor.*

  It calculates the flow rate in liters per minute.

- The **oldTime variable** is updated with the current time (millis()) to track the interval between measurements.
- **flowMilliLitres** is calculated by converting the flow rate to milliliters per minute:

*flowRate / 60 * 1000.*

- The **totalMilliLitres** variable is updated by adding the calculated flowMilliLitres.
- The flow rate and total liquid quantity are printed to the serial monitor.

```
    if (flowRate > 0.1)
    {
      digitalWrite(8, HIGH);
      delay(3000);
      digitalWrite(8, LOW);
      delay(2000);
    }

    Serial.print("Output Liquid Quantity: ");
    Serial.print(totalMilliLitres);
    Serial.println(" mL");
    Serial.print("\t");
    Serial.print(totalMilliLitres / 1000);
    Serial.print("");

    pulseCount = 0;
    attachInterrupt(sensorInterrupt, pulseCounter, FALLING);
  }
}
```

- If the flow rate is **above 0.1 L/min**, pin **8** is set to **HIGH** for 3 seconds using **digitalWrite()** and **delay()**. This can be used to control an external device.
- After the if block, the code continues to print the cumulative total liquid quantity in milliliters and liters.**pulseCount** is reset to **0** to start counting pulses again.
- **attachInterrupt(sensorInterrupt, pulseCounter, FALLING)** re-enables the interrupt to resume pulse counting.

pulseCounter() function:

```
void pulseCounter() {
  pulseCount++;
}
```

- This function is an interrupt service routine (ISR) associated with the flow sensor interrupt.
- It increments the pulseCount variable every time a falling edge is detected on the flow sensor pin.

That is the complete breakdown of the code! It measures liquid flow, calculates the flow rate, and keeps track of the total liquid quantity using a flow sensor and interrupts. The measurements are printed to the serial monitor,

5. Implementation Details

Water flow detection system project description, considering that the output will be displayed on a laptop screen instead of an LCD module:

➢ Hardware Setup:

- Obtain an Arduino Uno board, water flow sensor, buzzer, and necessary connecting wires.
- Connect the water flow sensor to the Arduino board. Typically, the sensor has three pins: Vcc (power supply), GND (ground), and OUT (signal output). Connect Vcc to 5V on Arduino, GND to GND, and OUT to any digital pin (e.g., pin 2).
- Connect the buzzer to the Arduino board. Connect the positive terminal (usually the longer pin) of the buzzer to a digital pin (e.g., pin 3), and connect the negative terminal to GND.

➢ Arduino IDE Setup:

- Download and install the Arduino IDE from the official Arduino website (https://www.arduino.cc/en/software).
- Launch the Arduino IDE and configure it to work with the Arduino Uno board by selecting the appropriate board and port from the "Tools" menu.

➢ Arduino Code:

- Open a new sketch in the Arduino IDE.
- Start by including the necessary libraries. For the water flow sensor, you might need the "PulseIn" library.
- Define the necessary constants and variables. For example, you'll need variables to store the flow rate, volume, and time.
- Set up the sensor and buzzer in the `setup()` function.

- Implement the main logic in the `loop()` function. Read the sensor output using `pulseIn()` or any other suitable method, calculate the flow rate and volume based on the sensor specifications. Print the values to the serial monitor using the `Serial.print()` function.
- Upload the code to the Arduino Uno board using the "Upload" button or by selecting "Sketch" > "Upload" from the menu.

➢ Laptop Setup:

- Connect the Arduino Uno board to your laptop using a USB cable.
- Open a serial communication program on your laptop, such as the Arduino IDE's Serial Monitor or a third-party terminal software (e.g., PuTTY, CoolTerm).
- Configure the serial monitor or terminal software to match the baud rate specified in your Arduino code (e.g., 9600 baud).
- Once the Arduino is connected and the serial monitor is open, it will display the flow rate and volume readings in real-time as the sensor detects water flow.

➢ Connecting Arduino to Wi-Fi (if required):

- To connect the Arduino Uno to Wi-Fi and transmit data to your laptop wirelessly, you'll need an additional component like an ESP8266 Wi-Fi module or an Arduino board with built-in Wi-Fi capabilities (e.g., Arduino MKR1000).
- Connect the Wi-Fi module to the Arduino board following the specific instructions for your module.
- Modify your code to include the necessary Wi-Fi libraries and functions for connecting to the network using the SSID, username, and password.
- Once connected, your Arduino can send data to your laptop over Wi-Fi, and you can view the data on the serial monitor or terminal software.

6. Result Analysis

The result analysis of the water flow detection system aimed to assess its accuracy, efficiency, and reliability. The objectives were to measure flow rates accurately, detect anomalies, and monitor water consumption. To evaluate accuracy, the measured flow rates were compared with known values or reference standards. The percentage error or variance was calculated, considering calibration drift, measurement resolution, and potential sources of error.

Precision and repeatability were assessed by conducting multiple measurements under the same conditions. Statistical measures such as standard deviation and coefficient of variation were calculated to determine result consistency. The sensitivity and detection limits of the system were analyzed to identify its ability to detect small changes in flow rates or anomalies. The minimum flow rate that could be accurately measured or the minimum detectable anomaly was determined.

Environmental factors, such as temperature, humidity, and water quality, were considered to evaluate the system's performance under different conditions. Limitations or dependencies related to the environment were identified. System efficiency was evaluated in terms of response time, data processing, and power consumption. The analysis aimed to determine if the system met real-time monitoring requirements and if there were any delays or bottlenecks.

Results were compared against initial requirements and specifications to identify any deviations or areas where the system fell short. User feedback and experiences were gathered to gain insights into practical usability and performance. Based on the analysis, areas for improvement and optimization were identified, such as recalibration, software updates, or hardware enhancements. Feasibility and cost-effectiveness of implementing these improvements were considered.

The result analysis provided valuable insights for decision-making, ensuring the accuracy, efficiency, and reliability of the water flow detection system. Iterative testing and refinement were recommended to continuously monitor and improve system performance over time.

7. Future Scope

- **Advanced Sensor Technologies:** Explore the use of advanced sensor technologies such as ultrasonic, laser-based, or electromagnetic flow sensors. These sensors can provide higher accuracy, improved sensitivity, and reduced maintenance requirements compared to traditional methods.

- **IoT Integration:** Integrate the water flow detection system with the Internet of Things (IoT) infrastructure for seamless connectivity and remote monitoring. This enables real-time data transmission, automated alerts, and remote-control functionalities for efficient water management.

- **Artificial Intelligence and Machine Learning:** Apply artificial intelligence (AI) and machine learning (ML) algorithms to analyze flow data patterns and detect anomalies or irregularities. This can enhance the system's ability to identify leaks, unusual consumption patterns, or potential failures.

- **Data Analytics and Predictive Maintenance:** Utilize data analytics techniques to analyze historical flow data and identify patterns that can predict maintenance needs or optimize water distribution systems. Predictive maintenance can reduce downtime, improve efficiency, and extend the lifespan of equipment.

- **Integration with Smart Grids:** Integrate the water flow detection system with smart grid infrastructure to enable intelligent load balancing, demand response, and energy optimization. This integration allows for better management of water resources and energy consumption.

- **Leak Detection and Localization:** Develop advanced algorithms and techniques to accurately detect and localize leaks within the water distribution network. This can help reduce water loss, minimize infrastructure damage, and improve maintenance efficiency.

- **Real-Time Monitoring and Decision Support:** Enhance the system's capabilities for real-time monitoring and provide decision support tools for water resource management. This can include automated alerts, predictive analytics, and optimization algorithms to improve operational efficiency and resource allocation.

- **Integration with Smart Home Systems:** Integrate the water flow detection system with smart home systems to enable personalized water consumption monitoring, conservation tips, and real-time usage information for homeowners. This promotes water conservation practices at the individual level.

- **Water Quality Monitoring:** Extend the capabilities of the system to include water quality monitoring parameters such as pH, turbidity, and contaminants. This provides a comprehensive solution for monitoring and managing both water flow and quality within the distribution network.

- **Scalability and Adaptability:** Design the system to be scalable and adaptable to different types of water distribution networks, from small residential complexes to large industrial setups. This ensures its applicability across various settings and allows for future expansion.

8. Conclusion

In conclusion, the result analysis of the water flow detection system has provided valuable insights into its accuracy, efficiency, and reliability. The analysis highlighted the system's ability to accurately measure flow rates and detect anomalies, ensuring precise monitoring of water consumption. By comparing the measured values with known standards, the system's accuracy was evaluated, and any potential sources of error were identified. The assessment of precision and repeatability demonstrated the system's consistency in providing reliable results, while the analysis of sensitivity and detection limits revealed its capability to detect even minor changes in flow rates or anomalies.

Moreover, the future scope for the water flow detection system holds great potential for advancements in the field. Integration with IoT infrastructure and the application of AI and ML algorithms can enable real-time monitoring, automated alerts, and advanced data analytics for efficient water management. The integration with smart grids and smart home systems offers opportunities for intelligent load balancing, energy optimization, personalized consumption monitoring, and water conservation practices. Additionally, the development of advanced sensor technologies, predictive maintenance techniques, and leak detection algorithms will further enhance the system's capabilities in reducing water loss, optimizing maintenance, and ensuring water quality monitoring.

In summary, the result analysis has provided a comprehensive understanding of the water flow detection system's current performance and identified areas for future development. By incorporating the future scope considerations, the system has the potential to evolve into a more advanced, intelligent, and adaptable solution, empowering effective water resource management and conservation efforts in various settings.

Participated In Profest 2k23 Project Competition

9. References

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