IOT Based Long Range Water Tap Monitoring System

University of Victoria

Student Name	Student ID	Email
Asif Khan	V00998481	asifk@uvic.ca
Afraz Ahmad	V01022144	afrazahmad@uvic.ca

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Instructor: Dr. Wei Li

TASK AND RESOURCE ALLOCATION

ALLOCATED TASKS	NAME	DELIVERY
Project Background and Technical Analysis	Afraz Ahmad	✓
System Design and Architecture	Asif Khan	✓
System Implementation and Simulation	Asif Khan	✓
Coding & Development	Asif Khan	✓
Operational Testing	Asif Khan	✓
Summary and References	Afraz Ahmad	✓
Presentation	Afraz Ahmad	✓
Final Report Draft	Afraz Ahmad	✓

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1st Asif Khan
Department of Electrical and Computer Engineering,
University of Victoria
British Columbia, Canada.
asifk@uvic.ca

2nd Afraz Ahmed
Department of Electrical and Computer Engineering,
University of Victoria
British Columbia, Canada.
afrazahmad@uvic.ca

***Abstract*—The world is faced with a challenge of freshwater preservation as it is one of the United Nation's (UN) Sustainable Development Goals (SDGs) as well. 40% of the world's fresh water is wasted due to the poor management of water system at domestic places.A major portion of water loss all around the world is due to domestic tap water leakage or accidental tap water flowing. The current modern concept and equipment can be the solution to this problem, which is Internet of Things (IoT). Therefore, we as reseachers and engineers has developed a smart and long range water tap monitoring system, comprised of a water flow sensor, Arduino UNO and web server that displays the state of water tap remotely on both webpage and mobile application, with an addition of a control switch for controlling the water tap remotely. Currently, this system has been simulated successfully and a long range communication on the web page and mobile application has been achieved using a third party web server.**

***Index Terms*—Internet of Things, IoT, Water Tap Management, Smart Water Tap, Dashboard based water monitoring.**

I. Introduction

Approximately 30% of the world is land and almost 70% of Earth is covered by water, so it's natural to assume that we'll never run out. But freshwater, the kind used for human consumption and other purposes like bathing and farming, is extremely scarce. It is worth to mention that only 3% of the water on Earth is fresh, and the majority of that is locked up in glaciers or otherwise inaccessible [1]. Consequently, there are more than 1 billion people globally do not have access to water, and a further almost 2.69 billion experience water scarcity for minimum of a almost month out of the year. About 2.4 billion people face the risk of contracting cholera, typhoid, and other dangerous water-borne diseases due to inadequate sanitation.

There are a lot systems for water that keep ecosystems healthy and sustain a rising human population have been strained. As a result of pollution and depletion, rivers, lakes, and aquifers are becoming unusable [1]. Unfortunately, we've lost more than half of the world's wetlands. More water is used in agriculture than any other industry, and much of it is wasted due to inefficiency. As a result of climate change, some regions are experiencing droughts and flooding while others are experiencing abnormally mild weather.

This was the bigger picture of what is going on in the world regarding loss of water. It tells us the importance of the water around the world and how much it is important to work since it can lead to disastrous consequences. A question in our minds arise that what contributes in the clean water loss. One reason can also be the dripping water from faucet or Tap. In the first thought it seems very unimportant to consider the water loss related to dripping from water tap but lets see how it is also a considerable source of losing water. Every home in the entire world has on average 5-6 taps inside it and its use is frequent. We also know how often a water tap leaks. Assume you have a single dripping faucet in your house. That's 3,600 drips each hour, 86,400 drips a day, and a staggering 31,536,000 drips a year.

Lets clarify our claim with some mathematics before going into some output. Lets say the volume of a single drop from a faucet might vary, we will round it off to the nearest quarter millilitre (ml). Our 1-second dripping faucet loses more than 5 gallons of water each day, or slightly under 2,080 gal/year. As we know that one gallon is equal to 3,785 ml, or in other words it is 15,140 drips. This is the rate at which we loose water with a dripping faucet and how much it will cost in the long run as well as if its two then this calculation become double of it [2].

Therefore, this problem has motivated the engineers and researcher to do something for it. There should be a system that can mitigate the loss of flowing water from tap weather its a leak or someone forgot to turn off the tap. In this modern era, we have a concept known as Internet of Things (IoT) which can become the solution to this problem. IoT is the interconnection of physical devices such as sensors, micro controllers, and any electronic devices that collects data and communicate it to the internet. To solve the problem of water leaking through taps and accidental flowing of water we have IoT, which can be used to integrate a system to monitor the unwanted water flow from any tap in a home. This will greatly help in knowing that water tap flowing can be closed any time when its being reported by IoT system.

In this work, we have developed a smart system for water taps in a home, which will monitor the water tap when the water is flowing and send its status to a web server employed for it. Moreover, this status of the tap water can be seen on a website, as well as on the mobile application. The range to communicate the status of the water tap is made limited to connection of internet. Which in other words means that even a person is thousands miles and connected to internet he can see the status of its water taps in home weather the water is flowing or not. This can be a great achievement in controlling and monitoring water taps form miles away through a personal device.

II. Literature Review

In recent years, water pollution has emerged as a serious global problem. Because water is so crucial to human survival, constant water monitoring will be necessary to address this problem. In Sung et al. [3] have created a reliable Internet of Things (IoT) system for real-time physiochemical sensor monitoring of water quality. Sensors for turbidity, temperature, pH, conductivity, and total dissolved solids (TDS) are integrated with an Arduino microcontroller to form the system. Every sensor's data is uploaded to a central server. Acquiring, transmitting, monitoring, recording, and analyzing water quality data online are all tested. The experimental results suggest that the water sources examined here meet the standards for potable water. In addition, we proposed a model for the quality of running water based on experiments connected to water diversion methods.

When it comes to technological research, the Internet of Things (IoT) has recently emerged as a fascinating topic. It's the practice of linking disparate devices together via the web. Many laypeople think about Internet of Things (IoT) in terms of self-driving cars and smart homes, however many groundbreaking IoT initiatives are really being carried out in highly applied domains. The "water pollution monitoring system" is just such an example. Over the course of human history, as populations have grown and as countries have become more industrialized, water pollution has become an issue of universal importance. Researchers have developed an Internet of Things (IoT)-based smart water pollution tracking equipment to aid in lowering the time and energy needed to perform analytical services. Islam et al [4] has proposed a system that uses the Internet of Things to keep tabs on water pollution and performs real-time quality checks on the supply. The water quality parameters measured by this apparatus include pH, Total Dissolved Solids (TDS), and temperature. Arduino, a microcontroller, is used to collect and format the data from the sensors before sending it through the Serial Wire to NodeMcu, the central controller. The data is then transmitted wirelessly from the NodeMcu to the internet-server. And lastly, the android app allows viewing of sensor data in a web browser or on a mobile device. Our aim is to rectify the lack of a suitable water pollution monitoring system in rural Bangladesh, therefore facilitating the cleaning of the machine. Thus, the primary objective is to facilitate trusted data sharing for remote tracking and guidance.

Increases in agricultural, industrial, and other needs are driving the need for better Fresh Water Management in India. The "chemical, physical, and biological" characteristics of fresh water define its quality. The three phases of conventional water quality monitoring are sampling, analysis, and investigation. The scientists perform these by hand. There is no way to predict the water's quality with this method, and it is not entirely dependable. Some studies have been conducted to monitor water quality using wireless sensors that are deployed in water and provide short messages to farmers regarding water. There has also been study on the feasibility of employing machine learning algorithms to assess water quality. With the rise of M2M technologies, which allow for inter-device communication and subsequent intelligent data analysis, Pappu et al [5] have created an "Intelligent IoT based water quality monitoring system" for residential areas' use of water storage tanks. The system uses a PH sensor and a TDS meter to determine the levels of hydrogen ions and total dissolved solids in the water. K-Means clustering, a machine learning algorithm, has also been used to forecast water quality using a trained data set consisting of several water samples. The initial version of this system is a prototype built with inexpensive embedded devices like Arduino Uno and Raspberry Pi3.

Solutions based on the Internet of Things (IoT) are becoming increasingly popular across a wide range of industries and use cases, including environmental monitoring, agriculture, energy, healthcare, and water supply and quality monitoring. Khan et al [6] proposes an Internet of Things (IoT)-based system for monitoring community water supplies and sending out timely alert messages. After the water supply was restored, we found that all networked sensors immediately began monitoring the water level and broadcasting an alert via the message-queuing telemetry transport protocol to the other nodes. Users will be relieved of the burden of waiting around for water and will have less need to use/switch inductive consumer electrical equipment thanks to this timely information. The findings of this study could serve as a springboard for future work in the development and implementation of wireless sensor technologies for use in household water supply systems, benefiting researchers and business owners alike.

India's demand for water has skyrocketed in the last decade. However, it has proven to be a significant obstacle for the global community to keep up with the rising demand for water. Conversely, water resources have been steadily deteriorating due to careless water consumption, natural and man-made disasters, global warming, sewage, and waste. Since water is essential to human survival, protecting it through optimal use and, more importantly, preservation, is the only way to ensure a prosperous future.

Tripathy et al [7], we introduce an IoT-based architecture for water monitoring and control that enables real-time data collecting through the web. The device solves the problem of measuring flow rates, and this research also suggests a technique for reducing water waste. pH and conductivity sensors can be installed to monitor the water quality before it is distributed to homes.

Kato et al [8] proposed a system to use a cheap electrochemical sensor to detect the level of residual chlorine in drinking water as it flows through the pipes. The research team here created potentiometric sensors using platinum, aluminum, and stainless-steel working electrodes. Pt and stainless-steel electrodes performed similarly well. An SUS304 stainless steel electrode, for instance, responded with 200 mV after being exposed to 1 mg/L of residual chlorine for roughly 4 minutes. Electrodes made of Pt and SUS316 showed the same variation with variations in pH and dissolved oxygen concentration as environmental conditions were assessed. The results indicate that all-solid-state sensor systems with benefits like small size, low power consumption, low cost, and resilience may be fabricated by using the right combination of electrode materials.

Choi et al [9] demonstrated the value of a Smart Water Management (SWM) system. By utilizing IoT technology for remote metering of consumers' water usage and minimizing supply-side leakage, SWM can cut down on production costs. The SWM Proof of Concept Model Enabled Real-Time Monitoring of the Operation Status by Installing a Remote Water Leakage Sensor, Smart Metering, and a Micro Multi Sensor in the Water Supply Facility. Using a mobile application, businesses and consumers may share information about water conservation and quality. We just conducted a survey to find out if people are reusing their bottled water or just drinking the water straight from the tap. This research is also intended to confirm whether the SWM technology has been successful in reducing consumer complaints, operating costs, and water consumption, as well as in raising water supply and drinking water rates. Events are identified using the operator monitoring system, the IoT sensor at the supply facilities, and the investigation of a recovery solution. Improving the standard of living in the home water sector by implementing cutting-edge SWM practices and advancing existing ones.

III. Methodology

In IoT we have a lot of micro controllers that are good for computational task some of them are optimized for power consumption and also good computationally. To develop this systems we have utilized Arduino UNO as our main micro controller which will communicate with water flow sensor and send the water tap status to a web server on internet. This web server will show us the status of the water tap water flowing and in the same time we also have a web application which can be used to see the water tap status.

The figure 1 below is the visualization of our system implemented. We have simulated a water flow sensor. We have used a Proteus software to demonstrate our work. Proteus is a simulation software that can simulate all the IoT electronic, which can portray to the real implementation of those circuitry. In this work, we have made our system on this Proteus software and meanwhile it is connected to the web server to exchange all the information. The general overview and working procedure of our work can be seen in the figure below. Furthermore, we will be discussing the module furthermore in this section.

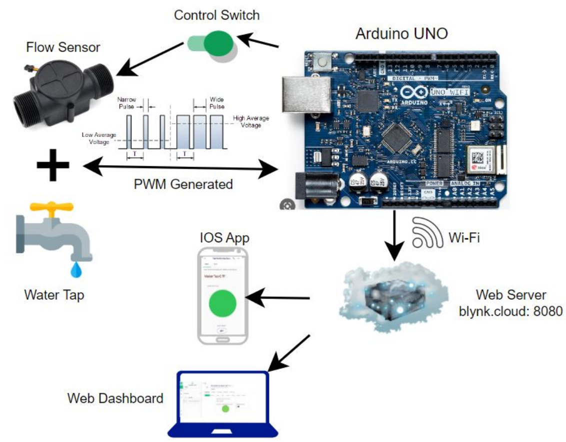

Fig. 1. Implemented System on Proteus

A. *Water Tap Flow Sensor:*

The water flow sensor used in this work is Water Flow Sensor Flow meter Hall Flow Sensor. This water flow sensor can be installed on any water tap with connecting groves on it as shown in the figure below. Whenever the water is flowing the sensor generates a square signal by driving a motor. This square signal is a Pulse Width Modulation signal. This square signal is an indication that water is flowing thorough the water tap. The water flow sensor is connected to the pin 3 of the Arduino. The Arduino has been coded with the Arduino application, a sketch is then programmed into the Arduino using the configuration window in Proteus.

Fig. 2. Water Flow Sensor With grove on it

B. *Arduino and Sketch:*

In this work we are using Arduino UNO micro controller. Electronics projects may be constructed with ease using the Arduino open-source platform. A physical programmable circuit board (sometimes called a micro controller) and accompanying computer software, known as an IDE (Integrated Development Environment), are required to utilise an Arduino board. The Arduino board consist of powerful IC's, USB ports, processor, input/output pins, communication TX/RX pins and much more a controller has to offer.

The IDE is used to write a code to generate a sketch, this catch is then programmed into the Arduino board. Here in this work we have configured the Arduino to installed a blank web server library and read the flow sensor output on pin 3 and in the mean time when the sensor is flowing water it should send a message to the web server to tell the status of the water tap weather its flowing or not.

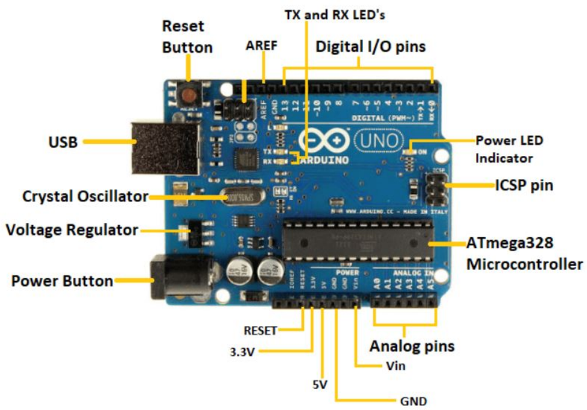

Fig. 3. Arduino Micro Controller

1) Logic Flow of system Reading Sensors Data and Notifying: The sketch programmed to run the whole system comprises of few sections. At first the sketch is configured to load all the libraries of the blynk web server. After that the sensor is connected with a button switch, when its turned on it means that the sensor is running, in other worlds its showing that a water is flowing. This is indicated as start in the flow diagram shown below. After that it the whole configuration is ok we start the simulations by running the simulation on Proteus. We then check the web dashboard or mobile application if its successfully established the connection a online status is indicated on it. After that the sensor is started, meanwhile we check in the all time running loop of the Arduino that if pin 3 is high indicate the web server that the tap is not running and if the pin 3 is low then indicate that the water is flowing. The logic here is reverse because we have the system to trigger on active low configuration. Meanwhile its checking if simulation is running it keeps in running on checking. When the simulation is ended the program closes. This flow of the logic established on Arduino can be seen in the flow chart shown below..

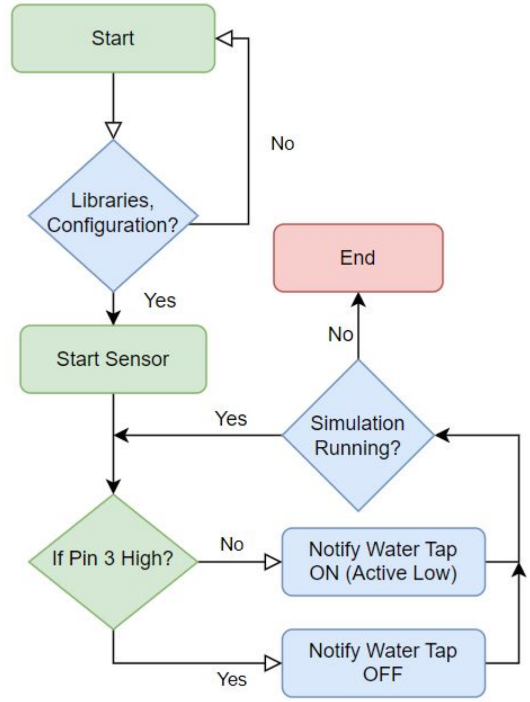

Fig. 4. The logic flow of the coding

2) Control Switch: We also have indicated a control LED, which can be controlled from the web application and it shows that any device can be controlled from the app as well. This can be a servo motor or actuator which can be installed with the water tap and it will turn on and off the tap in case the water is spilling or flowing at full. In this work we called it an control switch for the water tap. This configuration can be seen in the figure below.

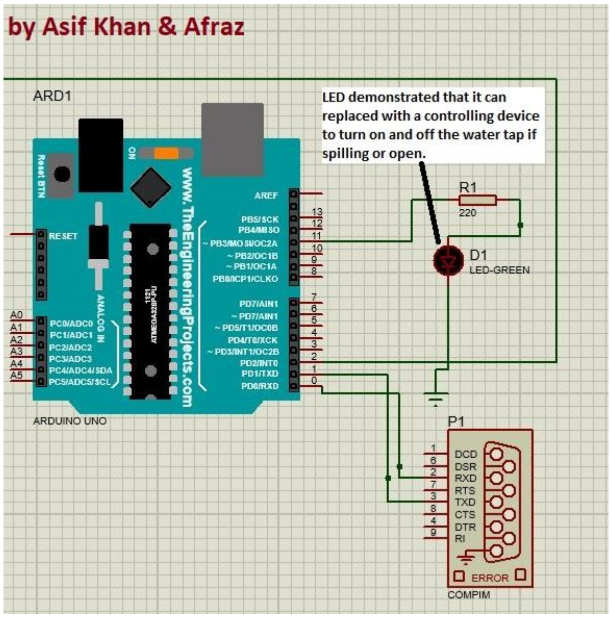

Fig. 5. Control Switch Configuration Depicting to Control Water Tap

C. Blynk Web server as IOT Platform

Blynk was created with IoT into consideration. It is a third part software It has numerous useful capabilities, including remote hardware control, visualisation of sensor data, data storage, and visualisation. You may build stunning user interactive interface and application for IOT project with the help of the Blynk App and the widgets we supply. This is accomplished through the Blynk Server, which acts as the bridge between the user's mobile device and the physical components. You have also the option of using Blynk Cloud or setting up a local instance of Blynk. It's also free and open-source, with the capacity to manage thousands of devices simultaneously. All the common hardware platforms have access to the Blynk Libraries that facilitate network connection and handle all the incoming and outgoing commands.

In this work we have utilized the blynk web services and IoT app building platform for our project. We created a display for our message coming from the Arduino to show on both of the platform. We also created a button to control a any module which is represented by LED in this work for now. Moreover, we connected our system for both web and app platform using the blynk.cloud services on a 8080 port.

The Link establish form Proteus circuitry to the blynk web server using the port configuration to communicate to the application. In real scenario this part would have skipped using Wi-Fi module directly to communicate to the cloud server of blynk.

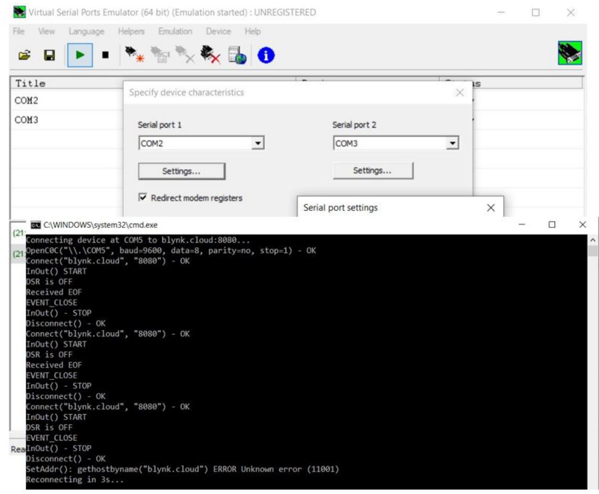

Fig. 6. Port Configuration and Connecting to blynk.cloud:8080

D. Web and Application Platform

We have utilized the blynk server for web platform to show water tap on message and to control the water tap. Moreover, we have also established an IOS application to control and see the water tap water flowing status and with the same functionalities as same as the web platform. Both of these platform is made using the blynk third part support to build web interface and IOS application. Furthermore, an android application can also be easily established using the same blynk third part software developing support.

IV. Results

In Fig 7 shows the schematic setup of proposed water tap monitoring system, the water flow sensor generates a pulse that provides the input signal to the Arduino UNO showing the on-state of water tap. To mimic a real flow of water through the water flow sensor, as shown in Figure 7, a pulse wave generator has been used. Arduino UNO is programmed for receiving the pulse as an ON state of water tap, and this information is further transmitted to the webserver, Blynk, through internet.

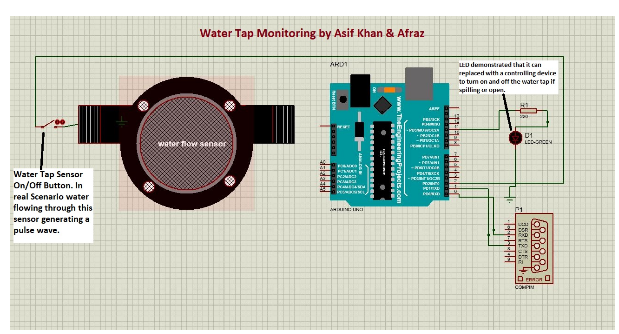

Fig. 7. Schematic of Our System

Figure 8 shows the state of water tap using dashboard for mobile application. As, most of the consumer these days have access to smart mobile phones, the mobile application using a third-party server, Blynk, is an effective addition to this water tap monitoring system. The networking layer for the communication of state of water tap between the dashboard at long and short range has been achieved by using the technique shown. For a real-time and controlled operation, the simulation has been conducted on Proteus software as it offers a variety of switches and libraries for swift monitoring.

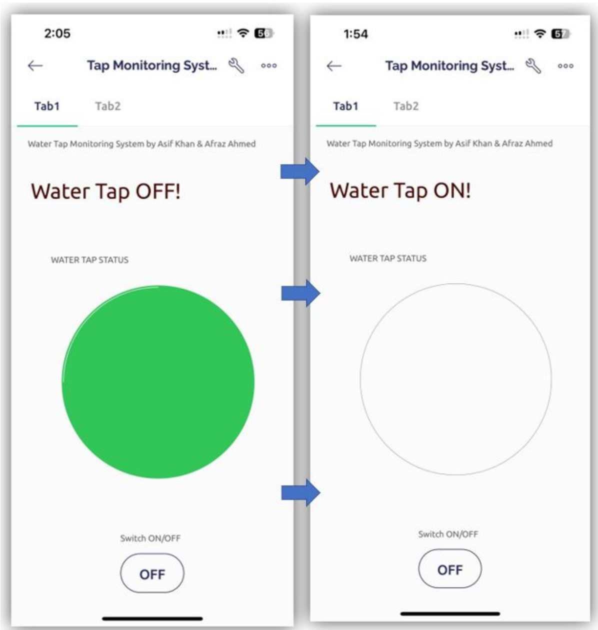

Fig. 8. IOS Application Layout Changing Stats

Blynk shows a real time condition of water tap, as shown in Figure 9. The figure 9 shows the OFF state of water tap as green, and just when the water tap is on, the green circle changes to white. The control switch in Figure 9 is used for turning water tap ON and OFF remotely, this state is also indicated by D1 switch in Figure 7 above.

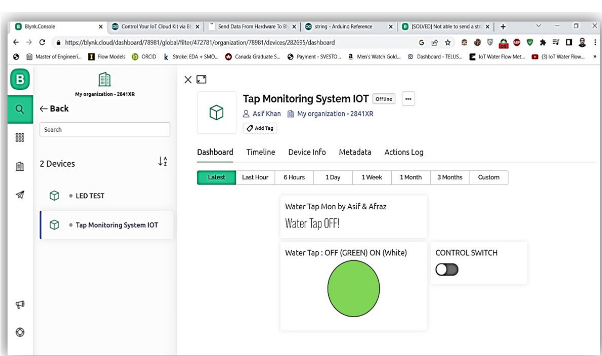

Fig. 9. Web Based Dashboard to Control the Water Tap

V. Conclusion

Water is an essential part of our daily life, and its preservation requires modern solutions. The system proposed in this study addresses the freshwater management issue by monitoring the state of water taps in residential buildings using a smart tap water monitoring system with a special water flow sensor, that sends the data in pulses to the Arduino UNO microcontroller and further transmits it over the internet to the user. This system is beneficial for controlling the use of water, information regarding water taps leaks, and provides detailed information on water usage timing. This real-time information is very helpful for water suppliers and building managers to identify water leaks and open future avenues for water billing methods. The control switch on the webpage and mobile application also can turn on or off the water tap from a remote location just by clicking the switch button.

VI. Acknowledgement

We would like to acknowledge the efforts of Dr. Wei Li and the teaching team of IOT Course in helping us understand the vital concepts of internet of things to build this project.

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Source Code:

```
/*************************************************************
  Download latest Blynk library here:
    https://github.com/blynkkk/blynk-library/releases/latest
  Blynk is a platform with iOS and Android apps to control
  Arduino, Raspberry Pi and the likes over the Internet.
  You can easily build graphic interfaces for all your
  projects by simply dragging and dropping widgets.

    Downloads, docs, tutorials: http://www.blynk.cc
    Sketch generator:           http://examples.blynk.cc
    Blynk community:            http://community.blynk.cc
    Follow us:                  http://www.fb.com/blynkapp
                                http://twitter.com/blynk_app

  Blynk library is licensed under MIT license
  This example code is in public domain.
 *************************************************************
  =>
  =>          USB HOWTO: http://tiny.cc/BlynkUSB
  =>
  Feel free to apply it to any other example. It's simple!
 *************************************************************/

/* Comment this out to disable prints and save space */
#define BLYNK_PRINT DebugSerial

/* Fill-in your Template ID (only if using Blynk.Cloud) */
//#define BLYNK_TEMPLATE_ID   "YourTemplateID"

#define BLYNK_TEMPLATE_ID "TMPLy5JxiXd0"
#define BLYNK_DEVICE_NAME "Tap Monitoring System IOT"
#define BLYNK_AUTH_TOKEN "5iC4Ia8EmXwzMtpo8YayusTmYEHIff0p"

// You could use a spare Hardware Serial on boards that have it (like Mega)
#include <SoftwareSerial.h>
SoftwareSerial DebugSerial(2, 3); // RX, TX
```

```
#include <BlynkSimpleStream.h>

// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = BLYNK_AUTH_TOKEN;
char message1[]="Water Tap ON!";
char message2[]="Water Tap OFF!";
int var;
int sensorpin = 3;
int dummy;

WidgetLED led1(V1);
BlynkTimer timer;

BLYNK_WRITE(V0)
{

  var = param.asInt();
  digitalWrite(11,var);

 }

void sensor1()
{

 int value = digitalRead(sensorpin);

 if(value == HIGH)
    {
    led1.on();
    Blynk.virtualWrite(V2, message2);
    }
    else if(value == LOW)
    {
      led1.off();
      Blynk.virtualWrite(V2, message1);
```

```
      }
      else
      {
        dummy=0;
        }
}



void setup()
{
  // Debug console

  DebugSerial.begin(9600);
  pinMode(sensorpin,INPUT);
  // Blynk will work through Serial
  // Do not read or write this serial manually in your sketch
  Serial.begin(9600);
  Blynk.begin(Serial, auth);
  timer.setInterval(100L, sensor1);

}

void loop()
{


  Blynk.run();
  timer.run();




}
```