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Efficient Water Management using LoRa in Advance IoT

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***Abstract*: Nowadays, the systems are operated manually and no single individual is aware of all the operating parameters of the whole system. Automating the system will enable prevention of water wastage a monitoring easier. The existing systems doesn't have a proper data base of flow, pressure, level and other ground conditions. So, we want to collect those data using flow, pressure and purity monitoring sensors. It resolves this by automating the leakage detection and also it is detecting in real time. so, we can immediately rectify the leakage as fast as possible due to instant alert sent to the intended authority/person. He/authority also can view the part/location of the pipe where the water is leaking.**

***Keywords*: Alert, automation, efficient, leakage, purity, pressure level, real-time, monitor, water flow.**

1. Introduction

The pipelines are planted with set of sensors like pressure sensor, flow meter sensors and purity sensor. these sensors are connected to the raspberry pi/Arduino. then the data from the Arduino is transferred to LoRa (Long Range) Shield.

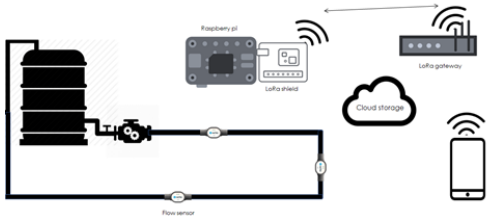


Fig. 1. System architecture

The data stream from the LoRa is transferred to the nearest base station gateway using LoRa shield client. Then the base station sends the data to the intended authority or the persons via mobile application where the location of leakage, purity. Amount of water lost till now is shown. So that the problem /issue can be rectified as fast as possible

A. Centralized control

Keeping everything centralize is a very import aspect of the system as it provides the most seamless and interruption and clutter-free experience. The below operation can be made through our water managing system in a single interface in web-site as well as web application

- Take control of the Entire System
- Automate the water flow
- Eliminate manual switching
- Monitor the Flow and prevent wastage

2. End node

The whole setup is based on centrally an Arduino Uno where all the sensors and Interfacing components which is the LoRa shield are connected. The data is collected and processed in the Arduino IDE embedded C program also the LoRa connectivity is made through the embedded C program.

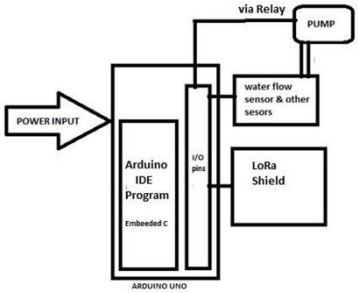


Fig. 2. End node device

A. Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino Uno can be programmed with the Arduino Software (IDE). The ATmega328 on the Arduino Uno comes preprogrammed with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol.

B. Flow sensor

This flow sensor is constructed of solid plastic, easy to install in a standard (1/2 ") piping system, measures the flow of water by means of an internal water rotor that activates a Hall effect sensor, it sends pulses The sensor is isolated from the water and

the rotor, so it is always kept dry and safe. With the help of this sensor you can enter the world of Home Automation, monitoring the consumption of water in your home, or you can make an automated volume dispenser with the help of an additional valve.

Fig. 3. Flow sensor

The sensor has three wires: red (v_{cc}: 5-18VDC), black (ground) and yellow (Hall Effect sensor pulse output). By counting the pulses the volume or flow rate of the water can easily be measured (the average volume per pulse is 2.25mL). This is not a precision sensor so orientation, water pressure and other conditions may affect the measurement. Any type of digital flow sensor like the ultrasonic ones and also in any scale of size this is the one which is standard in many piping systems.

C. LoRa shield

It is a long-range transceiver on an Arduino shield factor and based on Open source library system. The Shield allows the user to send data and reach extremely long (upto 12K.m) ranges at low data-rates. It provides ultra-long range spread spectrum communication (i.e.) the LoRa which operates on 868MHz In India and high interference immunity whilst minimizing current consumption.

Fig. 4. LoRa shield for Arduino

LoRa Shield is based on Semtech SX1276/SX1278 chip, it targets professional wireless sensor network applications such as irrigation systems, smart metering, smart cities, smartphone detection, building automation, and so on. Using Hope RF's patented LoRaTM modulation technique the Shield featuring LoRa® technology can achieve a sensitivity of over -148dBm using a low-cost crystal and bill of materials. The high sensitivity combined with the integrated +20 dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness. LoRaTM also provides significant advantages in both blocking and selectivity over conventional modulation techniques, solving the traditional design compromise between range, interference immunity, and energy consumption. These devices also support high performance (G)FSK modes for systems including WMBus, IEEE802.15.4g. The Dragino Shield featuring LoRa® technology delivers exceptional phase noise, selectivity, receiver linearity and IIP3 for significantly lower current consumption than competing devices.

D. Water pump

We use a simple 20v water pump to simulate the water loop which is connected to the power socket to satisfy its power needs and connected to Arduino with a relay so that it can also be controlled over the network as it also programmed in Arduino IDE it will also automatically turned off if the leakage is detected.

3. LoRa WAN

LoRa (short for long range) is a spread spectrum modulation technique derived from chirp spread spectrum (CSS) technology. Semtech's LoRa devices and wireless radio frequency technology (LoRa Technology) is a long range, low power wireless platform that has become the de facto technology for Internet of Things (IoT) networks worldwide. LoRa Technology enables smart IoT applications that solve some of the biggest challenges facing our planet: energy management, natural resource reduction, pollution control, infrastructure efficiency, disaster prevention, and more.

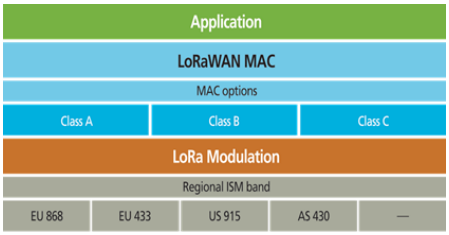


Fig. 5. Lora shield for Arduino

The LoraWAN open specification is a low power, wide area networking (LPWAN) protocol based on LoRa TM. Designed to wirelessly connect low-power operated things to the Internet in regional, global networks, the LoRa WAN protocol uses the unlicensed radio spectrum in the Industrial, Scientific and Medical (ISM) band. The specification device-to-infrastructure of LoRa physical layer parameters and the LoRaWAN protocol, also provides seamless interoperability between connectivity devices. While Semtech provides the radio chips featuring LoRa Technology.

A. LoRa Gateway

The LoRa gateway is the node which receives the data from the End Node as it works on the same frequency as the LoRa shield and forwards it to the user cloud interfaces like The Things Networks (TTN) systems through the internet. It ca provide this service for n number of End nodes within its

coverage area which is upto 7 k.m.

Fig. 6. Lora Gateway

4. AWS Simple Notification Service (SNS)

It is a notification service provided as part of Amazon Web Services. It provides a low-cost infrastructure for the mass delivery of messages, predominantly to all mobile users. From the sender's knowledge, SNS acts as a single interface that can message to a variety of devices and platforms, from the Kindle Fire to Baidu. A single code interface can find all of these equally, or message formats can be tailored to the particular needs of each platform. SNS can also send messages by SMS to 200+ countries.

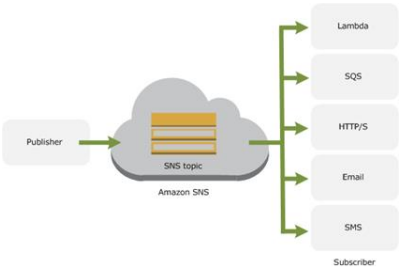


Fig. 7. SNS publish subscribe model

SNS uses the publish/subscribe model for push delivery of messages Recipients subscribe to one or more 'topics' within SNS. Typically, this is hidden from the user as an internal part of a mobile app. Receipt of a message could also be hidden from the user: this service is largely aimed at the internal processing of specific apps, rather than as email substitute. A game might receive bonus level announcements or unlock keys for in-game purchases by this route. A ticket booking app could use it for confirmation.

5. Result and discussion

The authorized user either can use the given credentials or the fingerprint to login the application.

Fig. 8. APP Login

The user can easily view the flow reading in a clean UI as a graph view as shown in the Fig. 8.

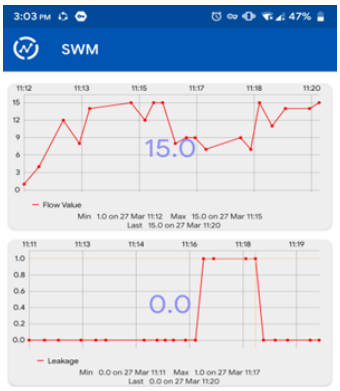
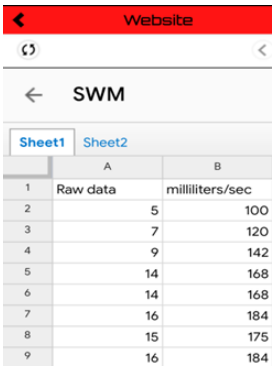


Fig. 9. Graph view

Also the reading value is store in a database (spreadsheet) as shown in the Fig. 10.



	A	B
1	Raw data	milliliters/sec
2	5	100
3	7	120
4	9	142
5	14	168
6	14	168
7	16	184
8	15	175
9	16	184

Fig. 10. Database

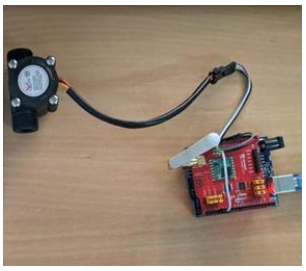


Fig. 11. Client side experimental setup

When any leakage is detected the authorizes user will get an alert message as shown in the Fig. 12.

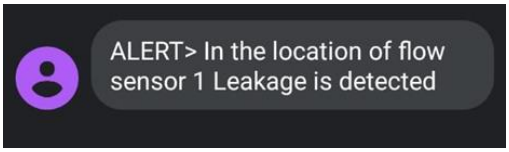


Fig. 12. SMS alert via Amazon SNS

A. Advantages

Its advantages over the traditional existing systems like scada are,

- No need for manpower to monitor water leakage.

- Faster leakage detection so water can be preserved as fast as possible.
- Monitoring water purity
- Easily manageable in a mobile application
- Water flow notification.
- Adequate water supply
- Clean water
- Efficient water usage

B. Centralized control

- Take control of the Entire System
- Automate the water flow
- Eliminate manual switching
- Monitor the Flow and prevent wastage

C. Applications

- It has various forms of application in several sectors
- Smart cities.
- Large scale water carrying pipelines
- Chemical Industries.
- Food industries
- Apartment's

6. Conclusion

This paper presented the implementation of efficient water management using LoRa in advance IoT.

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