Smart Water-Metering System for Domestic & Industrial Water Management

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***Abstract*—** A approach to performing automated water-metering for update of consumption information from field or home to the Utility office is described in this paper. The smart-metering approach may differ from existing commercial methodologies by using of low cost IoT hardware like WI-FI module or GSM module and android / iOS app. This scheme allows both Meter Reader as well as individual domestic / industrial consumers to utilise regular smartphones to perform meter reading and update to utility's portal / database through cloud servers for billing and payment individually. The proposed scheme reduces overheads on Utilities in handling meter reading and billing for water distribution in metropolitan and large urban conglomerates.

Keywords*—IoT, AMR, Arduino MKR1000, NodeMCUv2, Municipal Utilities, Smart Metering, Flow Meter, Cloud Database, Automated Reading, Wi-Fi, Billing.*

I. INTRODUCTION

A water meter is a device used to measure the amount of water utilised by a consumer. A smart water meter is a measuring device that has the ability to store and transmit consumption data continuously. Rapid changes in lifestyle and increased paying capacity have impacted use of water and related overheads on sewerage requirements. Sometimes smart meters are referred to as "time of use" meters because, in order to measure the volume consumed by a consumer on a real-time basis, they also record the date and time the consumption has occurred. Water Utilities have traditionally looked at managing water distribution as a sensitive task with humanitarian an approach which sometimes results in uneconomically high cost of water management and skewed cost-sharing arrangements among different categories of consumers.

The main revenue for water utilities have been through Billing for consumption. Traditional water meters read monthly or bi-monthly by an individual person and then a water bill is calculated from these manual readings of the meter. Smart meters can take readings remotely and more frequently every day, providing real-time access to water consumption data for both consumers and water utilities. Smart water meters are automated metering infrastructure (AMI) system that water utilities may consider deploying. AMI system with smart water meters are basically capable of measuring overall water consumption, collecting and analysing water utilisation information with calculating bill as per the rate decided by water utilities and by communicating this information sends back to user as well as water utility via the internet either on request or on a fixed schedule as it is programmed to do so. AMI systems consist of hardware mainly Arduino, software, communication over the internet using Wi-Fi module plus development kit (NodeMCU v2), consumer water use portals and controllers, flow meters.

Water utilities are implementing advanced metering infrastructure (AMI) systems as part of larger Smart Grid initiatives. AMI extends current digitally advanced meter reading system (AMR) technology by providing two-way communications, allowing information water consumption and commands to be sent to end users who are using smart meters for multiple purposes including Real-time usage and pricing information, leakage and abnormalities, targeted water efficiency messaging, measuring changes in water use, and even remote service disconnects. Internet of things is the revolution of the internet which will make the world smarter. This smart meter can also measure the water level of any domestic and industrial water storages as we have added the level sensor in the prototype. This water level measurement will help to automatically switch the water flow between utility to water storage tank. This is going to save plenty of water.

A wide range of physical objects is connected over the internet, providing them with the ability to think and communicate without requiring human to human or human to machine interaction. IoT can be considered as an emerging global technology, in which things can be connected and controlled remotely. As there are analogue meters are being used by the municipal corporation that meters need time to time reading by a person and still, there are an inconsiderable amount of water losses occur due to leakages, this topic has covered with water leakage detection by using two flowmeters. so that we will be able to compare both flow meters as per their speed, by comparing the speed of the flow meter, we will be able to understand leakage if any. The prototype system relies on the use of simple Internet of Things (IoT) approach for Water metering in conjunction with a custom-built Smartphone App.

II. SMART METERING DESIGN

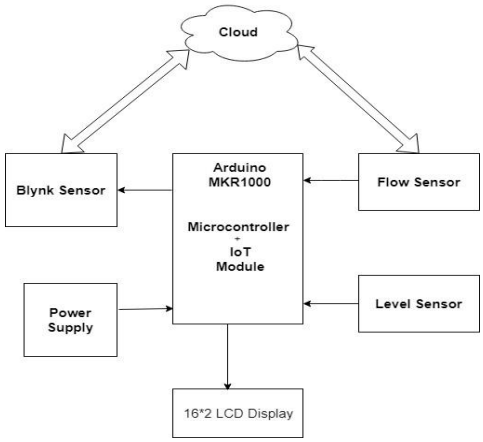

Fig. 1. Functional Block Diagram of Prototype

A. Arduino MKR1000-

This system uses Arduino MKR1000. MKR1000 has a 32bit computational and processing power similar to the Zero board, the usual useful set of I/O interfaces provided on board, low power Wi-Fi with a Crypto chip basically for secure communication, and the ease of use of the Arduino Software (IDE) for code development and programming. For visual confirmation 16*2 LCD display is also connected with development kit so that user will be able to see the consumption volume and total bill of consumed water. Buzzer is also added it the prototype for, whenever water will start to flow through the flow sensor it will indicate and vice versa. The flow sensor will give output in analogue value, then our Arduino will convert it to digital data.

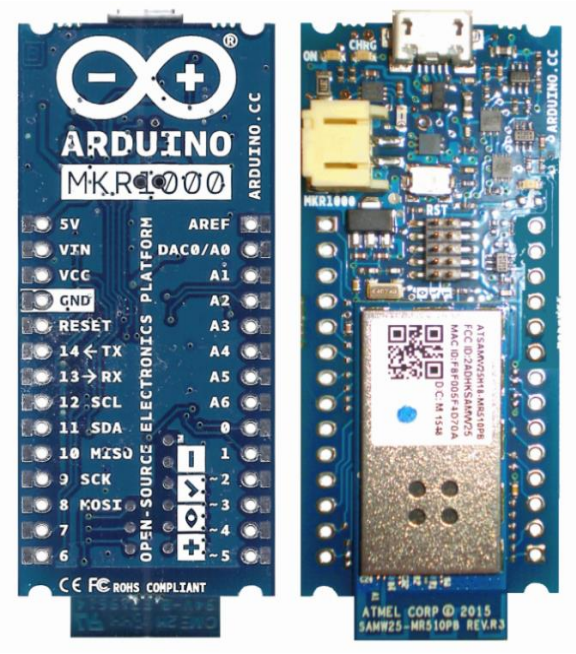

Fig. 2. Arduino MKR1000 Kit

The system can measure the water level and give the measurement to a municipal utility. With a user community that designs and manufactures microcontroller-based development kits for building digital devices and interactive objects that can sense and control objects in the physical world. This system provides a number of digital and analogue Input/output (I/O) pins that can be interfaced with various expansion boards and other circuits.

A. Water Flow Sensor YF-S201

This sensor is connected to water line and contains a rotating pinwheel sensor to measure how much water or liquid has moved through it. There's an integrated magnetic Hall Effect sensor that gives output in electrical pulses with every revolution. The Flow sensor is a device which is used to measure the water flow. Flow sensors use acoustic waves and electromagnetic fields to measure the flow through a given area via physical quantities, such as acceleration, frequency, pressure and volume.

Fig.3 Picture of Water Flow Sensor YF-S201

The sensors are solidly constructed and provide a digital pulse each time an amount of water passes through the pipe. The Hall Effect sensor is as shown in figure 3 which is normally sealed from the water pipe and it allows the sensor to stay safe and dry. This is known as G1/2 water flow sensor.

As the water flows through the rotor, its blades rotate. As the turbine rotates magnetic field is produced and accordingly an Ac pulse is generated which is then converted into the digital output with the help of Hall Effect sensor placed just after the turbine. Thus, pulses produce an output frequency which is directly proportional to the volumetric flow rate/total flow rate through the meter. Also measuring flow rate through rotating rotor provides high accuracy, excellent repeatability, simple structure and low-pressure loss, the sensor comes with three wires: red (5-24VDC power), black (ground) and yellow (Hall effect pulse output). The output of the sensor gives us analogue pulses, so that we can easily calculate water flowing through the pipe. Each pulse is approximately 2.25 millilitres.

The program generates the measure of water flow which passes through the sensor by digitally reading the rotatory motion of the wheel inside the sensor. For the sake

of the demo, blow air from mouth to rotate the wheel in the sensor. The air should come out from inlet to outlet of a flow sensor. As soon as the air enters, the wheel starts to rotate.

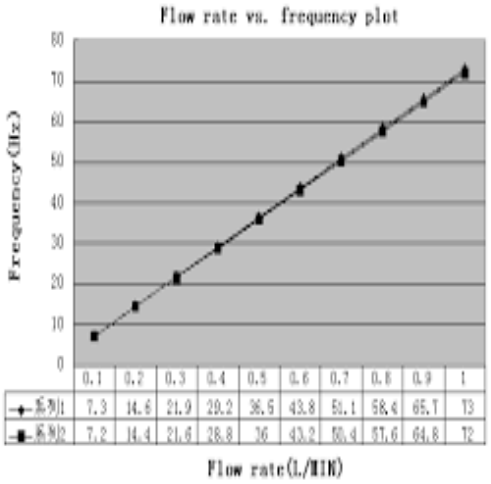

Fig. 4. Picture Contain Flow Rate vs. Frequency Plot of Flow Sensor

Formula to calculate water flow:

Low Rate (L/min) = Pulse frequency (Hz) / 7.5.

C. Connectivity

The prototype has it's built in Wi-Fi adapter with MKR1000. By using Wi-Fi, prototype can be easily able to connect with internet. And measured data with calculated bills of individual consumers will get sent to cloud server then cloud server will share data with both consumers and water utilities. Different devices use different communication protocols. We don't need a different system for enabling connection with internet because our development kit has in built Wi-Fi adapter. This system also notifies client about the flow rate via short message service (SMS) or by using mobile app on real time basis if it exceeds a specific threshold value.

III. RESULTS

We have used Arduino MKR1000 development kit and used flow sensor to measure flow rate and volume of water flew through the pipe. And it can be seen that every consumer can know their total use of water consumption easily on their smartphones. The various papers were discussed here with their authors some authors are very greatly done their work. This concept is surely going to help individual water consumers as well as water utilities. And if we are able to measure the water use properly then definitely we will be able to manage the water of all industrial and domestic users.

IV. CONCLUSION

The review will surely help for the next research in the same field. Based on this study work the smart water meter system done by using the IoT, Wi-Fi. The previous study done by authors hasn't used this device, also hasn't made simultaneous study. The main focus in this study is to measuring the water consumed by various industries and domestic users. The study done here is the literature review for next work. The work will be done by using circuit diagram, various component used in this concept and the android application.

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