

Smart water reading system using GPS Technology.

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Abstract— Water is one of the most essential needs of every living being and every nation take necessary steps to make sure clean, accessible water for all. All countries have official centralized water distribution bodies and they collect fees from the users for providing the service according to their usage. Different types of water meters are presented which uses different technologies that calculates the water consumption. The methodical way of collecting the water consumption data in Sri Lanka is traditional ever since Nation Water Supply and Drainage board has formed. The official way of collecting data is still depend on manual procedures where it can be easily automated. Even-though alternatives are presented where huge amount of money can be saved to national economy, traditional way of collective information cost a lot, both with money and time. Throughout this paper, it discussed about a smart solution for above problem saving big amount of money while increasing the efficiency and accuracy of usual procedure.

Keywords— Smart Water Meter

The rest of the paper is organized as follows.

I . INTRODUCTION

The National Water Supply and Drainage Board is the National Organization responsible for the provision of safe drinking water and facilitating the provision of sanitation to the people in Sri Lanka. It was formed in the year 1975 and since then, the mechanism of collecting data of water consumption was done by a separate individual. Currently there are total number of 700+ readers islandwise, taking care total number of 287,183+ connections where each reader should read 70 reading per day. The basic salary of each individual is above 40,000LKR where government have to take care of their wages and allowances. Furthermore, the water meters are mechanical and the cogwheels inside them are made of steel which become rusty with time.

There are mainly two common approaches to flow measurement, namely displacement and velocity which uses different technologies.

Common and usual displacement designs include nutating disc meters and oscillating piston. Velocity-based designs include turbine meters, single-jet and multi-jet meters. There are also non-mechanical designs like electromagnetic meters, ultrasonic meters, and special purpose meters. Additionally, there are electromechanical meters, like prepaid water meters and automatic meter reading meters. The latter integrates an electronic measurement component and a LCD with a mechanical water meter. Mechanical water meters normally use a reed switch, hall or photoelectric coding register as the signal output. After processing by the microcontroller unit (MCU) in the electronic module, the data are transmitted to the LCD or output to an information management system. Our proposed work follows the velocity flow measurement approach while turbine inside the meter will help to determine the speed of the flow, later converted into volume of flow to determine the usage.

Displacement water meters

This is the most common water meter where used in residential and commercial applications. Positive Displacement meters (PD meters) are also known as Displacement meters include two types namely oscillating piston meters and nutating disk meters. The method of measuring the water is by physically displacing the moving measuring element in direct proportional to the amount of water that passes through the meter. PD meters are generally very accurate at the low-to-moderate flow rates typical of residential and small commercial users. Because displacement meters require that all water flows through the meter to "push" the measuring element, they generally are not practical in large commercial applications requiring high flow rates or low pressure loss. PD meters normally have a built-in strainer to protect the measuring element from rocks or other debris that could stop or break the measuring element. PD meters normally have bronze, brass or plastic bodies with internal measuring chambers made of molded plastics and stainless steel.

Velocity water meters

A velocity-type meter measures the velocity of flow through a meter of a known internal capacity. The speed of the flow can then be converted into volume of

flow to determine the usage. There are several types of meters that measure water flow velocity, including jet meters (single-jet and multi-jet), turbine meters, propeller meters and mag meters. Most velocity-based meters have an adjustment vane for calibrating the meter to the required accuracy.

Multi-jet meters

Multi-jet meters are very accurate in small sizes and are commonly used in ½" to 2" sizes for residential and small commercial users. Multi-jet meters use multiple ports surrounding an internal chamber to create multiple jets of water against an impeller, whose rotation speed depends on the velocity of water flow. Multi-jets are very accurate at low flow rates, but there are no large size meters since they do not have the straight-through flow path needed for the high flow rates used in large pipe diameters. Multi-jet meters generally have an internal strainer element that can protect the jet ports from getting clogged. Multi-jet meters normally have bronze alloy bodies or outer casings, with internal measuring parts made from modern thermoplastics and stainless steel.



Fig 1 - Mechanical Water Meter



Fig 2- Digital Water Meter

data will be send to the computer with the house ID. From above mentioned two methods, the data in the computer will be downloaded and send it to the office. The third method is reading the data from the help of “Radio Frequency”. In that method, the meter emits radio signals that can be detected by the hand held computer which don’t even need to visit each house individually but can be gather many reading in one place.

Next two methods are currently practicing in Sri Lanka and one of them is, authorities have introduced a mobile application that the reader have to enter the water consumption units manually to the app and it will automatically calculate the bill. This the the newest method used in Sri Lanka and this brings down the error percentage to 3% than the traditional method which is described below that holds the error percentage of 29%. The final method is also the traditional method, that is still practiced in most of the ares in Sri Lanka is that the reader has to go home by home and read the consumption details and manually enter them to calculate the bill which costs a lot human error.



Fig 3 - Meter Reading Device

Fig 4- Taking the Reading

Drawbacks

Even the methods used in Pennsylvania are too complicated that need a lot of technologies but the reader still have to go to get the readings. Due to manual procedure where separate person is going to get the readings and giving the bill, the accuracy of the figures are not guaranteed due to human error can be take place very easily. There is no particular day in the month to get the readings but he comes as per his convenience. All the other processes other than getting the readings are automated but for a long period of time, this haven't replace. If we look at the scenario more deeply, this manual process can be automated that no need to incorporate with human just to read the data. There are some parts in the island where the reader cannot reach to the location due to geographical barriers. So he fails to achieve his usual target to get 70 readings per day. The other main problem is that the

II . EXISTING METHODS FOR WATER READING SYSTEM.

Currently there are 5 popular methods of reading the water consumption from the meter which requires various technologies. Following three methods are actively used in different American states, manly in Pennsylvania and they carry a tech gadget called “boomerang” which has two different slots at two ends and a handheld computer.

Usually any house has two different outside devices, either a “touch pad” or an “ARB box” which are compatible to connect at the two ends of boomerang. When a house has a touch pad, it just needed to place the correct end of the boomerang in it and it automatically reads the consumption data with the house ID and sends the data to the computer. When a house has an ARB box, it just needed to connect the socket of the boomerang to the box and the

reader face difficulty that he needs to calculate the same figures again when he is entering it to the system at the office. As mentioned before, by becoming rusty of certain parts of the mechanical meter, it may not give the actual output.

Due to different setbacks of the current methods for reading, it is really necessary for a new method to get the reading in a cost effectively without involving a third party.

III. BLOCK DIAGRAM

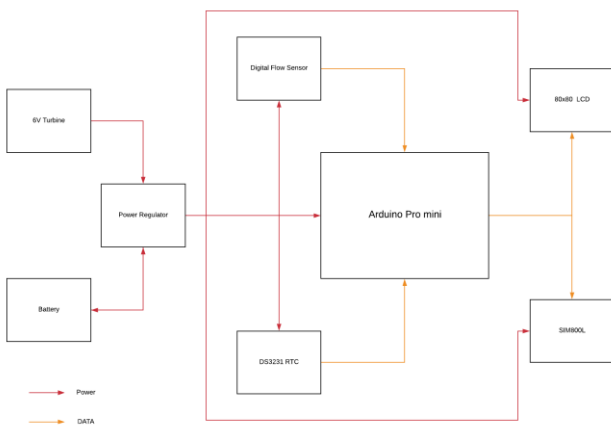


Fig 4 - Block Diagram of the device

The above block diagram shows the connection and the modules involved in this device. 6V Turbine is used to convert the water current that flows through the device into electricity and store in the battery. When there is no water flow, the device will use the battery power stored. Digital flow sensor is used to get the reading of the amount of water flow through the device per second. DS3231 RTC module is used to track the date and time. Arduino Pro mini module retrieves data from the Digital Flow Sensor and DS3231 RTC modules as input and display the results on 80 x 80 LCD module. SIM800L module is used to send the results calculated by the Arduino Pro mini module in the form of an SMS. This module will be activated to a given date and time, sending the data collected to the National Water Supply and Drainage Board.

IV. SCHEMATIC DIAGRAM

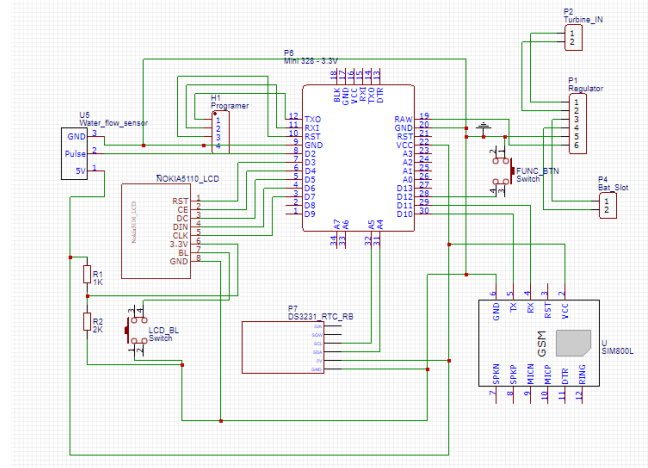


Fig 5 - Schematic Diagram of the device

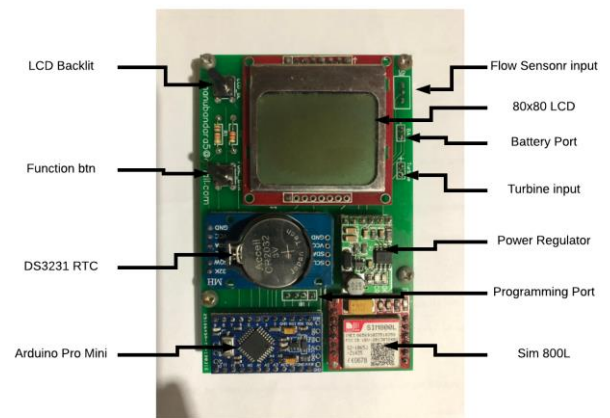


Fig 6 - Complete PCB of Meter Interface

Arduino Pro Mini

It is a microcontroller board built on ATmega328. It has 14 digital input and output jacks, 6 analog inputs, built-in resonator, reset button and pins for mounting pin headers. You can join a six pin header to the FTDI cable or the Sparkfun switch to deliver USB power and message with the board. This board is planned for a semi-permanent installation on objects or screens. The board comes with pre-mounting headers, letting the use of dissimilar categories of connectors or straight wiring of the cable. The pin layout is well-matched with the Arduino Mini. There are two types of the Pro Mini. One works at 3.3V and 8MHz, the other at 5V and 16MHz.

GSM GPRS SIM 800L Module

The SIM800L module supports quad-band GSM/GPRS network, available for GPRS and SMS message data remote transmission. The SIM800L communicates with microcontroller via UART port, supports command including 3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands. It also has built-in level translation, so it can work with microcontroller of higher voltage than 2.8V default. Besides, the board also supports A-GPS technique

which is called mobile positioning and gets position by mobile network. This feature make it can also be a tracker module.

½ Digital Flow Sensor

These components are perfect for use in water preservation systems, storage tanks, hot water systems, irrigation structures, and more. The sensors are inflexibly devoted and provide a digital pulse each time the total of water passes through the tube. The output can straightforwardly be connected to a water control microcontroller and calculate the amount of water remains in the tank. This flow sensor is appropriate for a 1/2 standard pipe and can effortlessly be positioned in a standard pipe system. It is conceivable to attach large voltages to the unit. Constructed with long-lasting polymers, this element is appropriate for outdoor installation. merging it is ideal for use in environmentally approachable water management systems.

DS3231 RTC Module

At the midpoint of the module is the Maxim-DS3231 RTC chip of low cost and accuracy. It accomplishes all the temporary functions and has a double interface I2C that can connect easily to any microcontroller that you pick. The chip preserves seconds, minutes, hours, days, dates, months and years. The end date of the month is automatically adjusted for months to fewer than 31 days, together with transition year modifications (valid up to 2100). The clock works in a 24 hour or 12-hour format with AM / PM indicator. It also suggestions two programmable alarms for days. The second feature of this board comes with a SQW pen, which delivers a fine square wave at 1Hz, 4kHz, 8kHz or 32kHz and that can be automated. It can be used as a disruption due to the alarm circumstances in many applications constructed on time.

LI-ion 18560 Battery

Lithium Ion Batteries (Li-Ion) The 18650 is the fastest battery expertise for utmost applications, plus screen LED Flashes, Electronic Cigarettes and Vaping. There are numerous methods of lithium-ion batteries for a wide choice of applications, from high power to high energy density, all in a very gainful package. Its assistances are known in its density and volume of energy. Extra compensations of Li-ion are such as long life cycles, smaller filling times, fuel metering and precise life anticipation, and significant enhancements in long-term stability at high temperatures have enlarged lithium ion presupposition for most applications.

80x80 LCD

LCD is an elementary LCD screen for numerous applications. Initially it was proposed to be used as a mobile phone display. It is mounted on a simple PCB for linking. Use the PCD8544 driver, which is the same as the Nokia 3310 LCD screen. The PCD8544 is a low-slung power CMOS intended to handle 48-line and 84-line graphical display. All the important purposes of the screen are shown in a single menu, with the generation of the LCD power supply and the voltage, subsequent in minimum external mechanisms and low power consumption. The PCD8544 connects to the microcontrollers through the serial bus interface.

Power Regulator

The power regulator can be defined as any electrical or electronic device that preserves the power of an energy source within satisfactory limits. A voltage regulator is mandatory to continue a voltage within a prearranged range that can bear electrical equipment with that voltage. Voltage electronic regulators use solid state semiconductor devices to moderate current distinctions. In most cases they function as adjustable resistors. This is because the resistance diminutions when the electric charge is substantial and growths when the load is calmer. The voltage regulators achieve the same purpose in significant power distribution systems such as motor vehicles and other machines. They decrease voltage differences to defend the equipment from the current in power distribution systems. Regulators are situated in substations or in the same lines.

V. HOW SYSTEM WORK

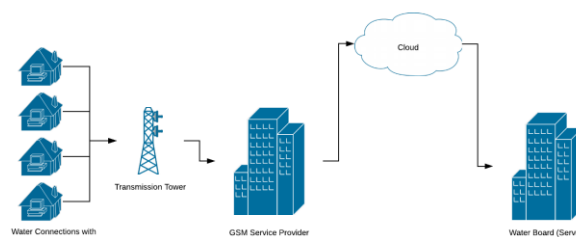


Fig 7 - Small Chart How It Works

Above figure shows how the National Water Supply and Drainage Board retrieves the data collected by each Smart Water Meter. At the end of each month, Smart Water Meters connected to houses and building that obtain

services from National Water Supply and Drainage Board will send the calculated results of water usage in the form of an SMS. The SMS will first be transmitted to a Transmission tower and forwarded to the GSM Service Provider of the subscribed SMS service. The message will be uploaded to the cloud and will be received by the Water Board server. Calculated results of water usage in the message will be added to the relative water connection profile.

VI. CONCLUSION & FURTHER WORK

The National Water Supply and Drainage Board faces many difficulties in retrieving readings from houses and buildings that uses their services. Reading are taken and calculated manually by employees visiting each place that uses water services from the National Water Supply Board on inconsistent days, which results in many inaccurate readings. As a solution, this device can replace the position of the employee. This device will calculate the water-usage readings on the last day of the month at a specified time and notify the National Water Supply and Drainage Board. Each reading per month will be recorded on the system present at National Water Supply and Drainage Board and a hardcopy of the bill will be mailed to the consumer. With the use of this device, measurement of water usage can be efficiently managed. Time and manpower used to obtain readings could be minimized and used elsewhere more productive. Also, the readings taken by this device is done digitally on consistent time intervals, hence ensuring accuracy of the readings.

Certain elements in this project leave scope for further development. With almost any project which falls into IOT category, a list of future enhancements could be endless. In this case, I will only highlight the general areas where extra work would benefit the project.

VII. ACKNOWLEDGMENT

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