A NON- CONTACT ARROW POINTER SENSOR DESIGN TO REDUCE POWER CONSUMPTION OF LOW –COST AND HIGH ACCURACY HYBRID WATER METER

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Abstract

Nowadays the arrow-pointer meter is currently widely used. In this paper, a low-cost and high accuracy water meter using arrow sensor is presented. To identify the location of arrow pointer on the scale panel of a water meter a low cost water meter using noncontact arrow-sensor is designed. This system involves embedding an electrical circuit into the body of a conventional mechanical water meter, to be compatible with the currently used arrow meter. . An electrical circuit is mounted on Printed Circuit Board (PCB) and only one low-cost PIC16F877A is used in the meter body for reading the arrow scale. To sense the position of an arrow pointer the electrical structure consists of signal generator, signal sensors, signal detection circuit, digital encoder, and remote controller. At a given frequency through the arrow sensor to a detection circuit, a signal generator (SG) outputs a square waveform. The detection circuit senses which number on the meter is indicated, when the signal arrives at sensing pads. A wireless communication system using GSM technology, the detected result is then binary encoded and transmitted to a server. So to the current water pipeline system, this method is easy to install and can save more power dissipation. Also, the cost of the water meter is reduced compared to the digital water meter. GSM technology is used, for long range communication. The data is transmitted for long range with high efficiency in GSM. Moreover, the meter reading can be sent to multiple users at a time and also can be sent to the server.

Index Terms—arrow pointer meter; arrow sensor; sensing pad; water monitoring system.;GSM technology***;***

I. INTRODUCTION

Water metering is the process of measuring the volume of water consumed. In many developed countries water meters are used to measure the volume of water used by residential and commercial building that are supplied with water by a public water supply system. Water meters can also be used at the water source, well, or throughout a water system to determine flow through a particular portion of the system. In most of the world water meters measure flow in cubic meters (m^3) or litres(l) but in the USA and some other countries water meters are calibrated in cubic feet ($ft.^3$), or US gallons on a mechanical or electronic register. Some electronic meter registers can display rate-of-flow in addition to total usage.There are several types of water meters in common use. The choice depends on the flow measurement method, the type of end user, the required flow rates, and accuracy requirements.

Pricing a natural resource such as water is no easy task. First it is hard to establish how much consumers are willing to pay for it. Generally the decision to have running water and sewerage services is not made by the user but collectively by a group of users (neighborhood)

or mandated by the local government. If this is the case then it is not generally correct to speak of access demand given a price. Besides, service disconnection is often not allowed once installed. Second it is hard to determine an opportunity cost for this resource in case of shortages. This is so because the opportunity cost of water depends on several factors such as source of extraction (i.e wells, rivers etc.) the region climate and the resource relative abundance. Finally, water consumption may involve hard – to - measure externalities. An excessively low consumption may endanger population health contributing to the spread of infectious and parasitic diseases like cholera and diarrhea. On the other hand, a high level of consumption can cause a drop in the level of water reservoirs hampering service continuity in hot seasons.

TABLE I. COMPARISONS OF VARIOUS TYPES OF WATER METERS

Kinds / Functions	Conventional Mechanism	Electronic Meter	Hybrid Meter
Performance	Uniform	Multifunction, dependent software	Multifunction, dependent software
Battery	No	Need	No
Communication interface	No	Yes	Yes
Data analyze	No	Yes	Yes
Water monitoring system	No	Yes	Yes
Power dissipation	Zero	Large	Little (supply when reading)
Compatible to the current system	Yes	No	Yes
Cost	Low	High	Median
Remote auto reading	No	Yes	Yes

This paper proposes a hybrid electrical/mechanical metering system designed for low cost implementation and reduced power consumption. Our motive is to embed the electrical circuit to the mechanical water meter for an arrow point sensing. The size and function of the device is compatible with the existing water meters, thereby facilitating easy installation on the current water pipeline. The Conventional water meter employed a mechanism structure in which the water flow drives gears that move an arrow pointer on a scale panel [1]. Fig 1. shows a typical water meter used in Taiwan that includes four coarse numbers and four fine arrow scales. When the water flow is recorded using the simple mechanical structure, the meter does not require electrical power. However, recording the flow of water using a mechanical device requires that values be recorded manually. Recently, the electronic water meter is presented to record digital data using electrical counters. The electronic meter can monitor the current metering value remotely [1]–[5]. Unfortunately, such meters draw power constantly, thereby wasting electricity. In addition, avoiding temporal power interruptions requires that batteries be embedded in the body of the meter. Electrical meters are incompatible with many existing water systems, which have prevented more widespread adoption. The proposed device works like a conventional gear meter; however, power is supplied to the electrical circuit of the meter only when the remote server sends a request for a metered value, after which power is automatically suspended. Hence the power dissipation is very slight.

Fig 1: A typical residential water meter

II. PROPOSED ARROW SENSOR FOR WATER METER

The location of arrow pointer on the scale panel of a water meter is determined to design a non contact arrow sensor. A small, inexpensive recognition system is embedded into the body of the water meter to accomplish this. Arrow sensor is designed and can be easily embedded and varied according to analog to digital conversion. The motive is to embed the electrical circuit to the mechanical water meter for an arrow point sensing. The size and function of the device is compatible with the existing water meters, thereby facilitating easy installation on the current water pipeline. The proposed device works like a conventional gear meter; however, power is supplied to the electrical circuit of the meter only when the remote server sends a request for a metered value, after which power is automatically suspended. Hence the power dissipation is very slight. Compared with the current electrical meter, this method can save more power dissipation and is easy to install to the current water pipeline. Also, this kind of meter can keep a simple and low-cost like a conventional gear meter. The conventional method used an optical image recognition approach to identify the arrow position and to read the metering value [7], [8]. The implementation cost becomes high, which is not appreciated for the current metering system.. Fig 2. shows the structure of proposed recognition system for an arrow meter. A signal generator (SG) outputs a square waveform at a given frequency through the arrow sensor to a detection circuit. When the signal arrives at sensing pads, the detection circuit senses which number on the meter is indicated. The detected result is then binary encoded and transmitted to a server by a wireless communication system.

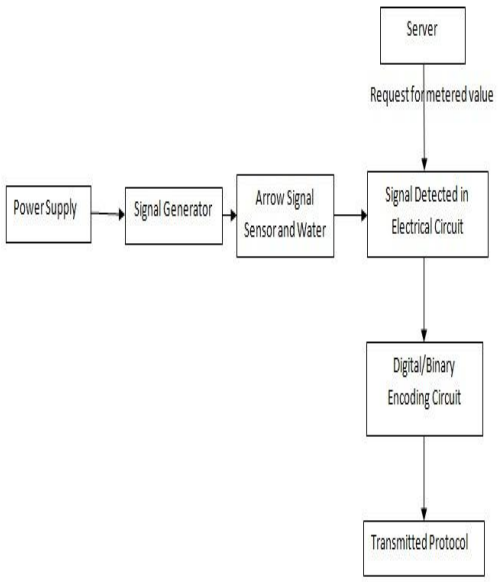

Fig 2: Arrow Pointer Sensor Design Architecture.

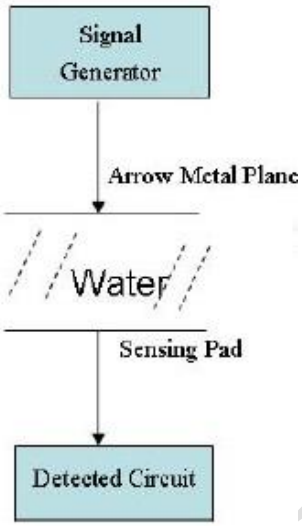

Fig 3: Structure of Proposed recognition system

A. *Originality Design*

For arrow point sensing, one designs a sensing pad on the location of each digital number. A capacitor is generated between sensing pad and metal arrow. Based on capacitive signal transfer theory, the high-frequency signal can be through the metal arrow pointer to sensing pads. Figure 2 shows the physical structure of the arrow sensor with on PCB (Printed Circuit Broad). To detect the numbers 0 to 9, we added copper foil into a PCB underneath the position of each number to act as a sensing pad for the signal detection.

Current-sense resistors, which come in a variety of shapes and sizes, are used to measure current in many automotive, power control, and industrial systems. When using very low value resistors (a few milliohms or less), the resistance of the solder becomes a substantial portion of the sense element resistance and adds significantly to the measurement error. High-accuracy applications often use 4-terminal resistors and Kelvin sensing to reduce this error, but these special-purpose resistors can be expensive. In addition, the size and design of the resistor pads play a crucial role in determining the sense accuracy when measuring large currents. This article describes an alternative approach that enables high-accuracy Kelvin sensing using a standard, low-cost, 2-pad sense resistor with a 4-pad layout. Fig 4. shows the test board used to characterize the errors caused by five different layouts.

Fig 4: Sense resistor layout test PCB.

To achieve maximum sensitivity, the sensing pad is laid out in the form of an inverted triangle. Each sensing pad is connected to the detection circuit. The signal generator produced a square waveform through a metal axis to the metal arrow, where the arrow pointer was made of stainless steel. If the arrow pointer touched the sensing pad, the copper foil would eventually be worn away.

Thus, a noncontact arrow sensor is proposed based on capacitive signal sensing [9]. The structure in Fig 5 acts like a capacitor between the sensing pad and the metal arrow. In practical applications, the water meter is filled to water. The water between the two parallel pieces of metal provides the medium of the capacitor.

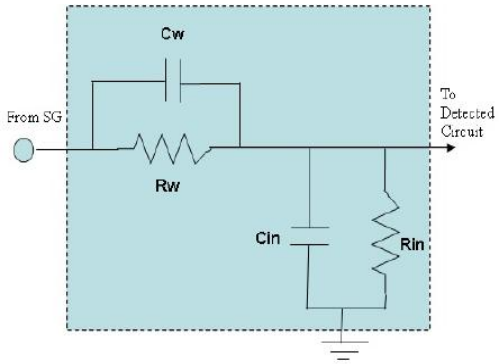

Fig 5: Equivalent circuit for arrow sensor

PIC16F877A microcontroller is used to implement hybrid water. Here long life battery is used to draw power when needed thus can reduce the power consumption. Fig 6 shows equivalent circuit diagram of hybrid water meter using PIC microcontroller with GSM. Here crystal oscillator is used to produce the signal. The TTL level produced in the PIC is stored in GSM by using MAX232. And thus it is stored in PC at 12V.Fig 6.shows the hardware circuit diagram.

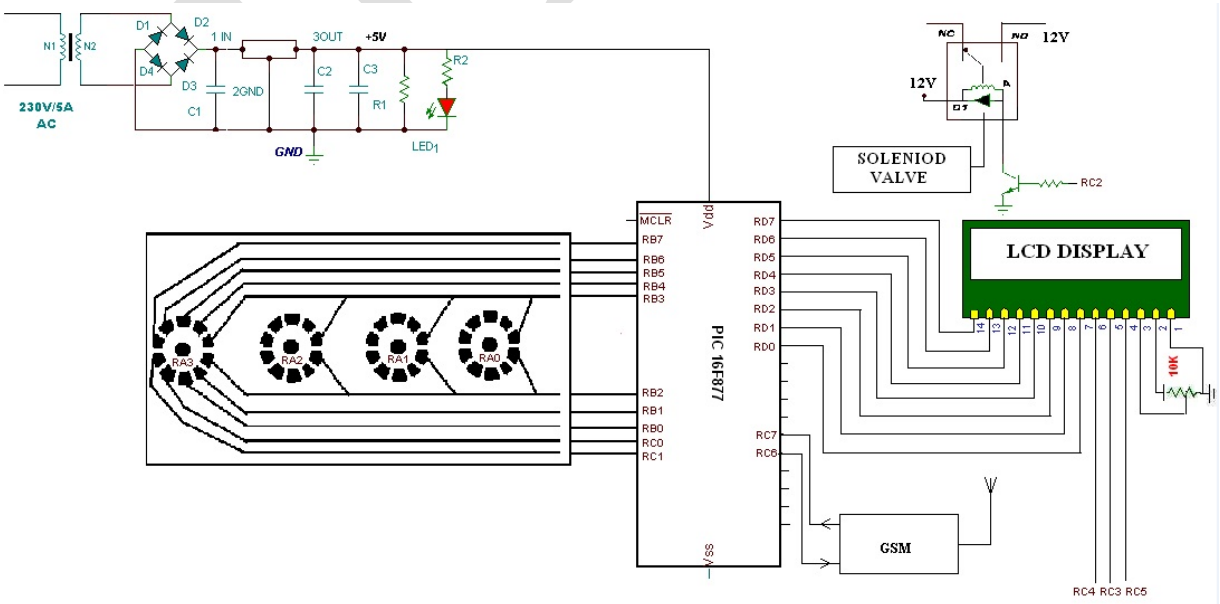

Fig 6: Hardware Circuit Diagram

B. *Block Diagram*

1) Transmitting Section

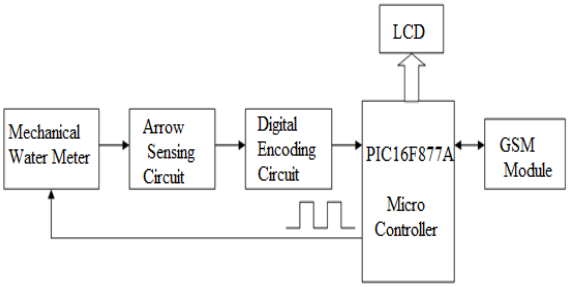

Fig 7:Block Diagram of Transmitting Section

2) Receiving Section

Fig 8: Block Diagram of Receiving Section

Figure 7 shows the block diagram of transmitting section where the water flow is sensed by arrow sensing circuit and then it is digitally encoded. Using PIC microcontroller the encoded value will be displayed on LCD and transmitted using GSM. At the receiver section the digitally encoded value gets stored in the PC using GSM module. The figure 8 shows the block diagram of receiving section. Here by using a microcontroller the values get stored in PC.

The hardware of the hybrid water meter consists of step down transformer, PIC microcontroller, arrow pointer, solenoid valve, relay, GSM, LCD display, crystal oscillator, bridge rectifier. Fig 9 shows the experimental set up of hybrid water meter.

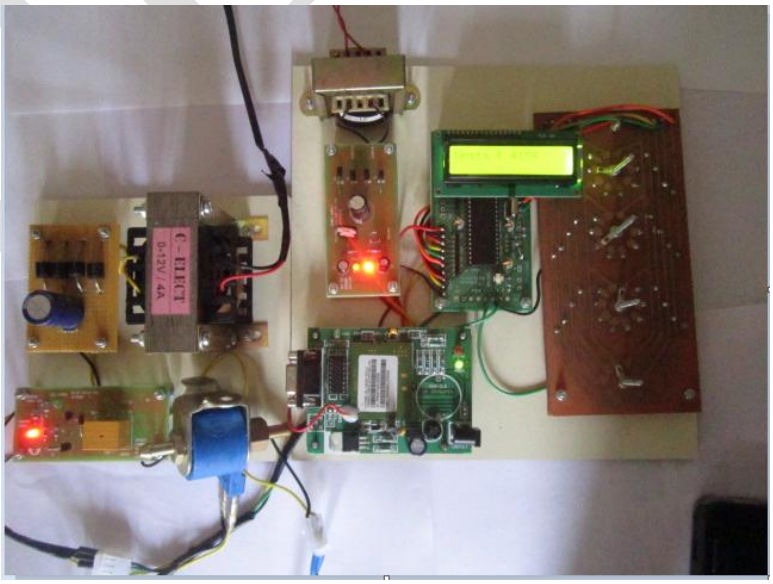

Fig 9: Experimental set up of the Overall Hardware System

III. HARDWARE RESULTS

The hybrid water meter consists of arrow pointer with four dials. According to the water flow, the arrow pointer moves and the corresponding readings are displayed on the LCD display as shown in the figure 5.4. A PIC microcontroller is used here. When a message 'send' is send, the readings are then automatically send to the consumer by using GSM as shown in figure 5.5. A solenoid valve is connected to the hardware. When the consumer fails to pay the bill, a message 'off' is send and the solenoid valve gets closed automatically. And thus the water flow gets automatically cut off. When a message 'on' is send, the solenoid valve gets opened automatically and the water thus flows.

Fig 10: Snap shot of Output- Hybrid Water Meter Reading

Fig 11: Snap shot of reading received by the consumer

IV. CONCLUSION

This paper presents a hybrid water meter of low cost and high accuracy, using arrow pointer sensor. For reading the arrow scale, an electrical circuit is mounted on Printed Circuit Board (PCB) and only one low-cost PIC16F877A is used in the meter body. The current flow of the water can be indicated using the GSM module. Also the water meter reading can be communicated to different users and to the server. The meter does not require electrical power, when the water flow is recorded using the simple mechanical structure. However, in a mechanical device the values of the flow of water are recorded manually. Using electrical counters the electronic water meter is presented to record digital data. The current metering value can be monitor by the electronic meter remotely. Unfortunately, such meters draw power constantly, thereby wasting electricity. In addition, batteries are embedded in the body of the meter in avoiding temporal power interruptions. This hybrid water meter has the advantages of low-cost embedded digital meter mounted on the body of conventional

mechanical water meter and low power consumption, on comparing both the mechanical and electrical system, where power supply is required only for reading the meter. The hybrid meter is fully compatible to the existing mechanism meter, thus facilitating easy installation. With these advantages, the proposed water meter using non contact arrow pointer sensor would be appreciated for real time applications.

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