Ultrasonic Water Flow Meter

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Abstract **-** Ultrasonic flow meter has been widely applied in the area of meteorology, petroleum, chemical engineering, water resources management and so on, owing to its advantages of high accuracy, non-blocking measurement, easy installation, low cost, optimization of leakage detection, low power consumption and zero maintenance. In this paper according to measurement principle of ultrasonic transit time method, low power microcontroller PIC14FJ128G308 is used as core for this system. A high precision chip TDC GP22 is specially adopted to collect the time difference signals in real time, hereby we design a new Ultrasonic transit time water flow meter. The experimental results show that the proposed method can effectively improve the measurement accuracy and real time performance and meet the measurement requirements of the flow meter.

Keywords *- Ultrasonic flow meter, transit time method, TDC GP22, high-accuracy.*

I. INTRODUCTION

According to the report of U.S. Flow Research in 2005[1], the annual sales of ultrasonic flow meter surpasses more than 3 billion U.S. dollars, accounting for 10% of all types of flow meters. The ultrasonic flow meter is quickly becoming the first choice of flow measurement, owing to its advantages of high-accuracy, non-blocking measure, easy installation, low cost and so on.

Ultrasonic technology and sensors play a vital role for a diverse field of industrial and medical applications. The global market for ultrasonic equipment in 2011 was estimated at $17.5 billion and will reach $27.7 billion by 2016 according to market analysts BCC Research. Demand for ultrasonic testing and imaging devices is expected to increase, however, sustaining high growth requires innovative and novel ultrasonic sensors, devices, and testing methodologies.

From the past many years we are seeing the water being wasted by many industries, domestic use, schools, colleges, etc. So there came an idea to our mind about minimizing the water wastage. This was only possible if like electricity there would be measurement of water and excess water avoidance. This project was chosen on the basis of same idea. The hardware is compact, compatible and easy handling. Much more water can be thus avoided from wastage and water supply will done for every need in our country.

Ultrasonic flow meters may provide lower capital costs than conventional measurement technologies, since a single ultrasonic meter in many instances can take the place of multiple conventional meters. Also, since ultrasonic meters have no moving parts and minimal flow blockage, they may provide operation and maintenance cost savings over the long term.

II. OBJECTIVE OF THIS PROJECT

The main objective of this paper is to develop a real time flow measurement system. One of the main concerns in the real time flow measuring is how to measure the flow of water which is bidirectional in nature accurately and avoid wastage of water. This paper provides information about the ultrasonic water flow meter which measures the flow of liquid with TDC, MCU and displays it on the graphic display. This paper introduces one method for flow measurement that is, using transit time measurement.

III. EXISTING SYSREM

The existing system was not much efficient. There was need of high accuracy as the measurement was not done in time. In this method, ultrasonic sensors, which are placed outside the pipes, use reflected ultrasonic sound to measure the fluid velocity. Technically, Doppler flow meters are based on frequencyshift f.

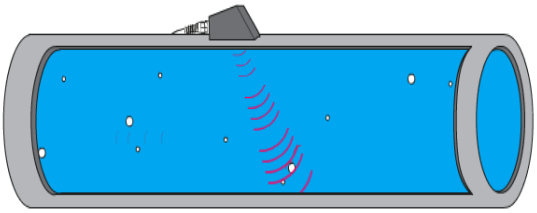


Fig.1: Doppler Type Flow Meter

However, this technique is only suitable for liquids with solids or gas bubbles such as slurries, sludge, and wastewater which may damage regular flow meters.

IV. PROPOSED SYSTEM

This paper presents the Ultrasonic transit time water flow meter. Most important part of this method is the accuracy.

Transit time measurement is based on a simple physical fact. Imagine two swimmers standing diagonally across from each other on two opposite river shores. If they were to swim to where the other is standing, the swimmer swimming with the current would reach the shore faster than the one that is swimming against the current. Ultrasonic waves behave exactly the same way. A sound wave travelling in the direction of flow of the fluid is propagated at a faster rate than one travelling against the flow.

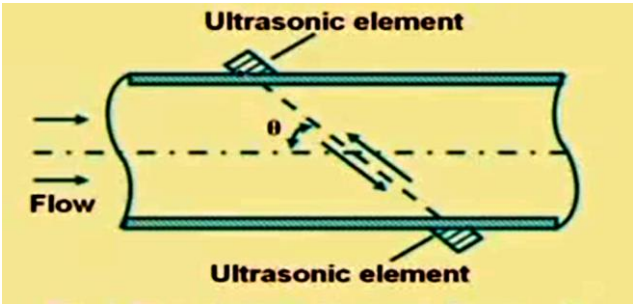


Fig.2: Transit time flow meter

The time which is travelling between two sensors is different due to the fluid flowing through the pipe. The measurement of the time difference gives the flow velocity

Where, "T_f" is the time that sound beam takes to travel to the second sensor, and "T_r" is time that sound needs to be received by first sensor, c is the velocity of sound in the fluid, V is the velocity of the fluid, L is the distance between ultrasonic transmitter and receiver, and θ is the angle between the ultrasonic beam and axis of the fluid flow.

The time difference is equal:

$$\Delta T = Tf - Tr = \frac{2vL\cos\theta}{c2 - v2\cos\theta}$$

$$Ff = \frac{c + v\cos\theta}{L}$$

$$Fr = \frac{c - v\cos\theta}{L}$$

$$\Delta F = Ff - Fr = \frac{2vL\cos\theta}{L}$$

$$V = \frac{L\Delta F}{2\cos\theta}$$

This method has been working successfully in industrial applications for more than 20 years. It is accurate and reliable. Besides measuring the volumetric flow rate, the method provides information on the type of liquid product based on the sound velocity that is measured in parallel. Ultrasonic flow measurement by the transit – time information on the type of liquid product based on the sound velocity that is measured in parallel. Ultrasonic flow measurement by the transit-time differential method is now one of the most universally applied flow metering processes. It is used for measuring cryogenic gases from-200°C, and hot liquids, gases and steam up to 500°C and above, and pressures up to 1500 bar, also for custody transfer applications for liquids other than water. Special versions are approved for custody transfer for volumetric gas meters (from domestic up to large-size meters), as volumetric measuring units for measurement of thermal energy and even for liquids, other than water, with accuracy specifications below 0.2% of the measured value

V. BLOCK DIAGRAM

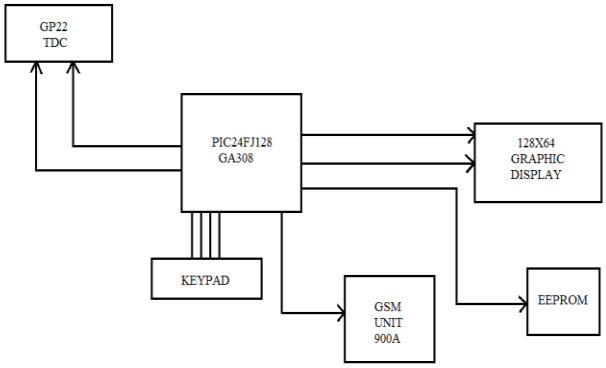


Fig.3: Block Diagram of Ultrasonic Water Flow meter

A. Block Diagram Description

- *MICROCONTROLLER*

The role of microcontroller is very crucial in this project. Microcontroller checks data from ultrasonic sensor. It checks & calculates transit time & control the whole process, then after confirmation it will command the LCD to display the message.

- *GRAPHIC DISPLAY*

128X64 COG character display with 3.6 volts operating voltage. To get the first proper results we are using this LCD to make sure that the expected results can be achieved on the big LCD screen also. Instead of increasing the cost in the initial stage we are avoiding the use of large LCD display so that the portability is maintained. Since it is the cheapest LCD display available we selected this for initial stage testing. After getting the appropriate results we will change this display with bigger LCD screen.

- *GSM MODULE*

GSM module SIM-900 is used as an optional function in this model of Ultrasonic Flow Meter. Main purpose of using GSM module is data sending if the flow meter is supposed to be mounted in any rural or remote areas where operator cannot go frequently for analysis of flow measurement.

- *TDC GP22*

TDC GP22 IS A 2-channel TDC with additional analog element like extended fire pulse generator, zero-cross detection and analog switches for simplifying the use in Ultrasonic flow meter applications. The addition first-hit detection makes TDC-GP22 suitable for high dynamic applications as Ultrasonic water meters. And optimized

power managements of various units brings down the operating current to the few microampere at 2 Hz measuring rate.

VI. WORKING PRINCIPLE OF PROPOSED SYSTEM

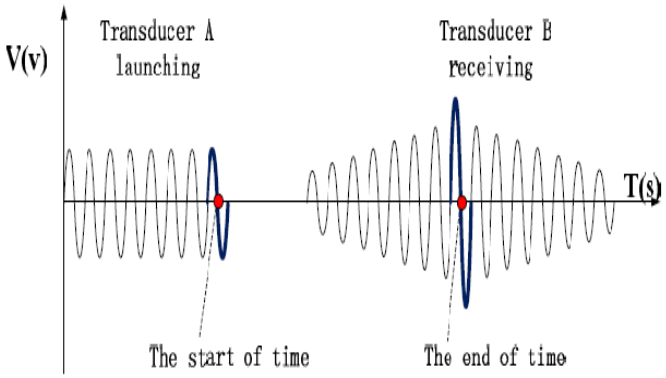
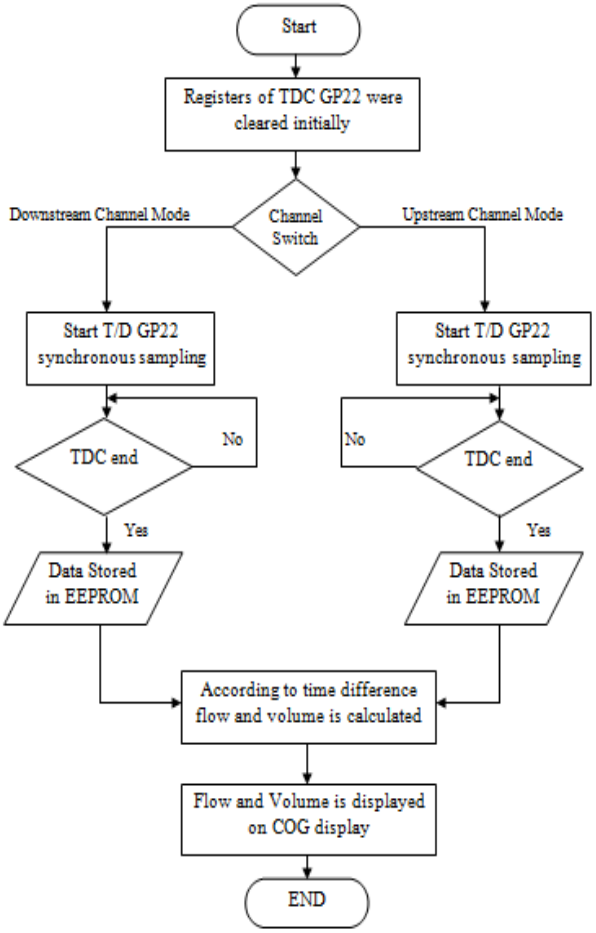


Fig.4: Waveforms of Transducer

Number of periodic sinusoidal ultrasonic wave were launched by transducer A, the wave was received by transducer B after transmitting in the liquid, and thereby the ultrasonic echo signal was generated. The amplitude of echo signal was increased due to the continuous excitation and gradually decreased due to the stop of excitation, it eventually became a periodic wave with a changing amplitude (see Fig.2). The period of largest echo amplitude corresponds to the period of final signal launched by transducer A. The start point of propagation time is set to the zero point of the last wave launched by transducer A. The end point of propagation time is set to the corresponding zero point of the characteristic wave which is characterized by the largest amplitude values in the echo wave received by transducer B.

VII. FLOW CHART



VIII. SCOPE OF STUDY

There is always a further scope of study for every system even if it is smooth in performance. The study is classified into 5 phases:

1. Idea studies
2. Feasibility study - The technical work in this phase should focus on new and modified equipments in systems that obviously will be affected by the actual design requirements.
3. Concept study - The objective of the concept phase is to select and define the modification concept for realizing a business opportunity, reduce operational expense, and demonstrate that execution risk is satisfactory to the company requirements and business plans.
4. Detail Engineering - To achieve the required goal of accuracy the disciplines involved must be well coordinated.
5. Pre-Engineering - The technical documentation to be further matured defining basis for project execution.

IX. RESULTS

Fig.5: Flow rate display

Fig.6: Ultrasonic Flow meter

X. CONCLUSION

In this project, the main objective was to design the PIC controller based battery powered Ultrasonic flow meter of the series ASIONIC UFM-400 for the measurement and storage of the measured data of instantaneous flow rate and total volume passed through the sensor of cold and hot water and other liquid of similar properties as water and heat supply system and in wide range of industrial applications.

This method has been working successfully in industrial applications for more than 20 years.

It is accurate and reliable. Ultrasonic flow measurement by the transit time differential method is now one of the most universally applied flow metering processes.

XI. REFERENCES

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