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Design of Labview Based Virtual Instrument for Sing around Technique

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Abstract
Among the pulse techniques in ultrasonics, Sing around technique is widely used for measurement of ultrasonic velocity in liquids and solids. This technique is simple, convenient, versatile and highly accurate for absolute and relative ultrasonic velocity measurements. In the present work, a virtual instrument for Sing around technique is designed using LabVIEW. Pulser and receiver circuits are designed using locally available electronic components. Embedded data acquisition card is designed using PIC18f2550 microcontroller and necessary GUI is designed in LabVIEW. Ultrasonic velocity measurements have been carried out in the standard samples and found to be in well agreement with the values reported in the literature.
Keywords- Pulse method, Sing around technique, Embedded data acquisition card, Virtual instrument, LabVIEW, GUI, PIC 18F2550, Time of flight, Ultrasonic velocity

I. INTRODUCTION

Virtual instrument is an effective and powerful combination of software and hardware. It combines processing power of PC with flexible software for numerous measurements. Engineers and scientists can create user-defined systems to meet their exact application needs. The VI can be realized using software like VB, JAVA, LabVIEW etc and DAQ card as per the application. LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming environment language to design virtual instrument.

Among the pulse techniques, Sing-around technique is widely used in the measurement of ultrasonic velocity with better accuracy in relative measurements. The principle of this technique was first proposed by Cedrone and Curran [1]; while its high accuracy was first attempted by Forgacs [2]. The technique was patented by H. Asada [3]. Since then, several workers [4-23] have improved this technique in terms of its performance, accuracy and stability. Ghodki *etal* [24],[28]-[30] have designed virtual sing around technique with improved accuracy and Singh *etal* [31]-[34] have controlled a virtual sing around wirelessly using e-mail, mobile phone and over internet to be operated remotely. Recently Sharma *etal* designed an embedded sing around system using microcontroller 18f4550 [35].

An electrical pulse is sent to the transmitting transducer by a triggered pulse generator. The pulse after passing through the specimen is received by the receiving transducer, amplified and used to generate a trigger signal that initiates a new pulse for the transmitter. This loop runs continuously and a counter measures the frequency of occurrence of triggered signals. The conventional sing-around technique is shown in Fig. 1.

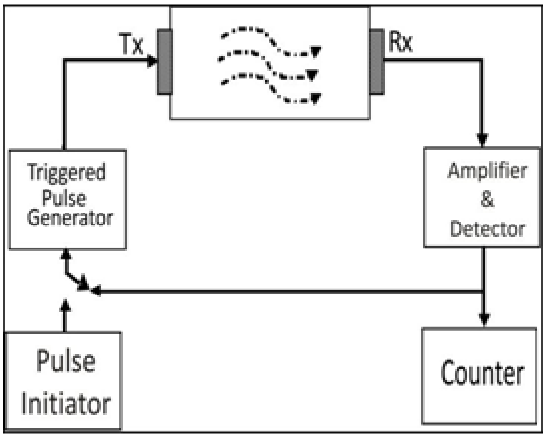

Fig. 1 Block diagram of Sing-around technique

II. EXPERIMENTAL

In present work, a virtual instrument for sing around system is designed using matched pair of 2 MHz PZT transducers, embedded data acquisition card, amplifier circuit and LabVIEW. 2 MHz PZT transducers are mounted on the two ends of the sample holder. An 8-bit microcontroller PIC 18F2550 is used to connect virtual instrument with the other hardware circuits.

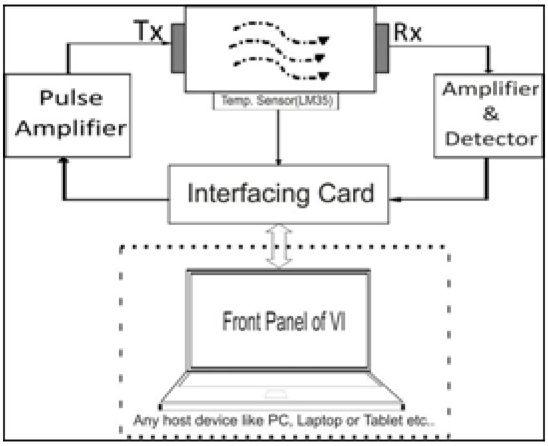

Fig. 2 Block diagram of VI for sing around system

Fig. 2 shows the block diagram of LabVIEW based virtual instrumentation for Sing around system, operated at 2MHz the complete setup has:

A. Front panel of VI
B. Embedded data acquisition card
C. Pulse amplifier
D. Echo amplifier and detector
E. Sample holder (Cell)

Fig. 3 Setup of the Virtual instrument for 2MHz sing around system

A. Front Panel

Front panel of VI is designed using LabVIEW software[37]-[38]. Fig. 3 shows the screenshot of front panel consisting of various control parameters. VI is programmed to automatically save time, date, sample name, user name and measured velocity with temperature in text file. User can use this for further analysis.

Fig. 4 GUI of Sing around system

B. Embedded data acquisition card

Embedded data acquisition card is the most important part in this work. This card designed using microcontroller PIC 18f2550 [39], establishes communication between VI and its hardware and has facility like serial communication between hardware and VI, 2MHz pulse generator, 16-bit operating fast timer and 10bit ADC. It is also used to generate tone burst of 2MHz

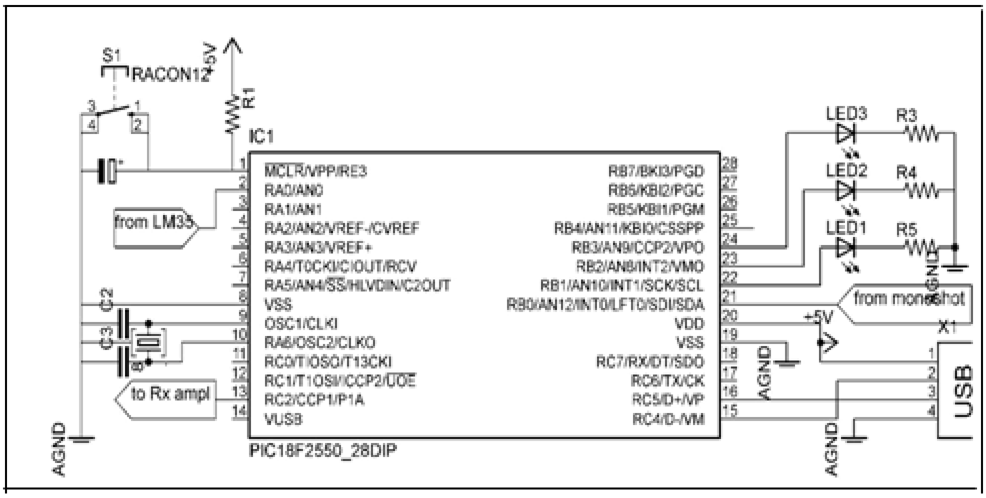

Fig. 5 Circuit diagram of embedded data acquisition card for interfacing

Fig. 6 Embedded data acquisition interfacing

C. Pulse Amplifier

This is used to amplify 2MHz tone burst upto 17 Volt. After amplification it sends tone burst signal to the transmitting transducer, Tx.

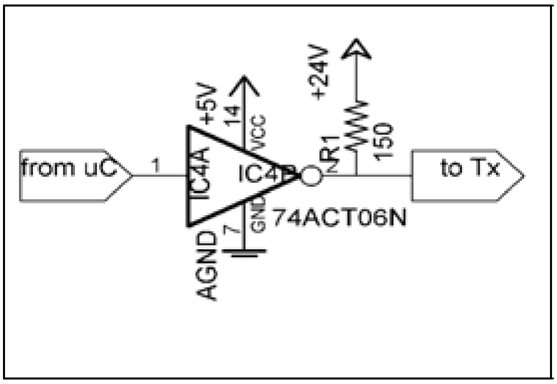

Fig. 7 Circuit diagram of pulser

D. Echo amplifier and detector

This block receives echoes from the receiving transducer, Rx and amplifies using op amp IC LM 7171 with overall gain of 200 and then feeds the comparator designed using NOT gate. It serves two purposes first there is no need to provide reference voltage and we require inverted pulse for single pulse generator. NOT gate compares input signal and generates inverted pulse for each echoes. These inverted pulses are transmitted towards 74LS221 multivibrator for single pulse generator.

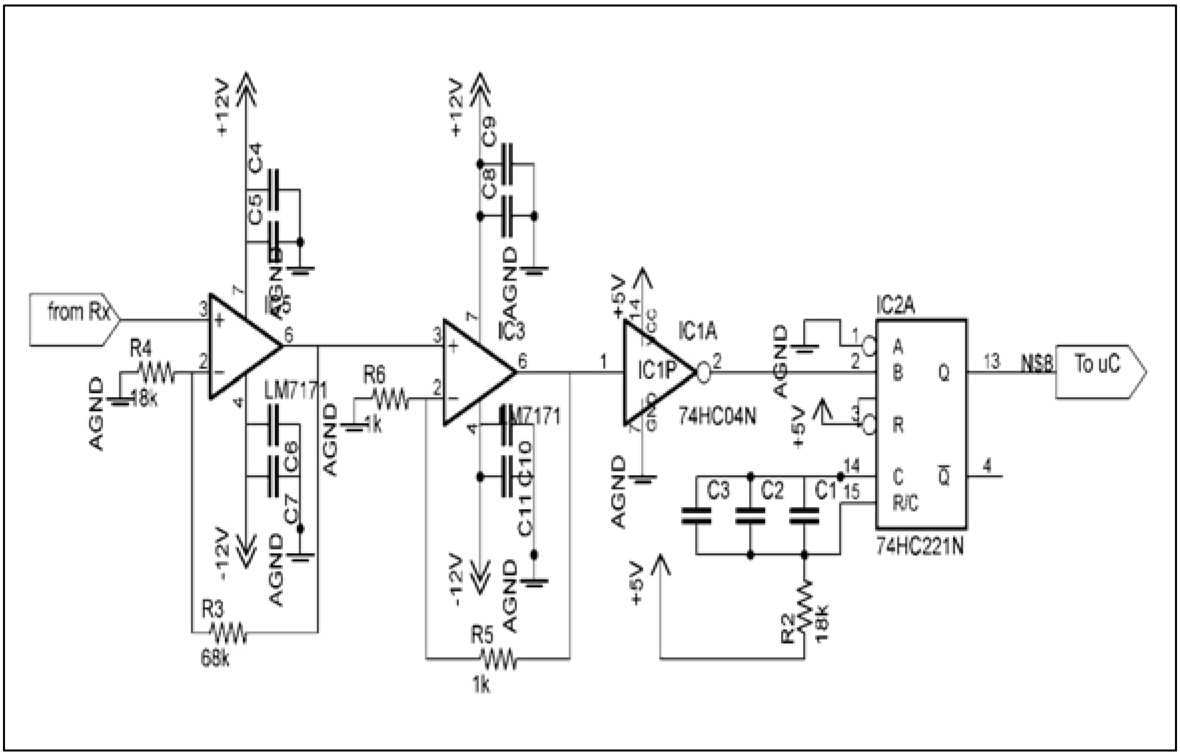

Fig. 8 Circuit diagram of receiver

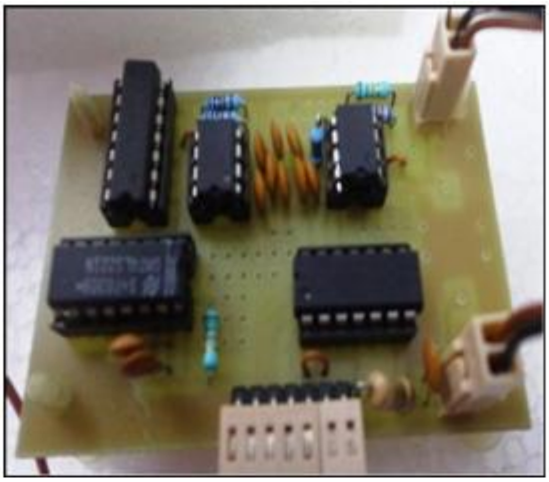

Fig. 9 Pulser and receiver board

E. Sample holder (Cell)

Sample holder i.e. Cell is nothing but the arrangement for sample and transducer for measurement. This sample holder consists of two steel cylinder inner cylinder for sample holding purpose and outer cylinder for cooling arrangement. Inner cylinder is closed with two transducers, transmitter, Tx and receiver transducer, Rx. Outer cylinder has facility for circulating thermostated water.

In the present work, we have modified the conventional detection technique where the received echoes were amplified using op- amps. In order to measure the time of flight, only the first echo is required. In the present work, NOT gate is used as a fixed voltage reference comparator. Whenever the input voltage of NOT gate is 1.5 Volt, output is 0 Volt. NOT gate always compares the input voltage with 1.5 Volt, hence the amplitude of received echo should be equal to 1.5 Volt or greater than that, otherwise the measurement of time between transmitting pulse and received echo would be wrong. To remove this difficulty, multistage amplifier is used in input stage so that amplitude of echo is more than 1.5Volt. As soon as the NOT gate receives input voltage greater than 1.5Volt, it generates inverted output, to be used to trigger monostable multivibrator to generate single pulse, used to stop the inbuilt high speed timer of the microcontroller, PIC18f2550.

The sample under investigation is placed in the liquid cell and Julabo ME-32 circulating thermostat maintains the constant temperature to ± 0.1^0C. The designed VI system measures the time of flight for 200 readings and displays the Velocity (m/s) and Temperature (°C).

III. RESULTS AND DISCUSSION:

The virtual instrument for Sing around technique developed in the laboratory has been tested for the ultrasonic velocity measurements in standard liquids. It is observed that the experimentally measured values match those reported in the literature. Table I shows the velocity measurement in standard liquids at particular temperature.

TABLE I VELOCITY MEASUREMENT IN STANDARD LIQUIDS

Sr. No	**Sample**	**T (^{O}C).**	**Velocity (m/s)**	
			Observed	**literature**
1	Water	20.5	1483.1243	1483.90 [21]
		25.4	1498.1000	1497.79 [21]
2	Benzene	20.0	1317.7427	1320.00 [42]
3	Methyl alcohol	20.0	1119.9276	1120.00 [42]
4	Ethyl alcohol	20.0	1199.3625	1200.00 [42] 1160.50 [26]
5	Toluene	20.0	1319.4168	1320.00 [42]
6	Acetone	22.5	1201.6861	1203.00 [43]

Fig. 10 Snapshot of received echoes with single pulse conversion

IV. ACKNOWLEDGEMENT

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