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Touch Screen Based Sing-Around System for Ultrasonic Velocity Measurements in Liquids

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Abstract: ***With the advancement in the semiconductor technology and the need for compact instruments, most of the instrument designs are rapidly changing towards touch screen based, for better physical interaction. Touch screen based systems are very compact, light, easier to handle and provides lot of flexibility due to multiple graphic user interface panels. In the present work, we have designed a touch screen based sing around system in laboratory, using locally available components and two microcontroller ATmega32, as a master and PIC18f4550, as a slave. PIC 18F4550 is used to handle the generation of 2 MHz r.f. pulse, exciting the transmitting transducer, processing received signal from the receiving transducer and retriggering the transmitting transducer and in due course measuring the travel time at a given temperature. Resistive touch screen is used to design the interactive controls. Touch screen operations are controlled by the ATmega32. Necessary control panels for data acquisition, processing and display are designed as per our requirements. The designed system is tested for measurement of ultrasonics velocity in standard liquids at various temperatures. The measured values are in agreement with those reported in literature.***

Keywords: Atmega32, PIC18f4550, Multiple GUI, Sing around system, Touch screen, Time of flight, Ultrasound velocity

1. Introduction

An conventional instrument has multiple displays and knobs or switches on the front panel for its operation, control of parameters of interest with their supporting hardware at the back of front panel. Such a system looks clumsy and unfamiliar and odd due to the large number of discrete components and buttons switches and knobs, it becomes bulky and occupies large space in working area. Due to the advances in semiconductor technology, researchers have replaced discrete components by microcontrollers which have reduced the size of system drastically with better efficiency, but the organization of front panel remains same. Hence, in order to have better physical interaction with the instrument, need for touch panel was indispensable. Using touch screen, the user is able to manipulate a digital environment by only the touch of finger or any other input devices such as stylus, on the screen of the control panel. The ability to physically touch is easy than searching for specific key or combination of switches in the sea of buttons. Through the use of touch screen technology, the user has a choice to interact in many ways: resistive, capacitive, infrared or SAW system[1-4]. Touch based system consist of a touch panel with either a TFT or GLCD and a controlling device meant for controlling this system.

Ultrasonic technique is widely used for non-destructive characterization of materials. Among the pulse techniques in ultrasonics, sing around technique is most widely used. This technique is first developed by Cedrone and Curran[5] and it is implemented by Forgacs[6] with improved accuracy. Since then many researcher[7-29] have modified this sing around system for its accuracy, reliability and portability. Recently Sharma etal designed sing around system, wherein pulse generator and counter block is embedded into microcontroller [30]. The operating principles and other details have been referred from our published work.

In present work, we have designed a resistive touch based sing around system at operating frequency of 2MHz. Pulser-receiver circuit is designed in laboratory, using locally available components. A pair of microcontrollers ATmega32, and PIC18f4550, has been used to realize data acquisition and display as per our requirements.

2. Experimental Work

In present work, a touch based sing around system is implemented using a matched pair of 2 MHz PZT transducers. Transducers are mounted at the two ends of the sample holder, designed in our laboratory. Fig 1. Shows the block diagram of touch screen based sing around system, two microcontrollers are used one as master and the other as a slave.

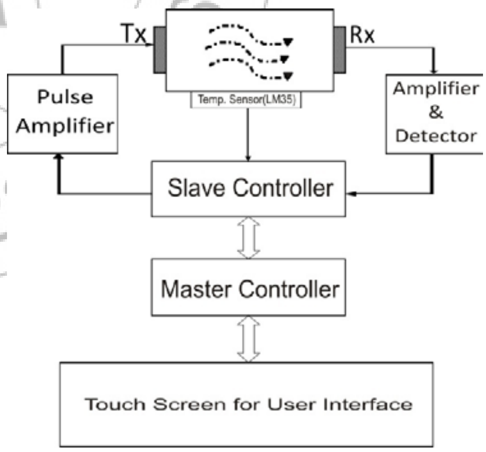
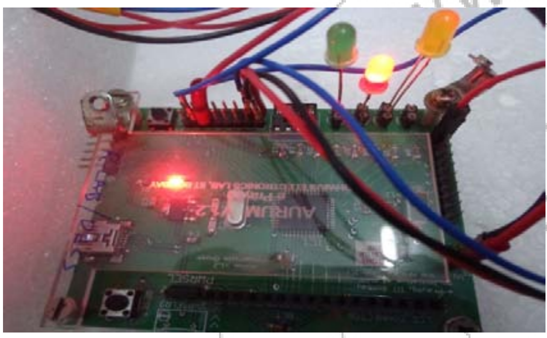
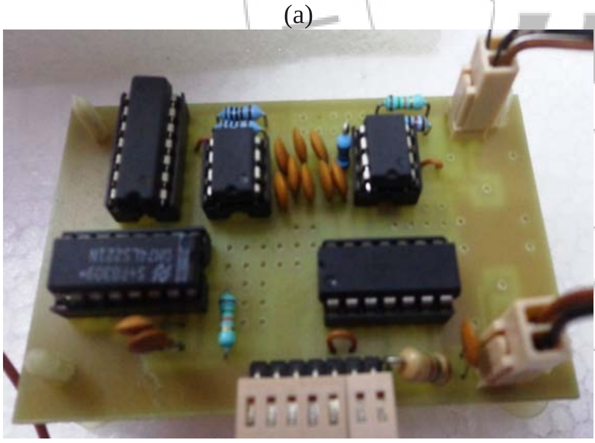


Figure 1: Block diagram of touch based sing around system

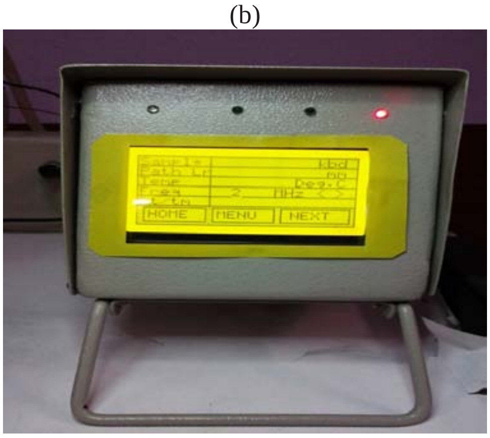
Present work is focused on the user control system using a resistive touch screen. Touch screen enables the user to interact with the system. Touch screens are of four types out of which resistive type is mostly used for commercial purpose. The resistive touch is more advantageous due to its low cost. Resistive touch screens consist of a glass or acrylic panel that is coated with electrically conductive and resistive layers made with indium tin oxide (ITO). The thin layers are separated by invisible spacers. The touch screen gives the output in the form of change in voltages according to the touch coordinates. The resistive touch screens are of two types 4 wire and 5 wire. In the present work, 4 wire resistive touch screen which has the four sides of rectangle defines the boundary of screen. To read one coordinate, we have to read one side of the X-axis as analogue output while other side has to be kept floating, also the other axis should be pull up to +Vref (+5V) and pull down to -Vref(-5V) at the other end. The same procedure is repeated to collect data from another axis[31-32]. In 4 wire touch screen only one axis can be read. Hence, to read both the axes we need a high speed switching circuit which will pull up and pull down and open same pin without disconnecting. To design a high speed switching circuit, we use simple transistor, resistor and diodes. It is necessary to avoid stray capacitance in the circuit; a small stray capacitance can cause changes or randomness in the voltages. This voltage is fed to 10 bit ADC which is inbuilt in microcontroller ATmega32. By obtaining the touch coordinates the task assigned is performed. The GLCD is placed below the screen. Numbers of pages were designed using microcontroller and displayed on GLCD. Touch panel consist of touch screen and GLCD and both of them are controlled by the same microcontroller i.e. master controller. According to the touch the pages gets open.



(a)



(b)



(c)

(d)

Figure 2: (a) Master controller (b) Amplifier, peak detector circuit (c) Final designed system (d) Velocity displayed on screen

The first page is called Home page which contains details regarding instrument i.e. its name and a software designed menu button. When touch on Menu button, the next page gets open which has number of buttons such as iF i.e. information button which gives information about the system, “hP” i.e help button which enables user to give information of the operation of system, “Home” button which enables user to go to the first page i.e. Home Page, “sA” i.e. sing around button which enables user to get into the sing around page. The sA page consists of the details to be filled by user such as sample name, path length and operating frequency through software keyboard provided on it (Fig.2(c)). Touching the next button, the next page gets open which consist of the information filled by the user. If the user finds the information correct then he can proceed by touching result option or can go back and reenter the details by touching back option. As result button is touch the panel shows processing which means that the master controller is communicating with slave controller. The communication between master and slave is serial communication and is based on query.

As the slave controller gets the query, the controller generates an rf burst of 2 MHz. The rf burst consists of 4 pulses each of 0.5us and 5V, which are amplified upto 24 V using buffer 7406 and pull-up resistor, and fed to the transmitting transducer, Tx. The received signal, after receiving by the transducer Rx, is multistage amplified by an operational amplifier, LM 7171. This signal is detected and fed to the µC 18F4550. After the reception of first echo the pulse is retriggered and again the same process is repeated for 200 times. The time of flight is measured using the internal timer of the micro-controller having frequency of 12 MHz. After calculating velocity from the time of flight the data is transmitted serially to the master controller and the velocity is displayed on the touch panel (Fig.5). The back button is provided which takes the user to sing around page and he can reenter the data or repeat the same procedure without reentering.

3. Design of sample holder or cell:

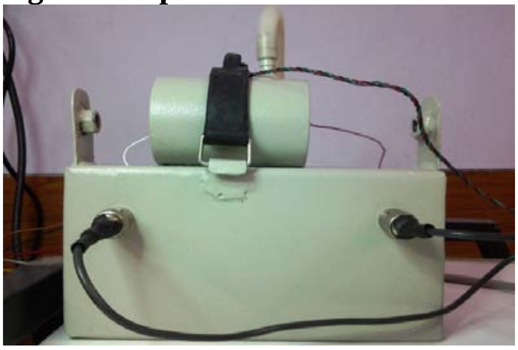


Figure 3: Sample holder with transducers fitted into it

Fig 3. Shows the sample holder or cell designed in the laboratory. The sample holder designed has two cylinders fitted into each other. An outer cylinder has inlet and outlet facility which is used to circulate water at constant temperature to maintain the temperature of the sample, by Julabo ME32. The inner cylinder is used to fill the sample and has two transducers fitted at the two ends of cylinder such that the transducers are parallel to each other and an inlet is also provided for filling the sample into sample holder. The sample holder is isolated so that no external parameters should affect the experimental setup. The precautions are taken that the cell is prepared with pure steel so that it does not react with the sample under test.

Figure 4: Photo of complete setup with temperature bath

4. Results and Discussion

Table 1: shows the experimental velocity observed on designed system in some standard liquids.

Material	Temperature in ºC	Observed velocity	Standard velocity
Water	20	1482.98	1482.343[33]@20ºC
	25	1498.05	
	30	1510.00	
	35	1519.87	
	40	1529.82	
	45	1536.61	
	50	1542.66	
Ethanol	20	1197.27	1200[34]@20ºC
	25	1175.49	
	30	1148.29	
	35	1137.61	
	40	1124.69	
	45	1101.74	
	50	1094.00	
Methanol	20	1123.13	1103.250[22]@25ºC
	25	1104.99	
	30	1177.89	
	35	1150.36	
	40	1060.61	
	45	1004.52	
Toluene	20	1327.97	1306.00[22]@25ºC
	25	1307.05	
	30	1284.20	
	35	1255.12	
	40	1233.93	
	45	1213.54	
	50	1186.96	

The system developed in the laboratory has been tested for the ultrasonic velocity measurements in various standard liquids. The sample under investigation is placed in the liquid cell and Julabo ME-32 circulating thermostat maintains the constant temperature to ± 0.1^0 C. It is observed that the experimentally measured values match those reported in the literature. Hence, the designed system adds compactness, user control and precision to the sing-around system.

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