

13

IMAGE RECONSTRUCTION COMPARISON ON QUANTITY OF ULTRASONIC TRANSCIEVER TOMOGRAPHY IN NON – INVASIVE IMAGING OF LIQUID / GAS FLOW

Jaysuman Pusppanathan
Ruzairi Abdul Rahim
Zulkarnay Zakaria
Mohd Hafiz Fazalul Rahiman
Yvette Shaan-Li Susiapan

13.1 INTRODUCTION

Currently, besides ultrasonic there are a number of tomography techniques available for studying complex multiphase phenomena. These include electrical tomography (Impedance, Capacitance and Resistance), optical, positron emission tomography (PET), X-ray, magnetic resonance imaging (MRI), ultrasonic and others. Each of these techniques has its advantages, disadvantages and limitations but each of it has common purpose

to analyze measured data. The best way is by reconstructing images from acquired data.

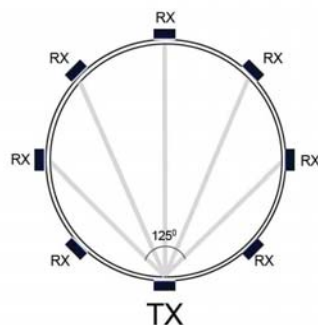
Process tomography consists of tomographic imaging of systems, such as process pipes in industry. In tomography the cross sectional image distribution of some physical quantity in the object is determined. There is a widespread need to get tomographic information about process. This information can be used, for example, in the design and control of processes. Tomography involves taking measurements around the periphery of an object such as process vessel to determine what is going on inside.

However process tomography instrumentation needs to be cheaper, faster and more robust. Ultrasonic sensors have a long history of success in a variety of non-tomographic applications: in process measurement in non-destructive testing and widely in single viewpoint medical imaging [1, 4, 5]. In all cases external sensors are used to detect signals from boundary of the object, and the three dimensional material distribution or the velocity field is computed using the measured data.

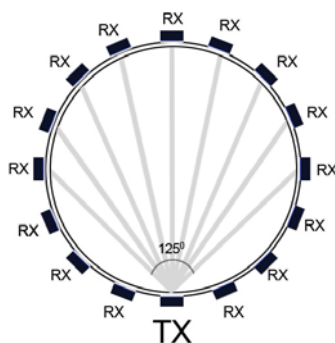
13.2 ULTRASONIC TRANSCIVER SENSOR UTILIZATION

Usually, a typical tomography system consists of three main units: The sensor, signal conditioning and a display unit. The sensor is so designed that it can interrogate the imaging area from many different viewing angles. Signal conditioning circuits takes measurements from the sensors, implements digitization and then sends the data to the computer. The computer controls the system hardware and implements image reconstruction [2]. The same case is applied to ultrasonic tomography system, where in general, the ultrasonic tomography system is being split into three sub-systems; namely the sensor array, signal conditioning electronics and data acquisition system, and host computer [3].

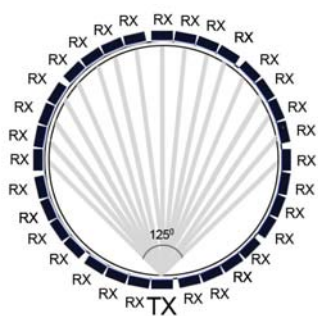
Common ultrasonic sensors like the separated transmitter – receiver sensors are single function either transmitting sensor or receiving sensor. Transceiver has the dual functionality to switch either as transmitter or as receiver. This can be done by using a analog switching devices. The advantages of using transceiver spaces required to install sensors are highly reduced into half comparing to the use of separated transmitter–receiver pair. Hence, more of these sensors can be installed. Below Figure 1 shows the transceiver setup for 8 channels, 16 channels and 32 channels.



8 channels transceiver.



16 channels transceiver.



32 channels transceiver.

Figure 13.1: Transceiver setup

13.3 TWO PHASE LIQUID – GAS FLOW

Since the acoustic impedance difference between the pipe wall and the water itself is not high, the signal from the transmitter can penetrate the pipe wall and then travel to the receiver through the water.

With the use of 8 channels, 16 channels and 32 channels of transceivers, measurements been conducted by injecting liquid (water) into the pipeline with 60 percent of water where remaining 40 percent contain gas (air) as shown in Figure 2(a) and 100 percent full flow with liquid (water) as shown in Figure 2(b). Full flow projection means that, the pipe is filled with water and there is no gas (air) at all.

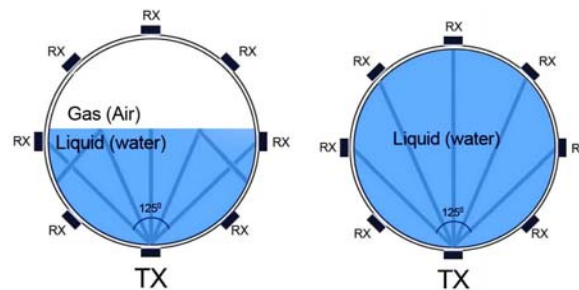
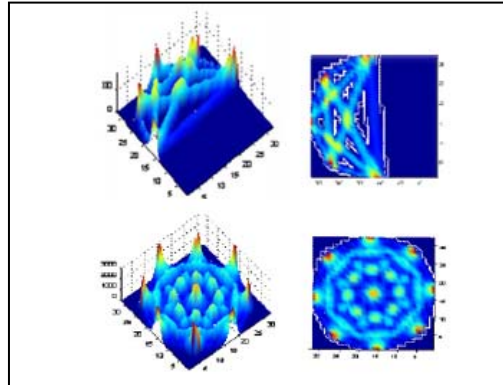


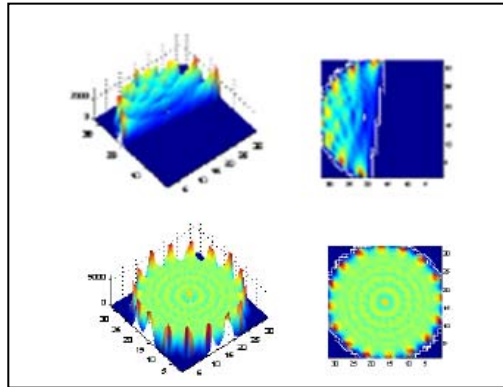
Figure 13.2: Pipeline with transmitter

13.4 RESULTS

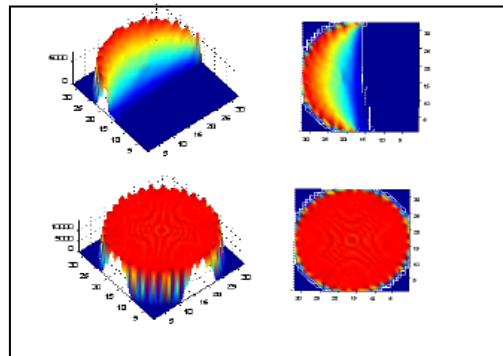
This research shows that this system is able to detect the presence of two phase liquid/gas flow in pipe. From the image that have been generated for three different numbers of transceivers applied with different types of flow scheme, it is clear that by increasing the number of transceivers will increase the spatial resolution of the reconstructed image, hence this will produce more clear and accurate images with both qualitative and quantitative information. Figure 3 shows the reconstructed images shows the different quality of image between 8, 16 and 32 channels of sensors. This is done by offline simulation using Mathlab software.



8 channels transceiver image.



16 channels transceiver image.



32 channels transceiver image.

Figure 13.3: Image reconstruction

13.5 REFERENCES

[1] Asher, R.C. (1983). "Ultrasonic Sensors in the Chemical and Process Industries" *J. Sci. Instrum. Phys. E*: Vol. 16. UK: The Institute of Physics. 959-963.

[2] W Q Yang, M Byars, "An Improved Normalisation Approach For Electrical Capacitance Tomography", *Proceedings 1st World Congress on Industrial Process Tomography*, Buxton, Great Manchester, 1999, p 215-218.

[3] R Abdul Rahim "A Tomographic Imaging System for Pneumatic Conveyors Using Optical Fibers." *PhD Thesis*, Sheffield Hallam University, 1996.

[4] Plaskowski, A., Beck, M.S., Thron, R., Dyakowski, T. "Imaging industrial flows: Applications of Electrical Process Tomography". UK: IOP Publishing Ltd. 1995, p76-160.

[5] Williams, R.A. and Beck, M.S. (Eds.) "Process Tomography: Principles, Techniques and Applications." Oxford: Butterworth-Heinemann. 119-149.
