

**PROFILE IMAGING OF CONVEYING PIPE VIA FAN BEAM PROJECTION
OF ULTRASONIC BASED TOMOGRAPHY**

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 PROJECTION OF ULTRASONIC BASED TOMOGRAPHY

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To my parents, family members, friends and all which involved

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ABSTRACT

Information on flowing particles is vital in the analysis and measurement of industrial process flow. The overall objective of this project is to implement Ultrasonic emitter and receiver in a Fan Beam Type Projection for monitoring of flowing particles. This method is able to provide cross-sectional image of material distribution i.e. the concentration profile. This image is formed by reconstruction of data obtained from the array of sensors. Images of the flow captured using infra-red sensors are digitized into a form suitable for computer processing of the flow pictures. The advantages of this method is that it is cheaper and safer than most of the current methods which mostly made use of radioactive methods. Various process industries such as petroleum and food processing can benefit from such invention to improve their products and reduce the amount of wastage. This project involved constructing hardware and interfaces it with software through Data Acquisition Card. In this project, student will design & implement signal control circuit, jig & fixture design / fabrication and data processing method using Visual Basic.

ABSTRAK

Maklumat mengenai zarah yang mengalir adalah penting dalam menganalisis dan mengukur untuk industri pemprosesan ukuran. Objektif keseluruhan projek ini adalah untuk melaksanakan pemancar dan penerima ultrasonic dalam 'Fan Beam Type Projection' untuk memantau pergerakan zarah. Kaedah ini berkebolehan untuk mendapatkan imej keratan retas bagi taburan material seperti profil penumpuan. Imej ini dibentuk menggunakan pembinaan semula data yang diperoleh daripada susunan sensor. Aliran imej yang diambil menggunakan sensor infra-merah didigit pada bentuk yang sesuai untuk menghasilkan gambar aliran dalam proses computer. Kelebihan kaedah ini adalah murah dan selamat berbanding kaedah yang digunakan sekarang yang kebanyakannya menggunakan kaedah radioaktif. Pelbagai proses industri seperti petroleum dan pemprosesan makanan akan mendapat faedah untuk meningkatkan kualiti produk dan mengurangkan pembaziran. Projek ini melibatkan pembuatan perkakasan dan juga dihubungkan dengan perisian melalui Kad Pemungutan Data. Dalam projek ini, pelajar akan merekabentuk dan melaksana litar kondisi isyarat, memasang rekabentuk/fabrikasi dan kaedah memproses data menggunakan 'Visual Basic'.

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LIST OF ABBREVIATIONS

AC	Alternating Current
CT	X-Ray Computed Tomography
DAS	Data Acquisition System
DC	Direct Current
ECT	Electrical Capacitance Tomography
EIT	Electrical Impedance Tomography
EMI	Electromagnetic interference
GUI	Graphical User Interface
IDE	Integrated Development Environment
kHz	kilohertz
LBP	Linear Back Projection
LED	Light Emitted Diode
MRI	Magnetic Resonance Imaging
$M_{Tx,Rx(x,y)}$	The normalized sensitivity matrices for the view of Tx-Rx
	Linear Back Projection algorithms
nm	nanometres
OpAmp	Operational Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
pm	picometres
PVC	Polyvinyl chloride
Rx	Receiver

$S_{RX,TX}$	Signal loss amplitude of receiver Rx-th for projection Tx- th in unit of volt
Tx	Transmitter
VB	Visual Basic
$V_{LBP(x,y)}$	Voltage distribution obtained using LBP algorithms

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LIST OF SYMBOLS

$V_{LBP(x,y)}$	-	Voltage distribution obtained using LBP algorithms
$S_{RX,TX}$	-	Signal loss amplitude of receiver Rx-th for projection Tx- th in unit of volt
$\overline{M}_{Tx,Rx(x,y)}$	-	The normalized sensitivity matrices for the view of Tx-Rx Linear Back Projection algorithms

CHAPTER 1

INTRODUCTION

This chapter will discuss the overview of project, the objectives of the project, problem statement and scope of the project. The end of this chapter will discuss the outline of the methodology used in this project.

1.1 Overview Of Project

This project describes an investigation of the use of ultrasonic based tomography to provide cross-sectional image of material distribution. The system employs fan beam projection with the using of ultrasonic sensor. The system can be applied to produce cross-sectional images of flowing particles. The ultrasonic tomography measurements circuit consists of sensors, signal conditioning circuits and data acquisition system. Sensors fixture are designed based on fan beam projection technique. The signal is transmitted from the transmitter to the receiver whereas for this project, the transmitter will produce three beam projections. The numbers of transmitter used are five in order to get fifteen projections to the receiver. This project also involves constructing hardware and interfaces it with software through Data Acquisition Card. Visual Basic 6.0 is used for software algorithms on concentration and velocity measurement. Interfacing card is

used to interface the analog signals to the computer. This provides information on the concentration of the flowing objects.

1.2 Objectives of the Project

This project aims to construct/fabricate an ultrasonic based tomography system which utilizes fan beam projection to obtain cross section view of conveying pipe. The specific objectives of this project are:

1. Become familiar with the concept of process ultrasonic based tomography.
2. To integrate hardware and data acquisition system that will provide data for cross sectional image of flowing particle.
3. To implement the using of infrared as the transmitter or source.
4. To produce a safer and cheaper products in industrial process.
5. Develop software using Visual Basic (VB) 6.0 to display the cross sectional image of flowing particle.

1.3 Problem Statement

The main purpose of this project is to find the cross section view by using tomography method. Previously, the methods that have been used are rectilinear and orthogonal method. These methods are very straight forward which is used just one emitter for one projection causing high cost with low number of resolution. The number of emitter is directly proportional to the number of resolution. In order to increase the number of resolution, fan beam projection method has been identified that is more effective which is using only one emitter can produce three projections. Besides, it also can reduce cost.

1.4 Scope of the Project

The scope of this project is:

1. Construct jig/fixture of ultrasonic tomography system.
2. Construct signal emitter circuit and signal conditional circuit for ultrasonic emitter and receiver.
3. Develop a fan beam based tomography system to display cross section view by using Visual Basic programming.
4. Ensure scope of work above can be integrate and measure. Besides, it can implement fan beam tomography system.

1.5 Methodology of the Project

Below is the flow of the methodology used in this project:

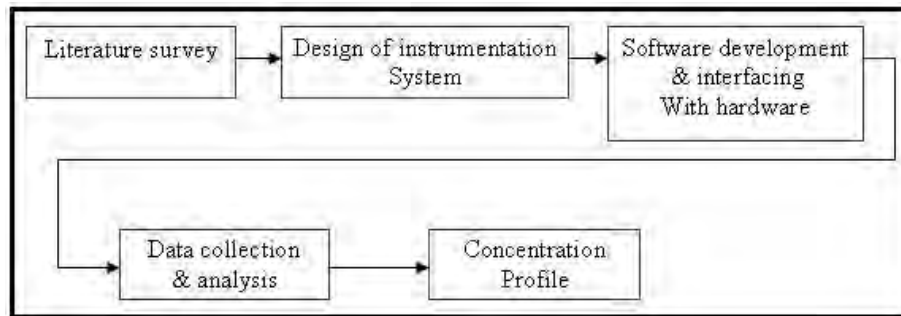


Figure 1.1 : Methodology flow

1. Literature Survey
 - Process tomography
 - Sensing techniques
 - Image reconstruction algorithms
2. Design of Instrumentation System
 - Sensor's fixture
 - Transmitter & receiver selection
 - Signal conditioning circuit
3. Software development & interfacing with hardware
 - Interfacing DAS card with measurement system
 - Design of PCB Circuit and also simulation
4. Data collection & analysis
 - Process measurement
 - Data collection & analysis
5. Concentration profile
 - Tomography image reconstruction by using Visual Basic 6.0

1.6 Project Outline

This report consists of five chapters. Chapter 1 introduces the overview of project, the objectives of the project, problem statement, scope of project, methodology and project outline.

Chapter 2 mainly discusses the literature review that is related to this project research. It consists of the introduction to process tomography, typical sensors used in process tomography, type of projection in tomography system and lastly some overview regarding Visual Basic 6.0.

Chapter 3 discusses on the research methodology hardware development process where the criteria of the sensors are presented. The basic structure of the process, data acquisition system, signal conditioning circuit and software development on image reconstruction using Visual Basic also discussed here.

Chapter 4 presents the results obtained from the experiments done to test the receiver circuit. The results obtained are discussed and a conclusion was drawn based on the analysis.

Chapter 5 contains the conclusions from this project and some suggestions for future work and development are given in order to improve the system ability.