OPTICAL TOMOGRAPHY SYSTEM FOR BUBBLES DETECTION IN LIQUID MEDIUM

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Dedicated, in thankful appreciation for support, encouragement and understandings to my beloved mother, Noriah Binti Hj. Maamor, my husband Jemmy @ Mohd Jemmy Bin Mohd Rohani, siblings and in memory of my late father Haji Jamaludin Bin Zakaria.

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ABSTRACT

Process tomography is widely used in industrial, medical diagnostic, chemical engineering and many more because this method is suitable for multiphase flow imaging and measurement system. Optical tomography is one of the most popular methods that had been used in tomography area because it has high resolution compare to other methods of tomography system. The main goal of this project is to build a new design of optical tomography system for bubbles detector using couple charge device linear sensor and laser diode. In this report it describes the objectives, problems encountered, and scopes of the project. Detail's discussion about research, methodology and result for this project also carried out in this report. This project present a new orientation of sensor and detectors compared to the previous research in a way to obtain more precise and concise of image reconstruction. The characteristics and the advantages of sensor and detectors that had been used in optical tomography system for bubbles detection also discussed in detail based on the literature review.

ABSTRAK

Tomografi adalah satu kaedah mendapatkan imej sesuatu bahagian dan ia sangat banyak digunakan dalam dunia industri, perubatan, kimia, dan dalam kaedah sains yang lain. Tomografi ini sesuai dalam melakukan pengukuran dan pengambilan imej bendalir yang mengalir dalam bentuk pelbagai fasa. Tomografi optik sangat sesuai digunakan dalam pengkajian imej kerana tomografi optik mempunyai resolusi yang tinggi berbanding dengan kaedah tomografi yang lain.Tujuan utama projek ini adalah untuk mereka dan membina sistem tomografi optik bagi pengesan kehadiran buih-buih udara di dalam aliran bendalir yang berbeza-beza. Sistem ini menggunakan 'Couple Charge Device Linear Sensor' dan diod laser. Di dalam tesis ini juga menerangkan tentang objektif, penemuan masalah, skop projek, metodologi dan keputusan akhir. Penerangan yang lebih mendalam dalam thesis ini akan turut dibincangkan. Projek ini juga akan memperkenalkan penyusunan bahagian sensor secara selari d imana sensor yang disusun secara selari dapat membantu dalam mendapatkan imej lebih menyeluruh. Ciri-ciri serta kelebihan penggunaan sensor ini turut dibincangkan.

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CHAPTER 1

INTRODUCTION

1.1. Background of The Project

Process tomography system is widely known in industrial and in medical area. The method that been used is the same but the particle that want to measured make the different of the system. Process tomography means obtaining the cross sectional image of process from either transmission or reflection data collected by illuminating the process from many different direction. Various method had been used in industry to measured objects in pipeline but nowadays industry more demand for system that can described the characteristic of component flow using methods that are non –invasive, fast response, and high resolution and process tomography full fill all the criteria needed. There are varieties of process tomography such as capacitance tomography, resistance tomography, terahertz tomography, ultrasonic tomography and the most popular is optical tomography system.

This project is entitled ‘Optical Process Tomography System for Bubbler Detector in Liquid Medium’. The main objective of this project is to build a hardware that can detect the flow of gas bubble in liquid medium. Bubble detectors already invented and sell in market at high price. Most of the bubble detector that sold in market implement video camera as their receiver and transmitter and have complexity data transfer and data captured. This situation result for the high cost and high maintenance for this product.

This project will represent a new invention of bubble detector using Couple Charge Device as receiver and laser diode as transmitter. The different in this project compare to the previous researchers is the orientation of sensor and detector. Usually, the concept of tomography system placed the sensor and detector at one straight line. But in this project it will introduce the new orientation of detectors and sensor. This project used principle of laser beam back projection and linear back projection algorithm for image reconstruction. This prototype also will be used for two different experiments which are to detect gas bubbles in transparent liquid (plain water) and gas bubbles or water droplet in opaque liquid (oil). Infrared laser diode will be used as a transmitter base on it high intensity source of light to detect gas bubbles or water droplet in opaque liquid.

As a conclusion, this project will discuss more details on the objectives, scopes, and its methodology .This project also will prove the capability of infrared laser diode to detect movement of particle in opaque liquid and provide a low cost of bubble detectors with new design and orientation of sensor and detectors which can give more range of image captured.

1.2. Objective of The Project

There are five objectives that this project needs to will achieve. The main objective for this project is to develop an optical tomography system for bubbles detection in liquid medium using couple charge device linear sensor as receiver and infrared laser diode as transmitter.

The second objective for this project is to do an experiment using transparent liquid to detect air bubbles flowing up in the pipeline. Gas bubble will be inject at the bottom of the pipeline that having a flow of transparent liquid (plain water).This second objective also want to prove that air bubbles in transparent liquid is easily can be detected using optical tomography system.

If the hardware success in experiment one, the second experiment will be carried out is to check air bubbles or water droplet in an opaque liquid such as oil. From previous study mention that particles moving inside opaque liquid is difficult to detect using optical tomography system unless the transmitter is infrared laser diode. The third objective here is to prove that infrared laser diode has high intensity of source of light.

1.3. Problems Statements

According to the previous study, bubble detectors already being developed using couple charge device linear sensor as receiver and infrared used variety type of source of light as transmitter. Unfortunately from the study show that this bubbles detector only effective to detect gas bubbles in transparent liquid rather than opaque liquid. Optical process tomography easily can detect gas bubbles flow in transparent liquid but hard to detect gas bubbles or water droplets in opaque liquid such as oil. Oil considered too opaque for visible radiation. The range for visible light wavelength is in between 350 nanometres to 740 nanometres. This range is visible light range for human eyes. Some research show that infrared spectrum have the capability to detect water droplet or gas bubbles in oil. It is because it has high intensity of source of light. This project wants to prove that infrared spectrum is the best choice to apply as transmitter for bubble detector.

There are many types of bubbles detector in today's market. Unfortunately the price for bubbles detector can reach until RM 20 000.00.This price including data acquisition system and its software. Most of the bubbles detector use video camera and complex circuit for data capture and data transfer signal. This project also aims to produce low cost bubble detector and the performance still can be accepted for industrial stage.

1.4. Scope of the Project

This project consist of six man stage which are literature review, analyze and design hardware, build hardware, test hardware and start the experiments, analyze data for image reconstruction, and demonstration. All this stage is very important to achieve to make sure this project is success.

The main scope for this project is to analyze and design the hardware. Process tomography consists of four main parts where there are sensor, detector, and circuit for data transfer and computer software for image reconstruction. The design for this prototype is based on the basic block diagram for tomography system. The specification of each component also needs to analyze before implement to avoid any problems occurred in the future.

After the design stage completed, the hardware will be developed based on the idea and the analysis of the design stage. The hardware is developing according to the schematic diagram that had been produce. In this stage all the criteria for all components must be full fill to make sure it can work properly. The orientation of the sensor is the most important part to check because this is the part for detects gas bubbles flow in the pipeline.

Once the hardware is ready to be tested, first experiment will be take place to check the performance of the hardware. The first experiment is to check gas bubbles in plain water. Plain water will be flow through glass pipeline and gas bubbles will be injected at the bottom of the pipeline. The second experiment is to check the capability of infrared laser diode to detect gas bubbles in opaque liquid. In this case oil will be used for the experiment.

Each of the data will be analyze for image reconstruction. Linear back projection algorithm is being chosen to apply for image reconstruction part because it is simple and easy to implement. The result will be display in the range of colour gradient to represent concentration of profile.

1.5. Summary of Works

Implementation and works of the project are summarized into the flow chart as shown in the **Figure 1.1** below.

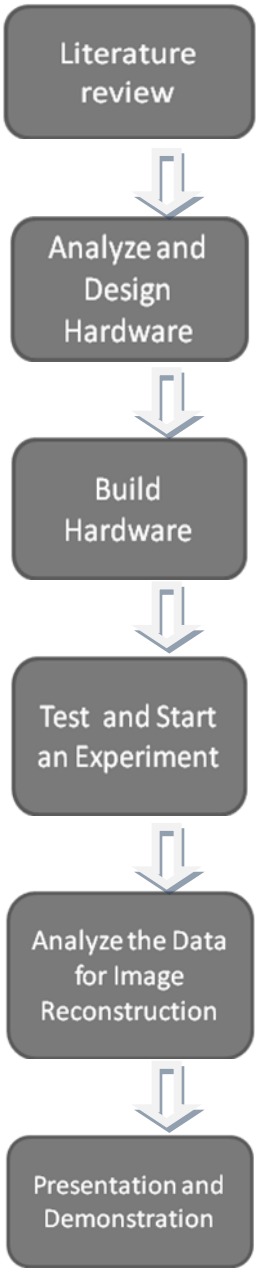

Figure 1.1: Flow Chart for Project

The Gantt Chart in **Table 1.1** and **Table 1.2** show the detail of the works of project that had been schedule for the first semester and incoming this second semester.

Month	February				March				April				May				June			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Confirmation Letter																				
Literature Review																				
Project Synopsis																				
Design Stage																				
Analysis Materials																				
Design Circuit																				
Preparation for Seminar																				
Presentation																				
Preparation for Report																				
Report Submission																				

Table 1.1: Gantt chart for semester 1

Month	September				October				November				December				January			
Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Hardware Development																				
Hardware Testing																				
Software Implementation																				
Run Experiments																				
Collected Data																				
Analysis Data Captured																				
Preparation for Seminar																				
Presentation																				
Preparation for Report																				
Report Submission																				

Table 1.2: Gantt chart for semester 2

1.6 Expected Result

An optical tomography system based on couple charge device linear sensor and fan beam projection will be design to measure and detect the gas bubbles flow inside a cylindrical pipeline. This new prototype will present a unique orientation of sensors and detector compare to the currently available solid air system. The new design also expected to be more precise and have high sensitivity by implement infrared laser diode to detect particles flow in opaque liquid. This project hope can produce low cost of bubbles detectors.

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