FLAME IMAGING USING COMBINATION OF LED AND OPTICAL SENSOR

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DEDICATION

Special dedication to my beloved father and mother, my entire sibling and my kind hearted supervisor En Adie bin Mohd Khafe and my dearest friends

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ABSTRAK

Projek ini bertujuan mengkaji penggunaan LED dan jujukan *sensor* untuk memaparkan gambaran api yang disebarkan didalam relau dengan menggunakan proses tomografi. Ia menggunakan kaedah tomografi optik iaitu menggunakan LED sebagai pemancar dan photodiode sebagai penerima (*sensor*). Jujukan s*ensor* ini akan diletakkan di bahagia luar jig/fixture, dimana cahaya laser akan dipancarkan kepada photodiode. Hasil daripada data yang diperolehi daripada *sensor* akan ditukarkan kepada bentuk digital yang sesuai supaya dapat diproses oleh komputer. Dengan menggunakan data yang diperolehi daripada sensor, imej keratan rentas akan terbentuk. Sistem ini menggunakan orthogonal projeksi, dimana bilangan pemancar LED dan penerima (photodiode) yang digunakan adalah sama dan diletakkan bersudut tepat. Selain daripada itu, projek ini juga menggunakan perisian Visual Basic (VB) bagi tujuan penghasilan imej.

ABSTRACT

This project describes of the use of LED and optical sensor to reconstruct flame image distribution in furnace in using tomography method. It use an optical tomography method which consist of a LED as emitter and photodiode as receiver (sensor). The array of sensor will be installed at the jig/fixture which the laser will emit the light to the photodiode. The data of the sensor will be converted to the suitable digital form for computer processing. The computer is use to reconstruct a tomography image of the cross-section detected by the sensor. This system use an orthogonal projection which both number of emitter (laser) and receiver (photodiode) are the same and each pair of transmitter and receiver is arranged in a straight line and received signal only correspond to its emitter source. Besides that, this project also uses the Visual Basic (VB) software to reconstruct the image.

CONTENTS

LIST OF TABLES

LIST OF FIGURE

LIST OF SYMBOLS

$V_{LBP}(x, y)$ = Voltage distribution obtained using LBP algorithm concentration profile in unit (volt) an *n x m* matrix where *n* equals to dimension of sensitivity matrix.

$S_{Rx,Tx}$ = 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.

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.0 Tomography Overview

As defined in one encyclopedia (Helicon l99l), the word "tomography" is derived from the Greek language, which tomo means "slice" and graph means "picture". In another word, tomography is a method of viewing the plane cross-section image of an object.

Process tomography provides several real time methods of viewing the cross-section of a process to provide information relating to the material distribution. This involves by taking numerous measurement from sensors which placed around the section of the process being investigated and process the data to reconstruct an image. The process involves the use of noninvasive sensors to acquire vital information in order to produce two or three-dimensional images of the dynamic internal characteristic of process system. Information on the flow regime, vector velocity, and concentration distribution may be determined from the images. Such information can assist in the design of process equipment, verification of existing computational modeling and simulation techniques, or to assist in process control and monitoring.

Process tomography refers to any tomography method used to measure the internal state of a heated process (e.g. heating distribution in a furnace and heating in boiler system). By tomography techniques, it can measure and display an image of heat distribution or can monitoring a location that had been heat. This type of information is not usually obtainable with the sensor traditionally used by engineer, therefore these techniques gives a better understanding of the heat system in the furnace through the plant and the data can be used to design better process equipment and to control certain processes to maximize yield and quality. Basically, in a tomography system several sensors are installed around the model of furnace to be imaged. The sensor output signals depend on the position of the component boundaries within their sensing zones .A computer is used to reconstruct a tomography image of the cross-section being interrogated by the sensors. Real time images can be obtains which measure the dynamic evolution of the parameters being detect at t the sensors.

1.1 Process Tomography

Process tomography involves the use of non-invasive sensors to acquire vital information in order to produce two or three dimensional images of the dynamic internal characteristics of process systems. Information can assist in the design of process equipment, verification of existing computational modeling and simulation techniques, or to assist in process control and monitoring.

At present, the usual objectives of using tomography systems is to obtain concentration profiles of moving components of interest within the measurement section in the form of a visual image, which is updated at a refreshment rate dependent upon the process being investigated.

Basically, in a tomography system several sensors are installed around the model of furnace to be imaged. A computer is used to reconstruct a tomography image of the cross-section being interrogated by the sensors [2]. The specific subsystem for heat imaging are shown in Figure 1.1 and described as follows :

1. The sensor and sensor electronics. The field sensing pattern of the sensors is also important, as it is related to the choice of image reconstruction algorithm.

2. Image reconstruction, which includes extraction of image characteristics and reconstruction of the image.

4. Image interpretation, to give the desired information on the heat, such as the heat distribution in the furnace or oven can be calculated and monitor.

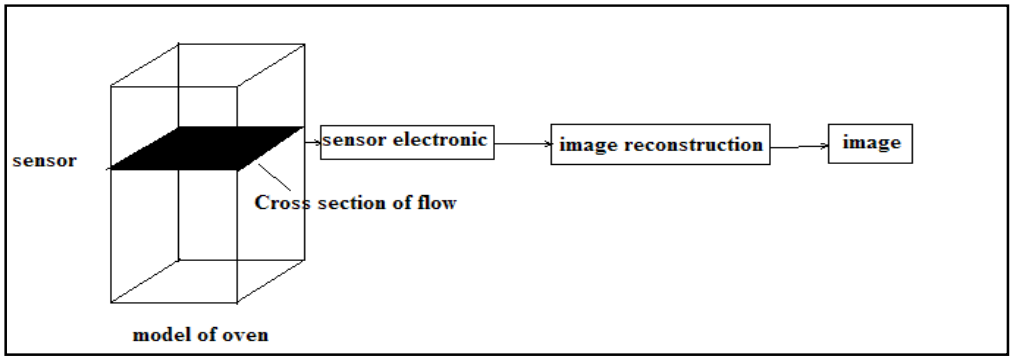

Figure 1.1 Basic schematic Diagram of Tomography System

Basically, in a tomography system, several sensors are installed around the model of furnace or oven to be converting an imaged. The sensor output signals depend on the position of the component boundaries within their sensing zone-A computer is used to reconstruct a tomography image of the cross section being interrogated by the sensors. Real time images can be obtained which measure the flame being detect at the sensor. And all that is required for a practical system is an image updated frequently enough for the smallest relevant feature of the flow to be observed [3].

1.2 Objectives Of The Project

The aim of this project is to know the heat distribution based on tomography process. The objectives of this project are:

1 To design and implement LED and optical sensor based tomography system for heat distribution.

2 To construct the model of oven for installing the sensor.

3 To design and implement voltage linear back projection (V_{LBP}) using visual basic to obtain cross-section image.

4 To design the circuit and implement data to manipulate in the program.

5 To display an image of heat distribution.

1.3 Scope Of The Project

This project is divided into two parts, which the first parts is hardware development and the second part is software development which include interfacing witch the data acquisition system (DAQ).

For part one, firstly, literature study in the measurement of heat distribution in the furnace or oven based tomography is conducted. Second, selection of sensor and build a sensor's jig/fixture. Then, study the receiving circuit which includes acing and testing the circuit.

For part two, Data Acquisition (DAQ) card is used as interface method to collect the heat distribution data before being transfered to Visual Basic (VB). By using a Visual Basic, an image of heat distribution will be reconstructed by performing V_{LBP}.

1.4 Project Plan

Schedule for the project are shown below. This project is based on the project planning schedule. For PSM I, the project started from July to October 2008. The project planning schedule is shown in Table 1.1 and for the PSM II the schedule is shown in table1.2

Table 1.1 Schedule for PSM I

JADUAL PERLAKSANAAN PROJEK SARJANA MUDA I																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
BIL	TASK	10/7	17/7	24/7	31/7	7/8	14/8	28/8	4/9	11/9	18/9	25/9	2/10	9/10	16/10	23/10	29/10
1	Literature Review																
2	Circuit Design (Sensor)																
3	Jig Design																
4	Circuit Prototype																
5	Visual Basic																
6	Presentation Preparation																
7	Presentation																

Table 1.2 Schedule for PSM II

JADUAL PERLAKSANAAN PROJEK SARJANA MUDA II															
		JANUARI					FEBRUARI				MAC				APRIL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
BIL	TASK	1-2	8-9	15-16	22-23	29-30	5-6	12-13	19-20	26-27	5-6	12-13	19-20	26-27	2-3
1	Setup Schedule					CUTI SEMESTER									
2	Circuit Design (Proteus software)														
3	PCB Design (Etching)														
4	Jig/Fixture Design														
5	Visual Basic														
6	DAQ Card & Testing														
7	Technical Report														
8	Presentation Preparation														

1.5 Thesis Outline

Chapter 1 present an overview of the process tomography, the objectives of the project, scope of the project, project planning and thesis outline.

Chapter 2 provides literature review which includes the tomography technique, Sensor type and selection photodiode, and orthogonal projection technique

Chapter 3 consist of explanation about methodology which covers about emitter and receiver, The design of optical receiving circuit, DAQ card and Visual Basic (VB) and Linear back Projection (LBP) Algorithm

Chapter 4 shows a result during PSM I and PSM II which include testing, experiment, constricting a jig and etching a circuit.

Chapter 5 includes the discussion, conclusion and future improvement for this research project.

CHAPTER II

LITERATURE REVIEW

2.0 Tomography Technique

Tomography techniques vary widely in their instrumentation and applications, all of them can be characterized by a common two-step approach to the imaging process; firstly gather projection data based on some physical sensing mechanism, then reconstruct a cross sectional image from the projections. The term "projection" has a specific meaning in tomography which a projection can be visualized as type of radiography of the process vessel [4].

In tomography, many projections are needed to reconstruct the interior volume or cross-section of an object. Projections actually can be referred as sensor arrangement. In practical systems, there are two types of projection that have been investigated and applied to measure flame, which are:

1. Parallel projection.
2. Fan bean projection.

For parallel projection, the number of emitter and receiver are the same. Each pair of trans-receiver is arranged in a straight line and the received signal

Only correspond to its emitter source, while for fan beam projection, the number of emitter and receivers can be unequal [5].

Nevertheless, the fan beam projection technique provides a higher resolution system compared to the same number of sensors used in parallel projection due to high obtaining information several projections are needed to reduce aliasing which occurs when two particles intercept the same view. [6]

However from both methods it can be illustrated into a various techniques of arrangement which all of that has been widely investigated to implement into flow imaging of conveying system. The various arrangements can be illustrated into six types of projection, which are:-

l. Two orthogonal projections (Figure2 .1)

2. Two rectilinear projections (Figure 2.2)

3. Three fan-beam projections (Figure2 .3)

4. Four fan-beam projections (Figure2.4)