

VISION BASED MAZE NAVIGATION USING NI-MYRIO

MUHAMMAD ZUL AZREN BIN SILAM

This Report Is Submitted In Partial Fulfillment of Requirements For
The Bachelor Degree in Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

June 2015



UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : **VISION BASED MAZE NAVIGATION USING NI-MYRIO**

Sesi Pengajian :

1	4	/	1	5
---	---	---	---	---

Saya **MUHAMMAD ZUL AZREN BIN SILAM** mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan () :

SULIT*

*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD**

** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

 (TANDATANGAN PENULIS)

 (COP DAN TANDATANGAN PENYELIA)

Tarikh:

Tarikh:

“I hereby that this report is the result of my own work except for quotes as cited in the references.”

Signature :

Author : MUHAMMAD ZUL AZREN BIN SILAM

Date : 11 JUNE 2015

“I hereby declare that I have read this and in my opinion this report is sufficient in term of the scope and quality for the award of Bachelor of Electronics Engineering.”

Signature :

Author : DR. SOO YEW GUAN

Date : 11 JUNE 2015

ACKNOWLEDGEMENT

Praise to God that with His blessings I am able to finish this project in time successfully. I would like to express my greatest gratitude to my supervisor Dr. Soo Yew Guan for his guidance in finishing this project. My next deepest appreciation is dedicated to my parents and family for their money and moral support. Thanks to my friend who had helped me a lot in finishing this project. Last but not least to whom directly or indirectly contribute to this project.

ABSTRACT

A vision based robot is a new technology that use image processing technique instead of using sensor. This to increase the various of application for the robot. Vision based robot mostly used for explore, for documentation, and so on. This project used Ni-myRIO from National Instruments as platform for the image processor. The existing type of this robot using robot that transfer the data and process by computer processor. The purpose of this project is to built a pocket-size image processing robot designed to be a navigation of a maze. The idea basically came from human. Human drive a car depends on a line to make sure the car in the middle of the lane and will turn according to the line. The methodology and scope of study are performed by doing literature reviews and research on various camera, motor, NI-myRIO, and the programming of the LabVIEW. Vision based Robot will have several criteria that are efficient, organized and user-friendly, which meets human needs.

ABSTRAK

Robot berdasarkan penglihatan ini adalah antara teknologi baru yang menggunakan teknik pemprosesan imej. Ini untuk mempelbagaikan aplikasi. Robot berdasarkan penglihatan ini kebiasaannya digunakan untuk meneroka, dokumentasi, dan lain-lain. Projek ini menggunakan NI-myRIO sebagai dari National Instruments sebagai platform untuk pemprosesan imej. Robot sedia ada jenis berdasarkan penglihatan ini menggunakan robot yang menghantar data ke komputer lalu diproses oleh pemproses komputer. Tujuan projek ini ialah untuk membina robot pemprosesan imej poket saiz digunakan untuk navigasi di dalam maze. Idea ini datang dari manusia. Manusia memandu kereta berpandukan kepada garisan untuk memastikan kereta berada di tengah-tengah garisan dan akan membelok berdasarkan garisan. Metodologi dan skop kajian dilakukan dengan melakukan tinjauan kesusasteraan dan penyelidikan mengenai kamera, motor, dan NI-myRIO. Robot berdasarkan penglihatan ini mempunyai beberapa kriteria seperti kecekapan yang tinggi, teratur dan mesra pengguna, yang memenuhi keperluan manusia.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	PROJECT TITLE	i
	DECLARATION	ii
	ACKNOWLEDGEMENT	v
	ABSTRACT	vi
	TABLE OF CONTENTS	viii
	LIST OF TABLE	xi
	LIST OF FIGURES	xii
I	INTRODUCTION	1
1.1	Background of Project	1
1.2	Introduction of Project	1
1.3	Objective of Project	2
1.4	Problem Statement	3
1.5	Scope of Project	3

II	LITERATURE REVIEW	5
2.1	Different Edge Detection Methodologies	5
2.1.1	First order edge detector	6
2.1.2	Second order edge detector	9
2.2	Vision Based System for Line Following Mobile Robot	11
2.3	Image Based Segmentation Of Indoor Corridor Floors For A Mobile Robot	13
2.4	Corridor Line Detection For Vision Based Indoor Robot Navigation	16
III	METHODOLOGY	20
3.1	General Process and Model Setup	21
3.2	Hardware	23
3.2.1	Webcam	23
3.2.2	NI-myRIO	23
3.2.3	DC Motor	25
3.3	Software	25
3.3.1	Decision making algorithm	28

IV	RESULT AND DISCUSSION	31
4.1	Raw image	31
4.2	Luminance image	34
4.3	Edge Detection	36
4.4	Threshold	38
4.5	Motor Connection	40
	4.5.1 Straight movement	41
	4.5.2 Reverse movement	42
	4.5.3 Turn right movement	43
	4.5.4 Turn left movement	45
4.6	Width Of The Maze	46
4.7	Pattern Matching	47
4.8	Discussion	49
V	CONCLUSION AND RECOMMENDATION	51
5.1	Conclusion	51
5.2	Recommendation for Future Research	52
	References	53
	Appendix A	

LIST OF TABLES

NO	TITLE	PAGE
4.2	Option values for color format mode	35
4.3	Option for Method	38
4.5	The connection of motor driver and NI-myRIO	38

LIST OF FIGURES

NO	TITLE	PAGE
2.1.1.1	Equation of first order	6
2.1.1.2	Equation of vector	6
2.1.1.3	Equation of gradient vector	6
2.1.1.4	Robert cross-gradient equation 1	6
2.1.1.5	Robert cross-gradient equation 2	7
2.1.1.6	Robert cross-gradient equation 3	7
2.1.1.7	Robert cross-gradient equation 4	7
2.1.1.8	Robert cross-gradient equation 5	7
2.1.1.9	Robert cross-gradient equation 6	7
2.1.1.10	A 3×3 area of an image.	8
2.1.1.11	The Roberts operators	8

2.1.1.12	The Prewitt operators	8
2.1.1.13	The Sobel operators	8
2.1.2.1	Second order derivative	9
2.1.2.2	Equation for 3 x 3 region 1 st	9
2.1.2.3	Equation for 3 x 3 region 2 nd	9
2.1.2.4	Two kind of 3 × 3 Laplacian mask	9
2.1.2.5	Gaussian function	10
2.1.2.6	Laplacian equation	10
2.1.2.7	Dimension coordinate of Laplacian of Gaussian (LOG).	10
2.1.2.8	Differentiation	11
2.2.1	Equation data	12
2.2.2	Sample of segmentation Image	12
2.3.1	Flowchart Of The Proposed Method For Floor Detection	13
2.3.2	Detection Algorithm Without Pruning	14
2.3.3	Detection Algorithm With Pruning	14
2.3.4	Gradient Magnitude Versus Intensity	15
2.3.5	Result Of Graph Based Segmentation	15
2.3.6	After Implement Proposed Method	16
2.4.1	Block Diagram Of The System	16
2.4.2	Original Intensity Image	17
2.4.3	Extracted Vertical Line	17

2.4.4	Extracted Horizontal Line	18
2.4.5	Corridor Line Hypothesis	18
2.4.6	Estimated Corridor Line	19
3.1.1	Model of Robot	21
3.1.2	General Block Diagram	22
3.2.1.1	Logitech C310 USB Webcam	23
3.2.3	Block Diagram of NI-myRIO	24
3.2.3.1	9V DC motor	25
3.3.1	LabVIEW coding for edge detection	26
3.3.2	Method in iMAQ edge detection VI	27
3.3.1.1	Flow chart of decision making algorithm	28
3.3.1.2	Webcam view region	29
4.1.1	Coding part that grab the image	31
4.1.2	iMAQdc Open Camera block diagram	32
4.1.3	iMAQdc Configure Grab block diagram	33
4.1.4	iMAQdc Grab block diagram	33
4.1.5	Raw Image	34
4.2.1	Block diagram that convert the image into luminance	35
4.2.2	Connection of iMAQ Extract Color Planes	35
4.2.3	Different of raw image and luminance image	36
4.3.1	Shows the edge detection block	36

4.3.2	iMAQ Edge Detection Block Diagram	37
4.3.3	Shows the output of the edge detection block	38
4.4.1	iMAQ Threshold block diagram	39
4.4.2	Shows output of Threshold block diagram	39
4.4.3	Different before and after Threshold block diagram	40
4.5.1	Connection of motor and motor driver.	40
4.5.1.1	LabVIEW coding for straight motor	42
4.5.1.2	Rotation of the motor	42
4.5.2.1	Coding for reverse movement	43
4.5.2.2	Rotation of the motor	43
4.5.3.1	Coding for turning right	44
4.5.3.2	Rotation of the motor	44
4.5.4.1	Coding for turn left	45
4.5.4.2	Rotation of the motor	45
4.6.1	iMAQ Clamp Horizontal Clamp block diagram	46
4.6.2	Image output	47
4.7.1	Image Template 1	48
4.7.2	Image Template 2	48
4.8.1	Frame rate for the whole process	49
4.8.2	Example of maze	50
6	Appendix A	54

CHAPTER 1

INTRODUCTION

1.1 Background of Project

Vision-based navigation for mobile robot uses to navigate the mobile robot based on track line. The idea to develop this project is from people drive a vehicle. The line on the road is becoming their guide to follow during driving. On human body, they have their eyes to visualize the image of road line and analyze by human's brain but robot uses camera to capture image of line and analyze by computer or embedded system.

The application of this project is in autonomous or unmanned robot. The robot will move based on vision-based navigation. The vision-based navigation or called by image processing will be done by the robot and will be the guide for the robot to move.

1.2 Introduction of Project

Vision-based navigation for line following robot is the fundamental independent versatile robot. It is suitable for the individuals in learner to plan or create a dream versatile robot. In spite of the fact that it stills truly a fundamental portable robot yet the

vital things that it needs to attain that the dependable, adaptable and quick reaction contrast and other versatile robot had been produced.

Vision-based navigation has been utilized as a part of unmanned or self-ruling vehicle. In this century, individuals began concentrate more points of interest to execute vision into independent vehicle. The focal points of this application are to stay away from the mischances and expand security by wiping out human misstep. In this extend, the fundamental objective is to create a portable robot which has capacity to explore focused around reference line or predefined way. Prior to this, there are numerous self-sufficient portable robots had created. Large portions of them utilized vision, infrared or ultrasonic sensors as their sensors to distinguish way. Each of sensors has its confinements and points of interest. On the off chance that we analyze among these sensors, the vision is superior to others focused around its adaptability. This is the fundamental component that numerous analysts changed infrared and ultrasonic sensors to vision sensor. Other than that, this task additionally presents the least difficult algorithm and technique to process the data particularly for image processing.

When we have utilized a dream sensor as a part of portable robot so we have to process and break down the picture that we have captured. It called as image processing. Image processing is one of the essential courses of action for line emulating versatile robot that uses a dream. It will impact the execution of this task including response, flexible, reliable and so on. Because of that, simple technique and algorithm for image processing will produce faster response but it doesn't determine either it more reliable or not. This project presents the simplest technique and algorithm but didn't affect the reliable and flexible.

1.3 Objective of Project

1. To develop an algorithm for vision-based navigation using LabVIEW software and NI-myRIO hardware.

2. To develop a robot for evaluating the proposed method
3. To build a stand-alone robot that can do image processing itself.

1.4 Problem Statement

In this century, there is a lot of navigation or line following mobile robots has been created. The issue is their mobile robots takes time in its decision so that it can't move quick. In other word, we called as processing time. Processing time is measured from the information has identified until produce the output. One of the reasons it takes low reaction time is their algorithm or technique excessively perplexing where it needs a period to finish it despite the fact that its more dependable.

Besides, they had confronted issue that the development of their mobile robot still unpleasant. It is happened due to their algorithm or system didn't deliver a shut yield to match with state of track where precisely take after the track. For instance the track has bended to the left yet the versatile robot turned to left ahead of schedule than it ought to be or its point not suitable with the bend of track. So it will be out from the track.

Lastly, most of the mobile robot created using computer processing unit to do an image processing. That means, the robot not a stand-alone robot and need a device or components that connect the robot and computer processing unit. So when the robot is far or the computer have problem, the robot cant be functioning.

1.5 Scope of Project

There are 3 major parts in vision-based navigation robot. First are the input, controlling unit, and lastly output. Each section has divided into subsections which are proposed to achieve their own goals. For input part, a webcam been used as a vision

sensor. The purpose using vision sensor as input is acts as a detector for reference line. In this project, the reference line is the edge detection.

For controlling unit, NI-myRIO been used as a controlling unit. NI-myRIO also will be used as a device that do image processing. This part is the important part, where the software used is LabVIEW. All the coding are in virtual instrument. Lastly is the output. Motor of the robot will be the output of this project. The movement of the robot either to move forward,backward, left or right, depends on the output of controlling unit.

CHAPTER 2

LITERATURE REVIEW

2.1 Different Edge Detection Methodologies

Edge detection is a basic tool used in image processing, basically for feature detection and extraction, which aim to identify points in a digital image where brightness of image changes sharply and find discontinuities. The purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties for further image processing. In a grey level image the edge is a local feature that, with in a neighborhood separates regions in each of which the gray level is more or less uniform with in different values on the two sides of the edge. For a noisy image it is difficult to detect edges as both edge and noise contains high frequency contents which results in blurred and distorted result.

Edge detection makes use of differential operators to detect changes in the gradients of the grey levels. It is divided into two main categories:

1. First order edge detector/Gradient based operator
2. Second order edge detector/Laplacian based operator

2.1.1 First order edge detector

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}.$$

Figure 2.1.1.1 Equation of first order

An important quantity in edge detection is the magnitude of this vector, denoted $|\nabla f|$, Where

$$|\nabla f| = \sqrt{G_x^2 + G_y^2}.$$

Figure 2.1.1.2 Equation of vector

Another important quantity is the direction of the gradient vector. That is,

$$\text{angle of } \nabla f = \tan^{-1} \left(\frac{G_y}{G_x} \right)$$

Figure 2.1.1.3 Equation of gradient vector

Computation of the gradient of an image is based on obtaining the partial derivatives of $\partial f/\partial x$ and $\partial f/\partial y$ at every pixel location. Let the 3×3 area shown in Fig. 2.1.1.1 represent the gray levels in a neighborhood of an image. One of the simplest ways to implement a first-order partial derivative at point z_5 is to use the following Roberts cross-gradient operators:

$$G_x = (z_9 - z_5)$$

Figure 2.1.1.4 Robert cross-gradient equation 1

And

$$G_y = (z_8 - z_6)$$

Figure 2.1.1.5 Robert cross-gradient equation 2

These derivatives can be implemented for an entire image by using the masks shown in Fig. 2.1.1.2 with the procedure of convolution. Another approach using masks of size 3×3 shown in Fig. 2.1.1.3 which is given by

$$G_x = (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$$

Figure 2.1.1.6 Robert cross-gradient equation 3

And

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7)$$

Figure 2.1.1.7 Robert cross-gradient equation 4

a slight variation of these two equations uses a weight of 2 in the center coefficient:

$$G_x = (z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_3)$$

Figure 2.1.1.8 Robert cross-gradient equation 5

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7)$$

Figure 2.1.1.9 Robert cross-gradient equation 6

A weight value of 2 is used to achieve some smoothing by giving more importance to the center point. Fig.2.1.1.4, called the Sobel operators, is used to implement these two equations.

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Figure 2.1.1.10 A 3×3 area of an image.

0	0	0
0	-1	0
0	0	1

0	0	0
0	0	-1
0	1	0

Figure 2.1.1.11 The Roberts operators.

-1	-1	-1
0	0	0
1	1	1

-1	0	1
-1	0	1
-1	0	1

Figure 2.1.1.12 The Prewitt operators.

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Figure 2.1.1.13 The Sobel operators.

2.1.2 Second order edge detector

The Laplacian of a 2-D function $f(x, y)$ is a second-order derivative defined as

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

Figure 2.1.2.1 Second order derivative

There are two digital approximations to the Laplacian for a 3×3 region:

$$\nabla^2 f = 4z_5 - (z_2 + z_4 + z_6 + z_8)$$

Figure 2.1.2.2 Equation for 3 x 3 region 1st

$$\nabla^2 f = 8z_5 - (z_1 + z_2 + z_3 + z_4 + z_6 + z_7 + z_8 + z_9)$$

Figure 2.1.2.3 Equation for 3 x 3 region 2nd

where the z 's are defined in Fig. 2.1. Masks for implementing these two equations are shown in Fig. 2.1.2.4

0	-1	0
-1	4	-1
0	-1	0

(a)

-1	-1	-1
-1	8	-1
-1	-1	-1

(b)

Fig. 2.1.2.4 Two kind of 3×3 Laplacian mask.