

**IMPLEMENTATION CAMERA VISION FOR OBJECT TRACKING
IN QUADRUPEL ROBOT**

By

Jason Fernandez Tatuil Gosal
11110041

BACHELOR'S DEGREE
in

MECHANICAL ENGINEERING – MECHATRONICS CONCENTRATION
FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY
EduTown BSD City
Tangerang 15339
Indonesia

Revision after the Thesis Defence on 25th January 2017

STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.

Jason Fernandez Tatuil Gosal

Student

Date

Approved by:

Dr. Rusman Rusyadi, B.Eng., M.Sc

Thesis Advisor

Date

Erikson Ferry S. Sinaga, ST., M. Kom

Thesis Co-Advisor

Date

Dr.Ir. Gembong Baskoro, M.Sc.

Dean

Date

ABSTRACT

IMPLEMENTATION CAMERA VISION FOR OBJECT TRACKING IN QUADRUPED ROBOT

By

Jason Fernandez Tatuil Gosal

Dr. Rusman Rusyadi, B.Eng., M.Sc, Thesis Advisor

Erikson Ferry S. Sinaga, ST., M. Kom, Thesis Co-Advisor

SWISS GERMAN UNIVERSITY

The purpose of this thesis is to develop a quadruped robot and to implement camera vision system for object tracking. The camera vision system intended to be used for tracking an object while the legged robot will be move to follow the object.

The main scope of the thesis is the development of the camera vision system which enables the robot to tracking a particular object and the performance of the robot while moving.

The robot will be controlled manually using Laptop and automatically by using camera to detect object. The input command will be transmitted wirelessly using Wi-Fi adapter as the communication media.

Keywords: Legged Robot, Quadruped Robot, Inverse Kinematics, Object Tracking



DEDICATION

I dedicate this works for the almighty God, myself, my family, my lecturers, SGU, my country Indonesia, and to all the people who supported me and gave me the opportunity to learn.



ACKNOWLEDGEMENTS

I wish to thank you for the almighty God for his guidance and blessing that allow me to finish this Thesis.

I also wish to thank you my family who always support me both spiritually and financially.

My Deepest gratitude for Dr. Rusman Rusyadi, B.Eng., M.Sc, my thesis advisor, who has guided me during the process of making this thesis and for his advices in programming, software troubleshooting, and always supports me to finish the thesis.

I also like to thank Mr. Erikson Ferry S. Sinaga, ST., M. Kom, my thesis co-advisor who has given advices and encouragement to me to finish the thesis.

Lastly to Reza Divasa Putra, ST., Linda Wijaya Jong ST., B.Eng., Muhammad Dana Dhanugraha, Gregorius Bayuputra, Cepi Mohamad Hanafi, S.S.T., MT , Herfianto Ng and all of my friends and colleagues that help me in the making of this thesis work.

Without all those who are listed above, this thesis would not have been completed.

TABLE OF CONTENTS

	Page
STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGEMENTS.....	6
TABLE OF CONTENTS.....	7
LIST OF FIGURES.....	11
CHAPTER 1 - INTRODUCTION.....	14
1.1 Background.....	14
1.2 Thesis Objectives.....	14
1.3 Thesis Problem.....	14
1.4 Thesis Scope.....	15
1.5 Thesis Limitation.....	15
1.6 Thesis Structure.....	15
CHAPTER 2 - LITERATURE REVIEW.....	17
2.1 Introduction.....	17
2.2 Legged Robot [1].....	17
2.3 Previous Studies.....	18
2.3.1 Hexapod Robot with Distribute Control System [2].....	18
2.3.2 Quadrupedal Robot with Speech Recognition Movement Control [3].....	19
2.3.3 An Object Tracking System Based on Image Processing [4].....	19
2.3.4 Obstacle Avoidance Using Vision System in MiniPC For Mobile Robot [5]	20
2.3.5 Colour Object Tracking On Embedded Platform Using OpenCV [6].....	21
2.3.6 Conclusion.....	21
CHAPTER 3 - RESEARCH METHODS.....	23
3.1 Introductions.....	23
3.2 Mechanical Design.....	24
3.2.1 Body Platform.....	24
3.2.2 Leg Parts.....	25
3.2.2.1 Coxa.....	25
3.2.2.2 Femur.....	26

3.2.2.3	Tibia	26
3.2.3	Degree of Freedom	27
3.2.4	Torque Calculation	29
3.2.5	Material	33
3.2.6	Movement Control Algorithm	34
3.2.6.1	Cartesian Coordinate System	35
3.2.6.2	Body Inverse Kinematics	35
3.2.6.3	Leg Inverse Kinematics.....	39
3.2.7	Leg Movement Gait.....	41
3.2.7.1	Defining Initial Leg Sequence.....	42
3.2.7.2	Creep Gait	43
3.2.7.3	Trot Gait	45
3.3	Electrical Design.....	46
3.3.1	Electrical System.....	46
3.3.2	Servo Motor.....	47
3.3.3	Power Supply	49
3.3.4	Web Camera	51
3.4	Software	51
3.4.1	Communication Program	51
3.4.2	Object Tracking Program	52
3.4.2.1	Image Processing.....	53
3.4.2.2	Object Tracking Movement Rules	55
3.4.2.3	Server Program.....	58
3.4.3	Servo Controller Program	59
3.4.3.1	Inverse Kinematics Algorithm	61
3.4.3.2	Client Program	63
CHAPTER 4	- RESULTS AND DISCUSSIONS	64
4.1	General Overview	64
4.2	Mechanical Results and Discussion.....	64
4.2.1	Quadruped robot body platform mechanical result.....	64
4.2.2	Quadruped robot leg part mechanical result.....	65
4.2.3	Quadruped robot assembly result	66
4.2.4	Friction Problems	67

4.3 Electrical Test and Results	68
4.3.1 Servo Motor Current-Load Consumption Test	68
4.3.2 Servo Motor Current-Speed Consumption Test	70
4.4 Program Test and Results	72
4.4.1 Graphical User Interface (GUI)	72
4.4.1.1 Advance Scanner	73
4.4.1.2 Setting	74
4.4.1.3 Working Configuration	74
4.4.2 Performance Tests and Results	77
4.4.3 Gait Movement Accuracy and Speed Test	77
4.4.3.1 Creep Long Gait Accuracy and Speed Test	78
4.4.3.2 Trot Gait Accuracy and Speed Test	79
4.4.4 Object Tracking Test	79
4.4.4.1 Forward and Backward Test	80
4.4.4.2 Move Left and Move Right Test	80
4.4.4.3 Rotate Left and Rotate Right Test	81
4.4.4.4 Look Up and Stop Test	82
4.4.5 Implementation of Object Tracking in Quadruped Test	82
4.4.5.1 Forward Movement Test	84
4.4.5.2 Backward Movement Test	86
4.4.5.3 Move Right Movement Test	88
4.4.5.4 Move Left Movement Test	89
CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS	92
5.1 Conclusions	92
5.2 Recommendations	92
GLOSSARY	94
REFERENCES	97
APPENDIX	99
Appendix A. Datasheet	100
A1. Datasheet of Dynamixel AX-12A	100
Appendix B. TECHNICAL DRAWINGS	122
B1. Body Frame Design	122
B2. Leg Part 1 Design	123
B3. Leg Part 2 Design	124

Appendix C. Program code.....	125
C1. Thesis Work - Quadruped Framework_Jason.....	125
C1.1 Mainwindow.cpp	125
C1.2 Thesis Work - OpenCV_Object_Tracking_Jason	189
Appendix D. Bill of Materials	196
CURRICULUM VITAE.....	197

