

DEVELOPMENT OF SWARM ROBOT BASED ON ROBOT OPERATING SYSTEM

By

Kevin Ramli Lie
11401056

BACHELOR'S DEGREE
in
MECHANICAL ENGINEERING –
MECHATRONICS
CONCENTRATION

FACULTY OF ENGINEERING AND
INFORMATION TECHNOLOGY



SWISS GERMAN UNIVERSITY
The Prominence Tower
Jalan Jalur Sutera Barat No. 15, Alam Sutera
Tangerang, Banten 15143 - Indonesia

July 2019

Revision After Thesis Defense on July 16th, 2019

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.

Kevin Ramli Lie

Student

Date



Dr. Rusman Rusyadi

Thesis Advisor

Date

Maulahikmah Galinium, S.Kom, M.Sc, PhD.

Dean

Date

ABSTRACT

DEVELOPMENT OF SWARM ROBOT BASED ON ROBOT OPERATING SYSTEM

By

Kevin Ramli Lie
Dr. Rusman Rusyadi, Advisor



The purpose of this thesis is to design a program to follow another robot or any other obstacle that can be recognized by the robot. This thesis also focuses on Robot Operating System (ROS) at which the program will capture the image of the obstacle or another robot and follow it according to the swarm behavior.

Keywords : swarm, robot operating system (ROS), programming)



© Copyright 2019
by Kevin Ramli Lie
All rights reserved



I dedicate this work to my family, friends, students of Kumon and the future of
Mechatronics Engineering in Swiss German University.

ACKNOWLEDGEMENTS

I would like to give special thanks to almighty Buddha for the blessings and support throughout my entire thesis work.

I would also want to thank my family for their constant support, motivation and financial support. They are the ones who always helped me and took care of me in every way possible.

I would also want to thank all my friends and students for their constant encouragement and cheer messages to me. Those words meant a lot to me especially when I am feeling down during this thesis work preparation.

I would also like to thank Dr. Rusman Rusyadi for his constant care and guidance throughout my thesis work. His advice and help meant a lot for the process of this thesis.

Without all those people listed above, this thesis would not be completed.

TABLE OF CONTENTS

Contents

DEDICATION.....	5
CHAPTER 1-INTRODUCTION.....	12
1.1 Background.....	12
1.2 Thesis Purpose.....	12
1.3 Research Problems.....	13
1.4 Research objectives.....	13
1.5 Significance of study.....	13
1.6 Research questions.....	14
1.7 Hypothesis.....	14
1.8 Thesis organization.....	15
CHAPTER 2-LITERATURE REVIEW.....	15
2.1 Swarm intelligence.....	15
2.2 Ubuntu OS (Operating System).....	16
2.2.1 Understanding Ubuntu.....	17
2.2.2 Unity.....	17
2.3 Robot Operating System (ROS).....	18
2.3.1 ROS Package.....	18
2.3.2 ROS Topic.....	18
2.3.3 ROS Messages.....	18
2.3.4 ROS Nodes.....	19
2.3.5 ROS Kinetic Kane.....	19
2.3.6 Rosserial.....	19
2.3.6.1 Client libraries.....	19

2.3.6.2 ROS_side interfaces.....	19
2.3.6.3 Limitations for maximum size of message and maximum number of subscribers.	19
2.3.7 ROS_lib Arduino.....	20
2.3.8 Rospy.....	20
2.3.9 RQT Tools.....	20
2.4 Vision System.....	21
2.4.1 OpenCV.....	21
2.4.2 Pyzbar.....	21
2.4.3 PS3 Eye Camera.....	21
2.5 Arduino.....	22
2.5.1 Arduino Nano.....	22
2.5.2 Serial Communication.....	22
2.5.3 PWM.....	23
2.6 Motor Driver.....	24
2.6.1 Direction of DC Motor rotation.....	24
2.6.2 Speed of DC Motor rotation.....	25
2.7 Encoder.....	25
2.8 IMU.....	26
2.9 DC Motor.....	26
CHAPTER 3 -METHODOLOGY.....	27
3.1 Software Design.....	27
3.1.1 Robot Operating System.....	27
3.1.2 ROS to Arduino.....	28
3.1.3 rqt tools.....	29
3.1.3.1 rqt graph.....	29
3.1.4 OpenCV.....	30

3.1.5 Pyzbar.....	31
3.1.6 Arduino Subscriber.....	32
3.2 Mechanical Design.....	32
3.3 Electrical Design.....	34
CHAPTER 4-RESULTS AND DISCUSSIONS.....	35
4.1 High Level Testing.....	35
4.1.1 Vision Subsystem Testing.....	35
4.1.1.1 Distance testing.....	36
4.1.1.2 Tracking testing.....	38
4.1.1.3 Conclusion.....	40
4.2 Low Level Testing.....	41
4.2.1 Sensor Subsystem Testing.....	41
4.2.1.1 Wheel Encoder Testing.....	41
4.2.1.2 IMU Testing.....	42
4.2.1.3 Ultrasonic Sensor Test.....	44
4.2.1.4 Conclusion.....	45
CHAPTER 5-CONCLUSIONS AND RECOMMENDATIONS.....	46
5.1 Conclusions.....	46
5.2 Recommendation and future development.....	47
APPENDICES.....	48
APPENDIX A-Programming Code.....	48
A.1 dd_robot_rviz.launch.....	48
A.2 Tracking2.py.....	48
A.3 robotfix.urdf.....	54
A.4 Cmakelist.txt.....	59
A.5 packages.xml.....	63

A.6 arduino_driver.py.....	65
A.7 arduino_sensors.py.....	73
A.8 Base_controller.py.....	79
A.9 arduino_node.py.....	85
A.10 RosArduinoBridge.ino.....	90
A.11 Encoder_driver.....	98
A.12 Motor.ino.....	100
A.13 RosArduino.ino.....	100

LIST OF FIGURES

Figures	Page
2.1. Ubuntu 16.04 Default Desktop.....	17
2.2. ROS.....	18
2.4.1 OpenCV.....	21
2.4.3 PS3 Eye Camera.....	21
2.5.1 Arduino Nano.....	22
2.5.2 Serial communication between 2 Arduinos.....	23
2.5.3 Pulse Width Modulation.....	24
2.7.1 Speed Encoder.....	25
2.8 Oculus Rift IMU.....	26
2.9 Brushless DC Motor.....	26
3.1.1 Robot Operating System.....	27
3.1.2 ROS to Arduino.....	29
3.1.3.1 rqt graph.....	30
3.1.4 OpenCV.....	31
3.2.1 Mechanical Design (Top View).....	32

3.2.1 Mechanical Design (Back View).....	33
3.2.1 Mechanical Design (Perpective View).....	33
3.2.1 Mechanical Design (Side View).....	34
3.3 Electrical Design.....	34
4.1.1.1 Distance Testing 1.....	36
4.1.1.1.2 Distance Testing 2.....	36
4.1.1.2.1 Tracking Testing 1.....	38
4.1.1.2.2 Tracking Testing 1.....	39
4.1.1.2.3 Tracking Testing 1.....	39
4.2.1.1 IMU Testing 1.....	42
4.2.1.2 IMU Testing 1.....	43
4.2.1.3 Ultrasonic Sensor Test.....	44
4.2.1.3 Ultrasonic Sensor Test 2.....	44

LIST OF TABLES
SWISS GERMAN UNIVERSITY

Table	Page
2.3.6.3 Comparison of buffer sizes and subscribers with different chip models	20
2.6.2 Speed of DC Motor rotation.....	25
4.1.1 Distance Test.....	37
4.1.2 Tracking Test.....	40
4.2.1.1 Wheel encoder testing...	41
4.2.1.2.1 IMU Testing.....	42
4.2.1.2.2 Tracking test with IMU companion.....	44