

**DEVELOPMENT OF OBJECT DETECTION, TRACKING, AND PATH
PLANNING IN AN AUTONOMOUS TRASH CATCHER**

By

Jean Gabriel Dufresse
11109022

A thesis submitted to the Faculty of

ENGINEERING AND INFORMATION TECHNOLOGY

in partial fulfillment of the requirements
for the
BACHELOR'S DEGREE
in

MECHATRONICS ENGINEERING

SWISS GERMAN UNIVERSITY



SWISS GERMAN UNIVERSITY
EduTown BSD City
Tangerang 15339
Indonesia

Revision after Thesis Defence On 24 July 2013

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.

Jean Gabriel Dufresse

Student

Date

Approved by:

Erikson F. Sinaga, ST, M. Kom.

Thesis Advisor

Date

Dr. Rusman Rusyadi, ST, M. Sc.

Thesis Co-Advisor

Date

Dr. Ir. Gembong Baskoro, M. Sc.

Dean

Date

Jean Gabriel Dufresse

ABSTRACT

DEVELOPMENT OF OBJECT DETECTION, TRACKING, AND PATH PLANNING IN AN AUTONOMOUS TRASH CATCHER

By

Jean Gabriel Dufresse

Erikson F. Sinaga, ST, M. Kom. Advisor

Dr. Rusman Rusyadi, ST, M. Sc. Co-Advisor

SWISS GERMAN UNIVERISTY

The objective of this thesis work is to develop the tracking of the object based on colour detection and develop the path planning based on prediction made by the kalman filter in order to catch the thrash automatically with the Autonomus Thrash Cachter. Furthermore the steering concept of the mobile robot will be developed in order to archive this purpose

Here the focus will be on developing and analyzing the use of Kinect Sensor in providing data and information required for 3D input to the Kalman Filter function and Analyzing the Kalman Filter Performance

SWISS GERMAN UNIVERSITY

Keyword: Kinect, Colour Tracking, Mobile Robot, Prediction, Kalman Filter



DEDICATION

I dedicate this thesis to God, my parents, my sister, and all of my friends



ACKNOWLEDGMENTS

The author wishes to God for all of His grace and blessing throughout the entire thesis work.

I wish to express my gratitude to Erikson Sinaga, ST, M.Kom and Dr. Rusman Rusyadi for their help and advice throughout the process of the thesis. Special thanks to Nicolaus Kevin to help, and give me a lot of support.

Many thanks and gratitude to my beloved parents, Vincent and Steffi, and sister, Margareta, who always encouraged and prayed for me, support the financial needs of this thesis and take care of me in every way.

I also wish to thank all my colleagues in Mechatronics Batch 2009. Also all of my best friends, Eric Permadi, William Tjiu, Fani Kurniawan Mista, Sutrisno Citra, Kevin Marcelino, Nicolaus Kevin, for supporting me all the time.

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



SWISS GERMAN UNIVERSITY

TABLE OF CONTENTS

STATEMENT BY THE AUTHOR.....	2
ABSTRACT.....	3
DEDICATION.....	5
ACKNOWLEDGMENTS.....	6
TABLE OF CONTENTS.....	7
CHAPTER 1 – INTRODUCTION.....	13
1.1 Background.....	13
1.2 Thesis Purpose.....	13
1.3 Thesis Scope.....	13
1.4 Thesis Limitation.....	14
1.5 Thesis Structure.....	14
CHAPTER 2 - LITERATURE REVIEW.....	15
2.1 Introduction of Kinect.....	15
2.1.1 History of Kinect.....	15
2.1.2 Data Produced by Kinect.....	16
2.2 Structured-Light 3D Scanning.....	18
2.3 Kinect Depth Sensing.....	19
2.4 Combining Kinect with Open CV.....	20
Object tracking.....	20
2.4.1 Color Based Object Tracking.....	21
Different Format of Colour.....	21
2.4.2 Contour Tracking.....	24
2.5 Methods for driving mobile Robot.....	25
2.5.1 Ackermann Steering.....	25
2.5.2 Differential Driving.....	26
2.5.3 Omni Wheel Driving.....	26
2.6 Kalman Filter.....	27
2.6.1 kalman Filter Introduction.....	27
2.6.2 Kalman Filter Constant, Input, and Output.....	28
2.6.3 Kalman Filter Formula.....	29
2.7 Previous Project Related to Thesis.....	30
2.7.1 Kinect Controlled Trash Can.....	30
2.7.2 Autonomus Mobile Robot.....	31
CHAPTER 3 – RESEARCH METHODS.....	33
3.1 General Overview.....	33
3.2 Mechanical Design.....	36
3.2.1 Base Plate.....	36
3.2.2 Upper Body.....	37
3.2.3 Top Cover.....	38
3.3 Electrical Design.....	38
3.3.1 Arduino Uno R3.....	39
3.3.2 Compass Module - HMC6352.....	41
3.3.3 EMS 2A H Bridge.....	42
3.3.4 Pololu DC Motor.....	43
3.3.5 Pololu Encoder.....	45

3.3.6 Power Supply	47
3.3.7 Electrical Interconnection	48
3.4 Control Strategy	48
3.4.1 Differential Drive Control Strategy	49
3.4.2 Pivot Drive Control Strategy	51
3.5 Software Design.....	54
3.5.1 Differential Drive software	55
3.5.2 Pivot Drive Software.....	57
3.5.3 Detecting and Tracking Strategy based on Colour Detection.....	60
3.5.4 Depth Image and RGB Image processing.....	61
3.5.5 Get Real World Position of the Object	65
3.5.6 Kalman Filter	67
3.5.7 Projectile Motion in Kalman Filter	68
3.5.8 QT Serial Port	69
3.5.9 QT User Interface	71
CHAPTER 4 – RESULT AND DISCUSSION.....	73
4.1 General Overview	73
4.2 Mechanical Result and Discussion	73
4.2 Electrical Result and Discussion.....	75
4.2.1 Encoder Test Result	75
4.2.2 Motor Starting Current Test Result.....	76
4.2.3 Xbee Range and Obstacles Test Result	77
4.3 Kinect Sensor Experiment and Result	79
4.3.1 Kinect Distance Calibration Result for Real World Coordinate.....	79
4.3.2 Kinect Angle of View Calibration Result.....	82
4.4 Programming Result and Discussion	83
4.4.1 Noise Filtering Result with Fill Color Function	83
4.4.2 Kalman Filter Result	86
4.5 Robot Performance Result and Discussion.....	89
4.5.1 Moving Forward Test Result	89
4.5.2 Turning Test Result.....	96
CHAPTER 5 – CONCLUSION AND RECOMMENDATION.....	99
5.1 Conclusion	99
5.2 Recommendation and Future Development.....	100
GLOSARRY.....	101
REFERENCE.....	102
OTHER USEFUL LINKS.....	103
APPENDIX A – MECHANICAL DESIGN.....	105
A.1 Base Plate	105
A.2 Upper Body	106
APPENDIX B – DATA SHEET.....	107
B.1 Arduino Uno R3	107
B.2 ATmega328.....	115
B.3 Xbee Wireless Module	117
B.4 EMS 2A HBridge	120
B.5 Pololu Encoder	125
B.6 HMC6352 Compass Module.....	131

APPENDIX C – PROGRAM CODE.....	135
C.1 MainWindow.cpp.....	135
C.2 ProcessingThread.cpp	138
C.3 KalmanFilter.cpp.....	141
C.4 Arduino Code	142
APPENDIX D – BILL OF MATERIAL.....	145
CURRICULUM VITAE.....	146

