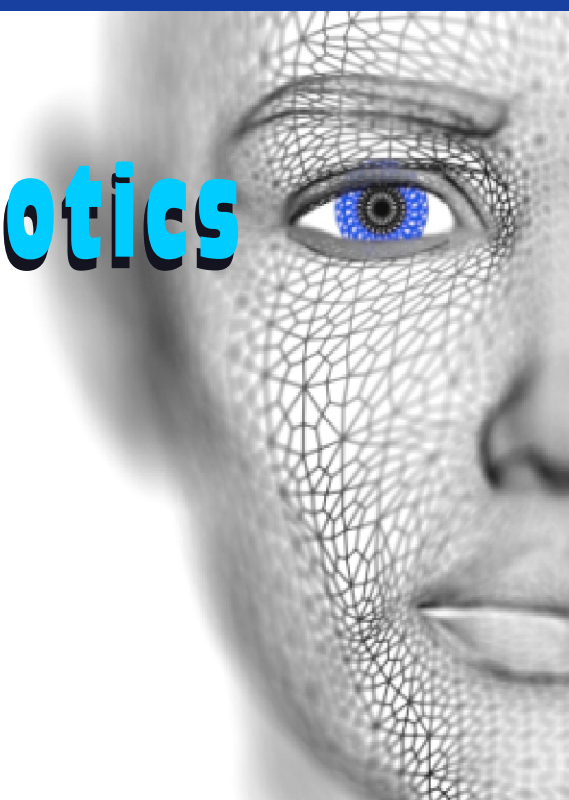


Modern Robotics with OpenCV

Widodo Budiharto



Modern Robotics with OpenCV

Widodo Budiharto

Science Publishing Group
548 Fashion Avenue
New York, NY 10018
<http://www.sciencepublishinggroup.com>

Published by Science Publishing Group 2014

Copyright © Widodo Budiharto 2014

All rights reserved.

First Edition

ISBN: 978-1-940366-12-8

This work is licensed under the Creative Commons Attribution-NonCommercial 3.0 Unported License. To view a copy of this license, visit

<http://creativecommons.org/licenses/by-nc/3.0/>



or send a letter to:
Creative Commons
171 Second Street, Suite 300
San Francisco, California 94105
USA

To order additional copies of this book, please contact:
Science Publishing Group
service@sciencepublishinggroup.com
<http://www.sciencepublishinggroup.com>

Printed and bound in India

Preface

Robotics is an interesting topic today. This book is written to provide an introduction to intelligent robotics using OpenCV. This very useful book intended for a first course in robot vision and covers modeling and implementation of intelligent robot. The need for this textbook arose from teaching robotics to student and hobbyist for many years and facing the difficulty to provide excellent book to explain advanced technology in intelligent robotics and kinematics of the robot.

This book differs from other robot vision textbooks:

- Its content is consisting of many implementations of mobile robot and manipulator using OpenCV.
- Using newest technology in Microcontroller such as Propeller Microcontroller for robotics.
- Its content is consisting of introduction and implementation of OpenCV described clearly.

This textbook is the result of many years of work, research, software development, teaching and learning. Many people have influenced its outcome in various ways. First, I must acknowledge my rector at Binus University, Prof. Dr. Harjanto Prabowo for his support, and my supervisors and friends. Some of my undergraduate students have also offered assistance to this book. Finally, a word of recognition goes to parent, my wife, and my children Tasya, Shafira, Aziz and Yusuf.

Jakarta-Indonesia, 2014

Dr. Widodo Budiharto¹

¹ Dr. Widodo Budiharto, School of Computer Science, Bina Nusantara University, Jakarta-Indonesia
Email: wbudiharto@binus.edu

Contents

Preface	III
Chapter 1 Introduction to Intelligent Robotics.....	1
Introduction	3
History of Robot	3
Types of Robot	7
Embedded Systems for Robot	12
Robot Vision.....	15
Exercises.....	18
References	18
Chapter 2 Propeller Microcontroller.....	19
Introduction	21
Introduction of Propeller Chip.....	21
Programming the Propeller.....	26
Exercises.....	30
Reference.....	31
Chapter 3 Basic Programming Robot	33
Introduction	35
Robot's Actuators.....	35
DC Motor.....	35
Servo Motor.....	37
Programming Motors of Robot.....	39
Sensors for Intelligent Robot.....	43
Ultrasonic Distance Sensor: PING)))™	43
Compass Module: 3-Axis HMC5883L	50
Gyroscope Module 3-Axis L3G4200D.....	54
PID Controller for the Robot.....	61

Exercises.....	62
References	62
Chapter 4 Serial Communication with Robot.....	63
Introduction	65
Serial Interface Using Microsoft Visual Basic/C# .Net.....	65
Wireless Communication for Robot.....	72
433 MHz Transceiver	72
XBee Transceiver.....	73
RN-42 Bluetooth Module	74
Exercises.....	75
References	75
Chapter 5 Mechanics of Robots	77
Introduction	79
Introduction of Gears.....	79
Types of Gears.....	81
Rack and Pinion Gears.....	82
Arm Geometries	83
Kinematics of Robot.....	85
References	85
Chapter 6 Introduction to OpenCV.....	87
Introduction	89
Introduction of OpenCV	90
Digital Image Processing.....	97
Edge Detection	100
Optical Flow	105
References	108
Chapter 7 Programming OpenCV.....	109
Introduction	111
Morphological Filtering.....	111

Camshift for Tracking Object.....	115
References	122
Chapter 8 Extracting the Component’s Contours for Calculating Number of Objects.....	123
Introduction	125
Introduction of Contours	125
Counting Objects.....	127
References	130
Chapter 9 Face Recognition Systems.....	131
Introduction	133
Face Recognition in OpenCV.....	133
Haar Cascade Classifier.....	135
Face Features Detector	144
Face Recognition Systems.....	151
Rapid Object Detection with a Cascade of Boosted Classifiers Based on Haar-like Features	152
Negative Samples.....	153
Positive Samples	153
Training.....	156
Test Samples	158
Exercises.....	159
References	160
Chapter 10 Intelligent Humanoid Robot.....	163
Introduction	165
Humanoid Robot	165
The Architecture of the Humanoid Robot	167
Ball Distance Estimation and Tracking Algorithm	170
A Framework of Multiple Moving Obstacles Avoidance Strategy	171
Experiments	173
Object Detection Using Keypoint and Feature Matching.....	177

References	183
Chapter 11 Vision-Based Obstacles Avoidance	185
Introduction	187
Obstacle Avoidance of Service Robot.....	187
Stereo Imaging Model	190
Probabilistic Robotics for Multiple Obstacle Avoidance Method.....	192
Multiple Moving Obstacles Avoidance Method and Algorithm	193
Multiple Moving Obstacle Avoidance Using Stereo Vision	198
References	201
Chapter 12 Vision-Based Manipulator	203
Introduction	205
Inverse Kinematics	205
Vision-Based Manipulator.....	206
Grasping Model	208
Exercise	212
References	213
Glossary	215