

CONTENTS IN DETAIL

ACKNOWLEDGMENTS	XIII
FOREWORD	XIV
INTRODUCTION	XV
WHY BUILD AND LEARN ABOUT ROBOTS?	XVI
WHY THE RASPBERRY PI?	XVII
WHAT IS IN THIS BOOK?	XVII
WHO IS THIS BOOK FOR?	XIX
WHERE SHOULD YOU BUY PARTS?	XIX
LET'S GET STARTED!	XX
CHAPTER 1: GETTING UP AND RUNNING	1
GET YOUR HANDS ON A RASPBERRY PI.....	2
YOUR FIRST TASTE OF PI	4
WHAT YOU'LL NEED	6
SETTING UP YOUR RASPBERRY PI.....	8
INSTALLING YOUR PI'S OPERATING SYSTEM	
ON WINDOWS/MACOS	8
PLUGGING IN AND WIRING UP YOUR RASPBERRY PI.....	12
INSTALLING RASPBIAN.....	14
CONFIGURING RASPBIAN	15
THE TERRIFIC WORLD OF THE TERMINAL	17
TOURING THE TERMINAL	18
ACCESSING YOUR RASPBERRY PI FROM	
ANOTHER COMPUTER	21
WHAT IS PROGRAMMING?	25
INTRODUCING PYTHON	25
WRITING YOUR FIRST PYTHON PROGRAM.....	26
SUMMARY	28
CHAPTER 2: ELECTRONICS BASICS	29
WHAT IS ELECTRICITY?	30
RESISTANCE.....	32
OHM'S LAW OF ELECTRICITY	33
MAKING AN LED BLINK: RASPBERRY PI GPIO OUTPUT	33
THE PARTS LIST	34

WIRING UP YOUR LED	37
PROGRAMMING YOUR RASPBERRY PI TO BLINK YOUR LED.....	39
RUNNING YOUR PROGRAM: MAKE YOUR LED BLINK.....	42
CHALLENGE YOURSELF: CHANGE THE TIMING.....	43
INPUT FROM A BUTTON: RASPBERRY PI GPIO INPUT	43
EXPLAINING THE PARTS LIST	44
WIRING UP YOUR BUTTON.....	44
PROGRAMMING YOUR RASPBERRY PI TO DISPLAY INPUT FROM YOUR BUTTON.....	46
RUNNING YOUR PROGRAM: GET INPUT FROM YOUR BUTTON	47
CHALLENGE YOURSELF: COMBINE YOUR BUTTON AND LED PROGRAMS.....	48
SUMMARY	48
CHAPTER 3: BUILDING YOUR ROBOT	49
YOUR FIRST ROBOT.....	50
WHAT YOU'LL NEED	51
CHASSIS.....	52
MOTORS.....	54
BATTERIES	57
VOLTAGE REGULATOR	58
MOTOR CONTROLLER.....	59
RECOMMENDED TOOLS	60
ASSEMBLING YOUR ROBOT	60
MAKING THE CHASSIS.....	60
ATTACHING THE MOTORS	62
STABILIZING THE ROBOT.....	63
ATTACHING THE BATTERIES.....	65
MOUNTING THE RASPBERRY PI, BREADBOARD, AND BUCK CONVERTER.....	66
WIRING UP POWER TO THE RASPBERRY PI.....	67
WIRING UP THE MOTORS	71
SUMMARY	78
CHAPTER 4: MAKING YOUR ROBOT MOVE	79
THE PARTS LIST.....	80
UNDERSTANDING THE H-BRIDGE.....	80
FIRST MOVEMENT	81
PROGRAMMING YOUR ROBOT WITH A PREDEFINED ROUTE	81
RUNNING YOUR PROGRAM: MAKE YOUR ROBOT MOVE.....	84

MAKING YOUR ROBOT REMOTE-CONTROLLED	87
THE WIIMOTE WIRELESS CONTROLLER.....	87
INSTALLING AND ENABLING BLUETOOTH.....	88
PROGRAMMING REMOTE CONTROL FUNCTIONALITY.....	90
RUNNING YOUR PROGRAM: REMOTE-CONTROL	
YOUR ROBOT.....	92
VARYING THE MOTOR SPEED	93
UNDERSTANDING HOW PWM WORKS.....	93
UNDERSTANDING THE ACCELEROMETER	95
LOOKING AT THE DATA.....	96
FIGURING OUT THE REMOTE MOVEMENT CONTROL	97
PROGRAMMING YOUR ROBOT FOR VARIABLE SPEED	99
RUNNING YOUR PROGRAM: REMOTE-CONTROL	
YOUR ROBOT WITH PWM.....	101
CHALLENGE YOURSELF: REFINE YOUR	
REMOTE-CONTROLLED ROBOT.....	101
SUMMARY	102
CHAPTER 5: AVOIDING OBSTACLES.....	103
OBSTACLE DETECTION.....	104
USING ULTRASONIC SENSORS FOR ANALOG	
OBJECT DETECTION	104
UNDERSTANDING HOW THE HC-SR04 WORKS	105
MEASURING A SHORT DISTANCE	106
THE PARTS LIST	106
REDUCING VOLTAGE WITH VOLTAGE DIVIDERS.....	107
WIRING UP YOUR HC-SR04	109
PROGRAMMING YOUR RASPBERRY PI TO	
READ DISTANCE.....	112
RUNNING YOUR PROGRAM: MEASURE A	
SHORT DISTANCE.....	114
MAKE YOUR ROBOT AVOID OBSTACLES.....	115
MOUNTING YOUR HC-SR04 ULTRASONIC SENSOR.....	115
PROGRAMMING YOUR ROBOT TO AVOID OBSTACLES.....	116
RUNNING YOUR PROGRAM: MAKE YOUR ROBOT	
AVOID OBSTACLES.....	119
CHALLENGE YOURSELF: IMPROVE THE OBSTACLE	
AVOIDANCE PROGRAM.....	119
SUMMARY	120

CHAPTER 6: CUSTOMIZING WITH LIGHTS AND SOUND 121

ADDING NEOPIXELS TO YOUR RASPBERRY PI ROBOT..... 122

- INTRODUCING NEOPIXELS AND THE RGB
COLOR SYSTEM..... 122**
- THE PARTS LIST 124**
- WIRING UP YOUR NEOPIXEL STICK..... 125**
- INSTALLING THE SOFTWARE..... 127**
- CONFIGURING THE LIBRARY’S EXAMPLE CODE 129**
- RUNNING THE EXAMPLE CODE 132**
- CONTROLLING NEOPIXELS USING THE WIIMOTE
PROGRAM..... 132**
- RUNNING YOUR PROGRAM: NEOPIXELS AND
WIIMOTE CONTROL 135**
- CHALLENGE YOURSELF: EXPERIMENT WITH
COLOR AND PATTERN 135**

ADDING A SPEAKER TO YOUR RASPBERRY PI ROBOT 136

- UNDERSTANDING HOW 3.5 MM SPEAKERS WORK 136**
- CONNECTING YOUR SPEAKER 137**

ADDING A CAR HORN TO THE WIIMOTE PROGRAM 138

- INSTALLING THE SOFTWARE..... 138**
- PLAYING SOUNDS FROM THE TERMINAL 140**
- PLAYING SOUND USING THE WIIMOTE PROGRAM 141**
- RUNNING YOUR PROGRAM: NEOPIXELS,
SOUND EFFECTS, AND THE WIIMOTE CONTROL..... 142**

ADDING BEEPING TO THE OBSTACLE AVOIDANCE PROGRAM 142

- INTEGRATING THE BEEP SOUND INTO THE OBSTACLE
AVOIDANCE PROGRAM..... 142**
- RUNNING YOUR PROGRAM: BEEPING OBSTACLE
AVOIDANCE..... 143**
- CHALLENGE YOURSELF: ADD SOUND EFFECTS
TO YOUR OTHER PROJECTS 143**

SUMMARY 144

CHAPTER 7: LINE FOLLOWING 145

- CREATING A TRACK..... 146**
- THE THEORY BEHIND LINE FOLLOWING 149**
- USING AN IR SENSOR TO DETECT A LINE..... 153**
 - THE PARTS LIST 153**
 - WIRING UP YOUR TCRT5000 LINE-FOLLOWING
SENSOR MODULE 155**

PROGRAMMING YOUR RASPBERRY PI TO DETECT A LINE	156
RUNNING YOUR PROGRAM: DETECT A LINE!.....	157
MAKE YOUR ROBOT FOLLOW A LINE AUTONOMOUSLY	158
WIRING UP THE SECOND TCRT5000 LINE-FOLLOWING SENSOR MODULE	158
MOUNTING YOUR SENSORS.....	159
PROGRAMMING YOUR ROBOT TO FOLLOW A LINE	160
RUNNING YOUR PROGRAM: MAKE YOUR ROBOT FOLLOW A LINE!	162
SUMMARY	164

**CHAPTER 8: COMPUTER VISION:
FOLLOW A COLORED BALL..... 165**

THE COMPUTER VISION PROCESS	166
THE PARTS LIST.....	167
THE TARGET: A COLORED BALL.....	167
THE OFFICIAL RASPBERRY PI CAMERA MODULE	168
CONNECTING AND SETTING UP YOUR CAMERA MODULE	169
MOUNTING YOUR CAMERA.....	171
ENABLING THE CAMERA AND VNC, AND SETTING THE SCREEN RESOLUTION.....	172
TAKING A TEST PHOTO	174
CONTROLLING YOUR PI'S DESKTOP REMOTELY WITH VNC.....	175
INSTALLING AND MAKING A CONNECTION WITH VNC VIEWER	175
TAKING AND VIEWING A PHOTO USING THE RASPBERRY PI CAMERA MODULE	177
MAKE YOUR ROBOT SEEK AND FOLLOW A BALL	179
UNDERSTANDING THE THEORY BEHIND COLORED-OBJECT RECOGNITION.....	179
INSTALLING THE SOFTWARE	183
IDENTIFYING THE HSV COLOR OF YOUR COLORED BALL	183
RUNNING THE HSV TEST PROGRAM.....	184
PROGRAMMING YOUR RASPBERRY PI TO FOLLOW A BALL	185
RUNNING YOUR PROGRAM: MAKE YOUR ROBOT FOLLOW A COLORED BALL!.....	192
SUMMARY	194

NEXT STEPS	195
THE RASPBERRY PI GUY	196
GET IN TOUCH!.....	196
OTHER WEBSITES.....	197
CLUBS AND EVENTS.....	198
BOOKS AND PUBLICATIONS	199
RASPBERRY PI GPIO DIAGRAM	200
RESISTOR GUIDE	202
HOW TO SOLDER	204
WHAT YOU NEED	205
SOLDER.....	205
SOLDERING IRON.....	206
STAND AND SOLDERING TIP CLEANER	207
SOLDERING COMPONENTS TOGETHER	209
PREPARING TO SOLDER	210
TINNING THE TIP	210
SETTING UP THE COMPONENTS.....	211
SOLDERING THE PERFECT JOINT	212
SUMMARY	214
RUN PROGRAM ON STARTUP	215
EDITING THE RC.LOCAL FILE	216
A PRACTICE EXAMPLE.....	217