

CONTENTS

ACKNOWLEDGMENTS	XVI
INTRODUCTION.....	XVII
PRIMER.....	2

LEDS

PROJECT 1: BLINKING AN LED	36
PROJECT 2: PUSHBUTTON LED FLASHLIGHT	46
PROJECT 3: LED DIMMER SWITCH.....	52
PROJECT 4: A GRAPHICAL USER INTERFACE FOR A MULTICOLOR LED	61
PROJECT 5: RAINBOW LIGHT STRIP	70

DISPLAYS

PROJECT 6: AN LCD REMINDER.....	84
PROJECT 7: MINI WEATHER FORECASTER.....	96
PROJECT 8: PONG WITH A SENSE HAT	110

SENSORS

PROJECT 9: ALL-IN-ONE WEATHER SENSOR STATION.....	126
PROJECT 10: INTRUDER ALARM WITH EMAIL NOTIFICATIONS.....	136
PROJECT 11: GAS AND SMOKE ALARM.....	145
PROJECT 12: TEMPERATURE AND HUMIDITY DATA LOGGER.....	153

CAMERAS

PROJECT 13: BURGLAR DETECTOR WITH PHOTO CAPTURE	162
PROJECT 14: HOME SURVEILLANCE CAMERA.....	171

WEB APPLICATIONS

PROJECT 15: BUILDING YOUR FIRST WEBSITE	180
PROJECT 16: CONNECTING YOUR ELECTRONICS TO THE WEB	195
PROJECT 17: INTERNET OF THINGS CONTROL CENTER WITH NODE-RED.....	208

GAMES AND TOYS

PROJECT 18: DIGITAL DRUM SET	224
PROJECT 19: MAKE A GAME IN SCRATCH: HUNGRY MONKEY.....	232
PROJECT 20: WI-FI REMOTE-CONTROLLED ROBOT	247

RASPBERRY PI GPIO PIN GUIDE.....	261
DECODING RESISTOR VALUES	264

CONTENTS IN DETAIL

ACKNOWLEDGMENTS	XVI
INTRODUCTION.....	XVII
WHO IS THIS BOOK FOR?	XVII
ABOUT THIS BOOK.....	XIII
WHAT DO YOU NEED FOR THIS BOOK?	XIII
ORGANIZATION OF THIS BOOK	XIX
PRIMER	2
GETTING STARTED WITH THE RASPBERRY PI	3
USES FOR THE RASPBERRY PI	4
DIFFERENTIATING BETWEEN BOARDS	5
GETTING TO KNOW THE RASPBERRY PI AND ITS ACCESSORIES	6
PROJECT COMPONENT LIST	9
UPLOADING THE OPERATING SYSTEM	10
DOWNLOADING NOOBS	10
FORMATTING A MICROSD CARD ON WINDOWS OR MACOS.....	11
FORMATTING A MICROSD CARD ON LINUX	12
LOADING RASPBIAN ONTO THE MICROSD CARD	14
SETTING UP YOUR RASPBERRY PI AS A DESKTOP COMPUTER	14
CONNECTING YOUR RASPBERRY PI	14
BOOTING UP YOUR PI FOR THE FIRST TIME	16
DESKTOP TOUR.....	18
SHUTTING DOWN, REBOOTING, AND LOGGING OFF.....	22
GETTING STARTED WITH PYTHON	23
PYTHON 3 INTEGRATED DEVELOPMENT ENVIRONMENT	23
BASIC PYTHON INSTRUCTIONS	24
THE PYTHON EDITOR.....	27
YOUR FIRST PYTHON PROGRAM	28
MAKING A SIMPLE CALCULATOR.....	31

LEDS

PROJECT 1: BLINKING AN LED	36
INTRODUCING THE GPIO PINS	38
INTRODUCING LEDS	39
FINDING THE RIGHT RESISTOR	40
WIRING THE CIRCUIT	41
WRITING THE SCRIPT	42
ENTERING THE SCRIPT	43
RUNNING THE SCRIPT	44
TAKING IT FURTHER	45
PROJECT 2: PUSHBUTTON LED FLASHLIGHT	46
INTRODUCING SWITCHES AND BUTTONS	48
WIRING THE CIRCUIT	49
WRITING THE SCRIPT	50
TAKING IT FURTHER	51
PROJECT 3: LED DIMMER SWITCH	52
INTRODUCING POTENTIOMETERS	54
READING ANALOG SIGNALS WITH RASPBERRY PI	55
ANALOG-TO-DIGITAL CONVERTERS	55
PULSE-WIDTH MODULATION	56
WIRING THE CIRCUIT	57
WRITING THE SCRIPT	58
ENTERING THE SCRIPT	59
RUNNING THE SCRIPT	60
TAKING IT FURTHER	60
PROJECT 4: A GRAPHICAL USER INTERFACE FOR A MULTICOLOR LED	61
INTRODUCING RGB LEDS	63
WIRING THE CIRCUIT	64

WRITING THE SCRIPT	65
CONTROLLING THE INTENSITY AND CLOSING THE WINDOW	67
DESIGNING THE USER INTERFACE WITH TKINTER	67
RUNNING THE SCRIPT	69
TAKING IT FURTHER	69
PROJECT 5: RAINBOW LIGHT STRIP	70
INTRODUCING THE WS2812B ADDRESSABLE RGB LED STRIP.....	72
INTRODUCING THE LOGIC LEVEL CONVERTER	73
WIRING THE CIRCUIT.....	74
WRITING THE SCRIPT.....	76
INSTALLING THE WS281X LIBRARY	76
ENABLING SPI COMMUNICATION	77
ENTERING THE SCRIPT	77
RUNNING THE SCRIPT	81
TAKING IT FURTHER	82

DISPLAYS

PROJECT 6: AN LCD REMINDER.....	84
INTRODUCING THE LIQUID CRYSTAL DISPLAY.....	86
SOLDERING THE HEADERS	87
THE LCD MODULE PINOUT.....	87
WIRING YOUR CIRCUIT	88
WRITING THE SCRIPT.....	89
INSTALLING THE PYTHON LIBRARY FOR A CHARACTER LCD.....	89
DISPLAYING A CHARACTER MESSAGE	90
ADDING OTHER FUNCTIONALITY.....	91
SCROLLING A REMINDER MESSAGE	92
RUNNING THE SCRIPT	95
TAKING IT FURTHER	95
PROJECT 7: MINI WEATHER FORECASTER.....	96
INTRODUCING THE OLED DISPLAY.....	98
USING THE OPENWEATHERMAP API.....	98
UNDERSTANDING JSON SYNTAX	100
MAKING AN API REQUEST	101

WIRING THE CIRCUIT.....	103
WRITING THE SCRIPT.....	103
INSTALLING THE LIBRARY FOR THE OLED DISPLAY.....	104
ENABLING I ² C COMMUNICATION.....	104
ENTERING THE SCRIPT.....	105
RUNNING THE SCRIPT.....	109
TAKING IT FURTHER.....	109
PROJECT 8: PONG WITH A SENSE HAT.....	110
INTRODUCING PONG.....	112
INTRODUCING THE RASPBERRY PI SENSE HAT.....	112
MOUNTING THE BOARD.....	112
USING THE SENSE HAT EMULATOR.....	113
WORKING WITH SENSE HAT FUNCTIONS AND CONTROLS.....	114
CONTROLLING THE LED MATRIX.....	114
READING DATA FROM THE JOYSTICK.....	117
WRITING THE SCRIPT.....	118
ENTERING THE SCRIPT.....	118
RUNNING THE SCRIPT.....	122
TAKING IT FURTHER.....	123

SENSORS

PROJECT 9: ALL-IN-ONE WEATHER	
SENSOR STATION.....	126
THE SENSE HAT AS A WEATHER STATION.....	128
THE TEMPERATURE SENSOR.....	128
THE HUMIDITY SENSOR.....	128
THE BAROMETRIC PRESSURE SENSOR.....	128
READING TEMPERATURE, HUMIDITY, AND PRESSURE.....	129
BUILDING A USER INTERFACE FOR YOUR READINGS.....	130
WRITING THE SCRIPT.....	131
CREATING THE USER INTERFACE.....	133
AUTOMATICALLY UPDATING THE READINGS.....	134
RUNNING THE SCRIPT.....	135
TAKING IT FURTHER.....	135

PROJECT 10: INTRUDER ALARM WITH EMAIL NOTIFICATIONS	136
INTRODUCING THE PIR MOTION SENSOR	138
SENDING AN EMAIL WITH PYTHON	138
FINDING YOUR SMTP SERVER DETAILS	138
THE EMAIL-SENDING SCRIPT	139
RUNNING THE EMAIL-SENDING SCRIPT	140
WIRING THE CIRCUIT.....	141
WRITING THE SCRIPT.....	142
TAKING IT FURTHER	144

PROJECT 11: GAS AND SMOKE ALARM.....	145
INTRODUCING THE MQ-2 GAS AND SMOKE SENSOR.....	147
INTRODUCING THE PIEZO BUZZER	148
WIRING THE CIRCUIT.....	148
WRITING THE SCRIPT.....	150
SETTING THE THRESHOLD VALUE.....	151
RUNNING THE SCRIPT	152
TAKING IT FURTHER	152

PROJECT 12: TEMPERATURE AND HUMIDITY DATA LOGGER	153
INTRODUCING THE DHT22 SENSOR	155
WIRING THE CIRCUIT.....	155
WRITING THE SCRIPT.....	156
INSTALLING THE DHT22 LIBRARY.....	156
ENTERING THE SCRIPT	157
CREATING, WRITING, AND CLOSING .TXT FILES	158
RUNNING THE SCRIPT	159
TAKING IT FURTHER	159

CAMERAS

PROJECT 13: BURGLAR DETECTOR WITH PHOTO CAPTURE	162
INTRODUCING THE RASPBERRY PI CAMERA MODULE V2.....	164
BUILDING THE BURGLAR DETECTOR	165
ENABLING THE CAMERA	165
CONNECTING THE CAMERA	165
WIRING THE CIRCUIT.....	166

WRITING THE SCRIPT	167
ENTERING THE SCRIPT	167
RUNNING THE SCRIPT	169
TAKING IT FURTHER	170
PROJECT 14: HOME SURVEILLANCE CAMERA.....	171
RECORDING VIDEO TO A FILE.....	173
WRITING THE SCRIPT.....	174
ENTERING THE SCRIPT	175
RUNNING THE SCRIPT	177
TAKING IT FURTHER	178

WEB APPLICATIONS

PROJECT 15: BUILDING YOUR FIRST WEBSITE.....	180
SETTING UP THE PROJECT FILES	182
SETTING UP AN HTML WEB PAGE	182
SETTING UP THE BASIC CONTENT	182
ADDING THE TITLE, HEADINGS, AND PARAGRAPHS	183
SEEING YOUR WEB PAGE	184
ADDING LINKS, IMAGES, AND BUTTONS.....	185
STYLING YOUR PAGE WITH CSS	188
EMBEDDING A STYLE SHEET	188
STYLING YOUR HTML CONTENT	189
STYLING THE HEADER	189
STYLING THE TITLE CLASS.....	190
STYLING THE HEADINGS, PARAGRAPHS, AND LINKS	192
STYLING THE BUTTON.....	193
TAKING IT FURTHER	194
PROJECT 16: CONNECTING YOUR ELECTRONICS TO THE WEB	195
INTRODUCING WEB SERVERS	197
INTRODUCING THE RELAY MODULE	198
RELAY PINOUT	198
RELAY USAGE	199
PROJECT OVERVIEW	200
WIRING THE CIRCUIT.....	200
PREPARING YOUR PI TO RUN A WEB SERVER.....	202
INSTALLING FLASK	202
ORGANIZING YOUR FILES	202

WRITING THE SCRIPTS.....	203
CREATING THE WEB SERVER.....	203
WRITING THE HTML FILE.....	204
WRITING THE CSS FILE.....	205
LAUNCHING YOUR WEB SERVER.....	206
TAKING IT FURTHER	207

PROJECT 17: INTERNET OF THINGS CONTROL CENTER WITH NODE-RED..... 208

INTRODUCING NODE-RED.....	210
INSTALLING THE DHT22 NODES.....	210
GETTING STARTED WITH NODE-RED	211
WIRING THE CIRCUIT.....	213
CREATING THE FLOW.....	214
CREATING THE DASHBOARD USER INTERFACE	215
WIRING THE NODES.....	216
RUNNING YOUR APPLICATION.....	220
TAKING IT FURTHER	221

GAMES AND TOYS

PROJECT 18: DIGITAL DRUM SET.....224

PREPARING THE AUDIO.....	226
CONFIGURING THE AUDIO	226
GETTING THE AUDIO SAMPLE FILES	226
WIRING THE CIRCUIT.....	228
WRITING THE SCRIPT.....	229
TAKING IT FURTHER	231

PROJECT 19: MAKE A GAME IN SCRATCH: HUNGRY MONKEY.....232

INTRODUCING SCRATCH 2	234
WIRING THE CIRCUIT.....	235
BUILDING THE SCRIPT.....	236
CREATING THE SPRITES AND	
CHOOSING THE STAGE BACKGROUND	236
EDITING THE SPRITES.....	237
ADDING CONTROLS TO THE MONKEY SPRITE	238
TESTING YOUR SCRIPT.....	239
CREATING THE COUNTDOWN TIMER.....	240
COUNTING AND DISPLAYING THE SCORE	241

MAKING THE BANANAS FALL FROM THE SKY	241
ADDING THE ROTTEN BANANAS	243
PLAYING THE GAME	245
TAKING IT FURTHER	246
PROJECT 20: WI-FI REMOTE-CONTROLLED ROBOT	247
PROJECT OUTLINE	249
PREPARING THE RASPBERRY PI.....	250
WIRING THE CIRCUIT.....	252
WIRING THE DC MOTORS TO MOTOZERO	252
CONTROLLING THE MOTORS WITH MOTOZERO.....	253
WRITING THE APPLICATION	254
FINDING THE RASPBERRY PI IP ADDRESS	254
CREATING THE NODE-RED FLOW.....	255
ENTERING THE SCRIPT	257
RUNNING THE APPLICATION.....	259
POWERING UP THE ROBOT	260
TAKING IT FURTHER	260
 RASPBERRY PI GPIO PIN GUIDE.....	 261
 DECODING RESISTOR VALUES	 264