



Quick answers to common problems

Raspberry Pi Cookbook for Python Programmers

Over 50 easy-to-comprehend tailor-made recipes to get the most out of the Raspberry Pi and unleash its huge potential using Python

Tim Cox

Download from Join eBook (www.joinebook.com)

[PACKT]
PUBLISHING

Raspberry Pi Cookbook for Python Programmers

Over 50 easy-to-comprehend tailor-made recipes to get the most out of the Raspberry Pi and unleash its huge potential using Python

Tim Cox

[PACKT]
PUBLISHING

BIRMINGHAM - MUMBAI

Raspberry Pi Cookbook for Python Programmers

Copyright © 2014 Packt Publishing

All rights reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, without the prior written permission of the publisher, except in the case of brief quotations embedded in critical articles or reviews.

Every effort has been made in the preparation of this book to ensure the accuracy of the information presented. However, the information contained in this book is sold without warranty, either express or implied. Neither the author, nor Packt Publishing, and its dealers and distributors will be held liable for any damages caused or alleged to be caused directly or indirectly by this book.

Packt Publishing has endeavored to provide trademark information about all of the companies and products mentioned in this book by the appropriate use of capitals. However, Packt Publishing cannot guarantee the accuracy of this information.

Raspberry Pi and the Raspberry Pi logo are registered trademarks of the Raspberry Pi Foundation.

All other trademarks are the property of their respective owners.

First published: April 2014

Production Reference: 2230414

Published by Packt Publishing Ltd.
Livery Place
35 Livery Street
Birmingham B3 2PB, UK.

ISBN 978-1-84969-662-3

www.packtpub.com

Cover Image by Darren Brindley (darrenbrindleyphotography@gmail.com)

Credits

Author

Tim Cox

Reviewers

Colin Deady

Ian McAlpine

Acquisition Editors

Pramila Balan

Luke Presland

Rebecca Pedley

Content Development Editor

Arvind Koul

Technical Editors

Shubhangi H. Dhamgaye

Novina Kewalramani

Rohit Kumar Singh

Pratish Soman

Copy Editors

Janbal Dharmaraj

Insiya Morbiwala

Aditya Nair

Karuna Narayanan

Project Coordinator

Wendell Palmer

Proofreaders

Simran Bhogal

Kirsty Cox

Maria Gould

Ameesha Green

Paul Hindle

Indexer

Tejal Soni

Graphics

Ronak Dhruv

Yuvraj Mannari

Abhinash Sahu

Production Coordinator

Aparna Bhagat

Cover Work

Aparna Bhagat

About the Author

Tim Cox lives in England with his wife and two young daughters and works as a software engineer. His passion for programming can be traced back to one Christmas in the mid 1980s when he received a Sinclair Spectrum 48k+ home computer (a joint present with his two elder brothers). By typing out and modifying BASIC programs, while dreaming about building robots, an interest in computers and electronics was sparked, which has never faded. This interest saw him through university, where he earned a BEng in Electronics and Electrical Engineering, and into a career in developing embedded software for a wide range of applications, for automotive, aerospace, and the oil industry, among others.

Keen to support the vision behind the Raspberry Pi, reignite engineering in schools, and encourage a new generation of engineers, Tim co-founded the MagPi magazine. Thanks to the dedication and time of the volunteers who contribute to it every month, it continues to have monthly issues and attract an ever-increasing number of readers (and writers) worldwide. Through his site PiHardware.com, Tim produces electronic kits and helps people learn about the Raspberry Pi and hardware interfacing; each of them is supported with detailed instructions and tutorials to help novices build the knowledge and skills for their projects.

This is Tim's first ever book; it mirrors his own experience of discovering the Raspberry Pi and showcasing its fantastic abilities.

Writing a book about the Raspberry Pi wouldn't have been possible without the creation itself, so thanks to the Raspberry Pi foundation for their hard work (and good humor) in making it a huge success. The Raspberry Pi community consists of an excellent group of exceptionally helpful people from all over the world, and it has been a pleasure to be involved with it from the start. In particular, I would like to thank The MagPi team that has supported me by reviewing the chapters and helping me achieve the best possible standard. Also thanks to the Pi3D team who worked hard to get their library running with Python 3 for the book.

Thanks to my family, particularly my wife Kirsty, who has supported me every step of the way and daily suffered my obsession with the Raspberry Pi. The excitement my daughters, Phoebe and Amelia, have as they discover new things inspires me to share and teach as much as I can.

About the Reviewers

Colin Deady started his career in IT in the late 1990s when he discovered software testing. By now he had already fallen in love with computers, thanks to his parents buying him and his brother ZX81 and ZX Spectrum+ home computers in the 1980s. He graduated to the Amiga 1200 in the early 1990s and spent countless hours learning the insides of the operating system. Now with 14 years' experience in testing, he works as a test manager with an emphasis on test automation and extolls the virtues of Agile using Kanban and behavior-driven development to great effect. (Test early, test often; fix early, fix often.)

In his spare time, Colin is part of the editorial team for The MagPi (www.themagpi.com), a community-written magazine for the Raspberry Pi. With several published articles and having reviewed and edited many more, he has built up extensive knowledge of this tiny platform. He can also be found jointly running The MagPi stand at regular Bristol DigiMakers events in the UK, demonstrating projects such as a remote control robot arm, a roverbot, and LED display boards, all of which he has programmed in Python.

He currently runs a blog related to the Raspberry Pi at www.rasptut.co.uk.

Ian McAlpine was first introduced to computers with his school's Research Machines RML-380Z and his Physics teacher's Compukit UK101 microcomputer. This was followed by a Sinclair ZX81 home computer and then a BBC Micro Model A microcomputer, which he still has to this day. His interest in computers resulted in him acquiring an MEng in Electronic Systems Engineering from Aston University and an MSc in Information Technology from the University of Liverpool. Ian currently works as a senior product owner at SAP Canada.

Being introduced to the Raspberry Pi not only rekindled his desire to "tinker", but also provided him with an opportunity to give back to the community. Consequently, Ian is a very active member of the editorial team for The MagPi, a monthly magazine for the Raspberry Pi, which you can read online or download for free from www.themagpi.com.

I would like to thank my darling wife, Louise, and my awesome kids, Emily and Molly, for their patience and support.

www.PacktPub.com

Support files, eBooks, discount offers and more

You might want to visit www.PacktPub.com for support files and downloads related to your book.

Did you know that Packt offers eBook versions of every book published, with PDF and ePub files available? You can upgrade to the eBook version at www.PacktPub.com and as a print book customer, you are entitled to a discount on the eBook copy. Get in touch with us at service@packtpub.com for more details.

At www.PacktPub.com, you can also read a collection of free technical articles, sign up for a range of free newsletters and receive exclusive discounts and offers on Packt books and eBooks.



<http://PacktLib.PacktPub.com>

Do you need instant solutions to your IT questions? PacktLib is Packt's online digital book library. Here, you can access, read and search across Packt's entire library of books.

Why Subscribe?

- ▶ Fully searchable across every book published by Packt
- ▶ Copy and paste, print and bookmark content
- ▶ On demand and accessible via web browser

Free Access for Packt account holders

If you have an account with Packt at www.PacktPub.com, you can use this to access PacktLib today and view nine entirely free books. Simply use your login credentials for immediate access.

Table of Contents

Preface	1
Chapter 1: Getting Started with a Raspberry Pi Computer	7
Introduction	7
Connecting the Raspberry Pi	10
Using NOOBS to set up your Raspberry Pi SD card	14
Networking and connecting your Raspberry Pi to the Internet via the LAN connector	24
Configuring your network manually	26
Networking directly to a laptop or computer	28
Networking and connecting your Raspberry Pi to the Internet via a USB Wi-Fi dongle	39
Connecting to the Internet through a proxy server	44
Connecting remotely to the Raspberry Pi over the network using VNC	47
Connecting remotely to the Raspberry Pi over the network using SSH (and X11 Forwarding)	49
Sharing the home folder of the Raspberry Pi with SMB	53
Keeping the Raspberry Pi up to date	55
Chapter 2: Starting with Python Strings, Files, and Menus	57
Introduction	57
Working with text and strings	58
Using files and handling errors	67
Creating a boot-up menu	71
Creating a self-defining menu	74
Chapter 3: Using Python for Automation and Productivity	79
Introduction	79
Using Tkinter to create graphical user interfaces	80
Creating a graphical application Start menu	84

Displaying photo information in an application	89
Organizing your photos automatically	98
Chapter 4: Creating Games and Graphics	103
Introduction	103
Using IDLE3 to debug your programs	104
Drawing lines using a mouse on Tkinter Canvas	107
Creating a bat and ball game	109
Creating an overhead scrolling game	116
Chapter 5: Creating 3D Graphics	125
Introduction	125
Starting with 3D coordinates and vertices	126
Creating and importing 3D models	134
Creating a 3D world to roam in	139
Building 3D maps and mazes	143
Chapter 6: Using Python to Drive Hardware	155
Introduction	155
Controlling an LED	158
Responding to a button	163
A controlled shutdown button	168
The GPIO keypad input	176
Multiplexed color LEDs	182
Chapter 7: Sense and Display Real-world Data	193
Introduction	193
Using devices with the I²C bus	194
Reading analog data using an analog-to-digital converter	201
Logging and plotting data	208
Extending the Raspberry Pi GPIO with an I/O expander	216
Sensing and sending data to online services	223
Chapter 8: Creating Projects with the Raspberry Pi Camera Module	229
Introduction	229
Getting started with the Raspberry Pi camera module	230
Using the camera with Python	233
Generating a time-lapse video	241
Creating a stop frame animation	250
Making a QR code reader	260

Chapter 9: Building Robots	267
Introduction	267
Building a Rover-Pi robot with forward driving motors	268
Using advanced motor control	281
Building a six-legged Pi-Bug robot	287
Avoiding objects and obstacles	298
Getting a sense of direction	305
Chapter 10: Interfacing with Technology	317
Introduction	317
Automating your home with remote sockets	318
Using SPI to control an LED matrix	326
Communicating using a serial interface	339
Controlling the Raspberry Pi over Bluetooth	352
Controlling USB devices	357
Appendix: Hardware and Software List	369
Introduction	369
General component sources	370
Hardware list	371
Software list	375
Index	379