



eLektor

树莓派 项目实战

(影印版)

RASPBERRY PI : Hardware Projects

Dogan Ibrahim 著



东南大学出版社
SOUTHEAST UNIVERSITY PRESS

树莓派项目实战(影印版)

Dogan Ibrahim 著

南京 东南大学出版社

图书在版编目(CIP)数据

树莓派项目实战:英文/(英)易卜拉欣(Ibrahim, D.)著. 影印本. —南京:东南大学出版社, 2015.9

书名原文: RASPBERRY PI: Hardware Projects

ISBN 978-7-5641-5949-8

I. ①树… II. ①易… III. ①Linux 操作系统—英文 IV. ①TP316

中国版本图书馆 CIP 数据核字(2015)第 177348 号

© 2014 by Elektor International Media BV

Reprint of the English Edition, jointly published by Elektor International Media BV and Southeast University Press, 2015. Authorized reprint of the original English edition, 2015 Elektor International Media BV, the owner of all rights to publish and sell the same.

All rights reserved including the rights of reproduction in whole or in part in any form.

英文原版由 Elektor International Media BV 出版 2014。

英文影印版由东南大学出版社出版 2015。此影印版的出版和销售得到出版权和销售权的所有者——Elektor International Media BV 的许可。

版权所有, 未得书面许可, 本书的任何部分和全部不得以任何形式重制。

树莓派项目实战(影印版)

出版发行: 东南大学出版社

地 址: 南京四牌楼 2 号 邮编: 210096

出 版 人: 江建中

网 址: <http://www.seupress.com>

电子邮件: press@seupress.com

印 刷: 常州市武进第三印刷有限公司

开 本: 787 毫米×980 毫米 16 开本

印 张: 18.5

字 数: 362 千字

版 次: 2015 年 9 月第 1 版

印 次: 2015 年 9 月第 1 次印刷

书 号: ISBN 978-7-5641-5949-8

定 价: 58.00 元

本社图书若有印装质量问题, 请直接与营销部联系。电话(传真): 025-83791830

Declaration

To my wife Nadire, my daughter Alev, and my son Ahmet, for their love and wisdom.

Declaration

The author and publishers have used their best efforts in ensuring the correctness of the information contained in this book. They do not assume, and hereby disclaim, any liability to any party for any loss or damage caused by errors or omissions in this book, whether such errors or omissions result from negligence, accident or any other cause.

Acknowledgements

The following material is reproduced in this book with the kind permission of the respective copyright holders and may not be reprinted, or reproduced in any way without their prior consent.

Figure 9-3 to Figure 9-6 are taken from Adafruit website

Figure 9-8, Figure 9-10 to Figure 9-12 are taken from the website of ModMyPi

Figure 9-9 is taken from the website of PiBorg

Figure 9-13 and Figure 9-14 are taken from the website of Amazon

Figure 11-55 and Figure 11-74 are taken from the website of mikroElektronika

About the Author

Prof. Dr. Dogan Ibrahim has a B.Sc. degree in electronic engineering, an M.Sc. degree in automatic control engineering, and a Ph.D in digital signal processing. Dogan has worked in many industrial organizations before he returned to academic life. He was the head of computer engineering department and the biomedical engineering department at the Near East University in Cyprus. Dogan is the author of over 50 technical books on microcontrollers, microprocessors and related fields. He is a Chartered electrical engineer and a Fellow of the Institution of Engineering Technology.

Table of Contents

Chapter 1 – Introducing the Raspberry Pi	9
1.1 What Can You Do With a Raspberry Pi ?	9
1.2 The Raspberry Pi Models	10
1.3 The Anatomy of the Raspberry Pi	10
1.4 Setting Up Your Raspberry Pi	12
1.4.1 Power Supply	13
1.4.2 Monitor	13
1.4.3 TV	14
1.4.4 USB Keyboard and Mouse	15
1.4.5 Powered USB Hub	15
1.4.6 SD Card	16
1.4.7 Speakers	16
1.4.8 Case	17
1.4.9 USB Flash Memory Drive	17
1.4.10 USB Flash Hard Disk	17
1.4.11 USB Wi-Fi Adapter	17
1.5 Connecting Everything Together	18
1.5.1 Option 1 – Standard Setup	18
1.5.2 Option 2 – Setup Using Powered Hub	19
1.6 Summary	20
Chapter 2 – Downloading and Installing the Operating System	21
2.1 Downloading the Operating System	21
2.1.1 Downloading the NOOBS Software	22
2.2 Installing the Operating System onto the SD Card	23
2.2.1 Expanding the Filesystem	28
2.2.2 Changing User Password	28
2.2.3 Enabling Boot to Desktop	28
2.2.4 International Options	29
2.2.5 Enable Camera	29
2.2.6 Add to Rastract	29
2.2.7 Overclock	29
2.2.8 Advanced Options	29
2.2.9 About	30
2.3 Logging in to the Raspberry Pi	31
2.4 Summary	32

RASPBERRY PI® - Hardware Projects

Chapter 3 – Using the Linux Command Line	33
3.1 The Command Prompt	33
3.2 Useful Linux Commands	33
3.2.1 Directory related commands	33
3.2.2 File related commands	34
3.2.3 Other commands	34
3.3 The Directory Structure	34
3.4 Command Examples	35
3.4.1 Current Directory	35
3.4.2 Directory Structure	35
3.4.3 Creating a Subdirectory	36
3.4.4 Displaying File Permissions	37
3.4.5 Changing File Permissions	38
3.4.6 To Change the Working Directory	40
3.4.7 Help	41
3.4.8 Date, Time, and Calendar	42
3.4.9 Copying a File	42
3.4.10 Wildcards	42
3.4.11 Renaming a File	43
3.4.12 Deleting a File	43
3.4.13 Removing a Directory	44
3.4.14 Re-directing the Output	44
3.4.15 Writing to the Screen or to a File	45
3.4.16 Matching a String	45
3.4.17 Head and Tail Commands	45
3.4.18 Super User Commands	46
3.4.19 What Software is Installed on My Raspberry Pi	46
3.5 Resource Monitoring on Raspberry Pi	47
3.5.1 Killing a Process	48
3.5.2 Disk Usage	49
3.6 Shutting Down	49
3.7 Summary	49
Chapter 4 – Connecting the Raspberry Pi to Wired Network	51
4.1 Connecting to a Wired Network	51
4.2 Unable to Connect to a Wired Network	52
4.3 Connecting to your Raspberry Pi Remotely	53
4.3.1 The SSH Client	53
4.4 Summary	55
Chapter 5 – Using a Text Editor in Linux Command Mode	57
5.1 nano Text Editor	57
5.2 vi Text Editor	61

Chapter 6 – Using the Desktop	65
6.1 Installing the VNC Software	65
6.2 The Desktop Environment	68
6.3 The Task Bar	69
6.4 The Start Menu	70
6.4.1 Accessories Menu	71
6.4.2 Education Menu	75
6.4.3 Graphics Menu	77
6.4.4 Internet Menu	77
6.4.5 Other Menu	79
6.4.6 Programming Menu	80
6.4.7 Sound & Video Menu	80
6.4.8 System Tools Menu	80
6.4.9 Preferences Menu	81
6.5 Using External USB Flash Memory Drive	81
6.6 Summary	82
Chapter 7 – Some Useful Software Packages for the Raspberry Pi	83
7.1 LibreOffice	83
7.1.1 The Text Document Program	84
7.1.2 The Spreadsheet Program	85
7.1.3 The Drawing Program	86
7.1.4 The Presentation program	86
7.1.5 Formula	87
7.1.6 The Database Program	87
7.2 XInvaders 3D	88
7.3 LXMusic	89
7.4 Installing From the Pi Store	89
7.5 Summary	90
Chapter 8 – Python Programming	91
8.1 Starting Python	91
8.2 Variable Names	93
8.3 Reserved Words	93
8.4 Comments	94
8.5 Indentation	94
8.6 Line Continuation	94
8.7 Blank Lines	95
8.8 More Than One Statement on a Line	95
8.9 Python Data Types	95
8.9.1 Numeric Variables	95
8.9.2 String Variables	96
8.9.3 List Variables	97

RASPBERRY PI® - Hardware Projects

8.9.4	Tuple Variables	97
8.9.5	Dictionary Variables	98
8.10	Python Operators	98
8.10.1	Arithmetic Operators	99
8.10.2	Comparison Operators	99
8.10.3	Logical Operators	99
8.10.4	Assignment Operators	99
8.10.5	Bitwise Operators	100
8.11	Control of Flow	100
8.11.1	if, if..else, and elif	101
8.11.2	'for' Statement	102
8.11.3	'while' Statement	103
8.11.4	'continue' Statement	104
8.11.5	'break' Statement	105
8.12	Number Type Conversion	105
8.13	Trigonometric Functions	106
8.14	Mathematical Functions	106
8.15	Integer Random Number Generation	107
8.16	Using Non-printable ASCII Characters	108
8.17	Print Statement	108
8.18	String Manipulation	109
8.19	String Functions	109
8.20	List Functions	111
8.21	Dictionary Functions	112
8.22	Date & Time Functions	112
8.23	User Defined Functions	113
8.24	Keyboard Input	115
8.25	Files	116
8.26	Exceptions	117
8.27	Example Programs	118
8.27.1	Using the Editor to Create Programs	118
8.28	Summary	136

Chapter 9 – Raspberry Pi Hardware Interfacing. 137

9.1	GPIO Pin Definitions	137
9.2	Raspberry Pi Hardware Development Boards and Hardware Tools	139
9.2.1	Pi Cobbler	140
9.2.2	Pi Plate	140
9.2.3	Pi T-Cobbler	141
9.2.4	PiFace	141
9.2.5	RasPiComm – Piggyback Extension Board	142
9.2.6	PiBorg – TriBorg – GPIO Triple Header Extender	142
9.2.7	Gertboard	143

9.2.8	BerryClip – LED and Buzzer	143
9.2.9	MyPi – Push Your Pi -8 LED & 8 Button Breakout Board	143
9.2.10	Raspberry Pi Electronic Starter Kit.	144
9.2.11	Starter Kit-A for Raspberry Pi.	145
9.3	Summary	146
Chapter 10 – Raspberry Pi GPIO Software		147
10.1	Installing the GPIO Library	147
10.2	GPIO Library Functions	147
10.2.1	Pin Numbering	147
10.2.2	Channel (I/O pin) Configuration	147
10.3	GPIO	150
10.4	Program Development	150
10.4.1	Using the Program Description Language and Flow Charts	151
10.4.2	Calling Subprograms.	153
10.4.3	Subprogram Structure	154
10.5	Examples.	155
10.6	Representing 'for' Loops in Flow Charts	160
10.7	Summary	162
Chapter 11 – Raspberry Pi Hardware Projects		163
11.1	PROJECT 1 – Flashing an LED	163
11.2	PROJECT 2 – Lighthouse Flashing LED	169
11.3	PROJECT 3 – Flashing 8 LEDs	171
11.4	PROJECT 4 – Flashing 8 LEDs Using Functions	176
11.5	PROJECT 5 – Random Flashing LEDs	178
11.6	PROJECT 6 – Rotating LEDs	179
11.7	PROJECT 7 – LED With Push-button Switch	179
11.8	PROJECT 8 – Morse Code Exerciser	182
11.9	PROJECT 9 – Event Counter With Callback Code	184
11.10	PROJECT 10 – Electronic Dice (Output to the Monitor)	187
11.11	PROJECT 11 – Electronic Dice (Output to LEDs)	189
11.12	PROJECT 12 – LED with Graphical User Input	192
11.13	PROJECT 13 – PWM Wave Generator	193
11.14	PROJECT 14 – Using an LCD	196
11.14.1	HD44780 LCD Controller	196
11.15	PROJECT 15 – Counting Seconds on the LCD	200
11.16	PROJECT 16 – Temperature and Humidity Display on the LCD	202
11.17	PROJECT 17 – Using External EEPROM Memory	210
11.18	PROJECT 18 – Using Digital to Analog Converter (DAC)	217
11.19	PROJECT 19 – Expanding the I/O Ports	224
11.20	PROJECT 20 – Using Analog Temperature Sensor	228
11.21	PROJECT 21 – Temperature Data Logger	232

RASPBERRY PI® - Hardware Projects

11.22	PROJECT 22 – Using The PiFace I/O Board	234
11.23	PROJECT 23 – PiFace Motor Controller	242
Appendix A. Raspberry Pi To PC File Transfer.		245
Appendix B. Using Wi-Fi with Raspberry Pi		247
Appendix C. Graphical User Interface.		249
Appendix D. Raspberry Pi LCD Library.		253
Appendix E. Hardware Projects - PDL and Program Listings		255
E.1	Project 3 - Program Listing.	255
E.2	Project 4 - Program Listing.	256
E.3	Project 5 - Program Listing.	257
E.4	Project 6 - Project PDL	258
E.5	Project 6 - Program Listing.	259
E.6	Project 8 - Project PDL	260
E.7	Project 8 - Program Listing.	261
E.8	Project 9 - Program Listing.	263
E.9	Project 11 - Project PDL.	264
E.10	Project 11 - Program Listing	265
E.11	Project 12 - Program Listing	266
E.12	Project 16 - PDL	267
E.13	Project 16 - Program Listing	268
E.14	Project 17 - PDL	271
E.15	Project 17 - Program Listing	272
E.16	Project 18 - PDL	273
E.17	Project 18 - Program Listing	274
E.18	Project 19 - Program Listing	275
E.19	Project 19 - Modified Program Listing	276
E.20	Project 20 - Program Listing	277
E.21	Project 21 - Program Listing	278
E.22	Project 23 - Program Listing	279
E.23	Program Listing for LCD Library	280

Table of Contents

Chapter 1 – Introducing the Raspberry Pi	9
1.1 What Can You Do With a Raspberry Pi ?	9
1.2 The Raspberry Pi Models	10
1.3 The Anatomy of the Raspberry Pi	10
1.4 Setting Up Your Raspberry Pi	12
1.4.1 Power Supply	13
1.4.2 Monitor	13
1.4.3 TV	14
1.4.4 USB Keyboard and Mouse	15
1.4.5 Powered USB Hub	15
1.4.6 SD Card	16
1.4.7 Speakers	16
1.4.8 Case	17
1.4.9 USB Flash Memory Drive	17
1.4.10 USB Flash Hard Disk	17
1.4.11 USB Wi-Fi Adapter	17
1.5 Connecting Everything Together	18
1.5.1 Option 1 – Standard Setup	18
1.5.2 Option 2 – Setup Using Powered Hub	19
1.6 Summary	20
Chapter 2 – Downloading and Installing the Operating System	21
2.1 Downloading the Operating System	21
2.1.1 Downloading the NOOBS Software	22
2.2 Installing the Operating System onto the SD Card	23
2.2.1 Expanding the Filesystem	28
2.2.2 Changing User Password	28
2.2.3 Enabling Boot to Desktop	28
2.2.4 International Options	29
2.2.5 Enable Camera	29
2.2.6 Add to Rastract	29
2.2.7 Overclock	29
2.2.8 Advanced Options	29
2.2.9 About	30
2.3 Logging in to the Raspberry Pi	31
2.4 Summary	32

RASPBERRY PI® - Hardware Projects

Chapter 3 – Using the Linux Command Line	33
3.1 The Command Prompt	33
3.2 Useful Linux Commands	33
3.2.1 Directory related commands	33
3.2.2 File related commands	34
3.2.3 Other commands	34
3.3 The Directory Structure	34
3.4 Command Examples	35
3.4.1 Current Directory	35
3.4.2 Directory Structure	35
3.4.3 Creating a Subdirectory	36
3.4.4 Displaying File Permissions	37
3.4.5 Changing File Permissions	38
3.4.6 To Change the Working Directory	40
3.4.7 Help	41
3.4.8 Date, Time, and Calendar	42
3.4.9 Copying a File	42
3.4.10 Wildcards	42
3.4.11 Renaming a File	43
3.4.12 Deleting a File	43
3.4.13 Removing a Directory	44
3.4.14 Re-directing the Output	44
3.4.15 Writing to the Screen or to a File	45
3.4.16 Matching a String	45
3.4.17 Head and Tail Commands	45
3.4.18 Super User Commands	46
3.4.19 What Software is Installed on My Raspberry Pi	46
3.5 Resource Monitoring on Raspberry Pi	47
3.5.1 Killing a Process	48
3.5.2 Disk Usage	49
3.6 Shutting Down	49
3.7 Summary	49
Chapter 4 – Connecting the Raspberry Pi to Wired Network	51
4.1 Connecting to a Wired Network	51
4.2 Unable to Connect to a Wired Network	52
4.3 Connecting to your Raspberry Pi Remotely	53
4.3.1 The SSH Client	53
4.4 Summary	55
Chapter 5 – Using a Text Editor in Linux Command Mode	57
5.1 nano Text Editor	57
5.2 vi Text Editor	61

Chapter 6 – Using the Desktop	65
6.1 Installing the VNC Software	65
6.2 The Desktop Environment	68
6.3 The Task Bar	69
6.4 The Start Menu	70
6.4.1 Accessories Menu	71
6.4.2 Education Menu	75
6.4.3 Graphics Menu	77
6.4.4 Internet Menu	77
6.4.5 Other Menu	79
6.4.6 Programming Menu	80
6.4.7 Sound & Video Menu	80
6.4.8 System Tools Menu	80
6.4.9 Preferences Menu	81
6.5 Using External USB Flash Memory Drive	81
6.6 Summary	82
Chapter 7 – Some Useful Software Packages for the Raspberry Pi	83
7.1 LibreOffice	83
7.1.1 The Text Document Program	84
7.1.2 The Spreadsheet Program	85
7.1.3 The Drawing Program	86
7.1.4 The Presentation program	86
7.1.5 Formula	87
7.1.6 The Database Program	87
7.2 XInvaders 3D	88
7.3 LXMusic	89
7.4 Installing From the Pi Store	89
7.5 Summary	90
Chapter 8 – Python Programming	91
8.1 Starting Python	91
8.2 Variable Names	93
8.3 Reserved Words	93
8.4 Comments	94
8.5 Indentation	94
8.6 Line Continuation	94
8.7 Blank Lines	95
8.8 More Than One Statement on a Line	95
8.9 Python Data Types	95
8.9.1 Numeric Variables	95
8.9.2 String Variables	96
8.9.3 List Variables	97

RASPBERRY PI® - Hardware Projects

8.9.4	Tuple Variables	97
8.9.5	Dictionary Variables	98
8.10	Python Operators	98
8.10.1	Arithmetic Operators	99
8.10.2	Comparison Operators	99
8.10.3	Logical Operators	99
8.10.4	Assignment Operators	99
8.10.5	Bitwise Operators	100
8.11	Control of Flow	100
8.11.1	if, if..else, and elif	101
8.11.2	'for' Statement	102
8.11.3	'while' Statement	103
8.11.4	'continue' Statement	104
8.11.5	'break' Statement	105
8.12	Number Type Conversion	105
8.13	Trigonometric Functions	106
8.14	Mathematical Functions	106
8.15	Integer Random Number Generation	107
8.16	Using Non-printable ASCII Characters	108
8.17	Print Statement	108
8.18	String Manipulation	109
8.19	String Functions	109
8.20	List Functions	111
8.21	Dictionary Functions	112
8.22	Date & Time Functions	112
8.23	User Defined Functions	113
8.24	Keyboard Input	115
8.25	Files	116
8.26	Exceptions	117
8.27	Example Programs	118
8.27.1	Using the Editor to Create Programs	118
8.28	Summary	136

Chapter 9 – Raspberry Pi Hardware Interfacing. 137

9.1	GPIO Pin Definitions	137
9.2	Raspberry Pi Hardware Development Boards and Hardware Tools	139
9.2.1	Pi Cobbler	140
9.2.2	Pi Plate	140
9.2.3	Pi T-Cobbler	141
9.2.4	PiFace	141
9.2.5	RasPiComm – Piggyback Extension Board	142
9.2.6	PiBorg – TriBorg – GPIO Triple Header Extender	142
9.2.7	Gertboard	143