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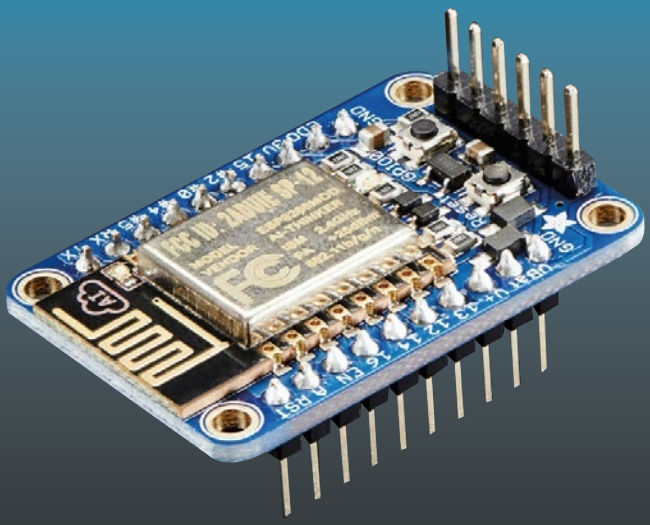

Raspberry Pi IoT Projects

Prototyping Experiments for Makers

John C. Shovic

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Printed on acid-free paper

To my best friend Laurie and also to my cat Panther,
who is an IOT device by himself.

Contents at a Glance

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About the Author

Dr. John C. Shovic is currently Chief Technical Officer of SwitchDoc Labs, a company specializing in technical products for the Maker Movement and the IOT; and InstiComm, a company specializing in mobile medical software solutions for health practitioners. He was also Chief Technology Strategist at Stratus Global Partners with a focus on supplying expertise in computer security regulatory and technical areas to health care providers. He has worked in the industry for over thirty years and has founded seven companies: Advanced Hardware Architectures, TriGeo Network Security, Blue Water Technologies, MiloCreek, InstiComm, SwitchDoc Labs, and bankCDA. As a founding member of the bankCDA board of directors, he currently serves as the chairman of the technology committee. He has also served as a Professor of Computer Science at Eastern Washington University, Washington State University, and the University of Idaho. Dr. Shovic has given over eighty invited talks and has published over seventy papers on a variety of topics on Arduinos/Raspberry Pi's, HIPAA, GLB, computer security, computer forensics, and embedded systems.

About the Technical Reviewer

Gheorghe Chesler is a Senior Software Engineer with expertise in Quality Assurance, System Automation, Performance Engineering, and e-Publishing. He works at ServiceNow as a Senior Performance Engineer, and is a principal technical consultant for Plural Publishing, a medical-field publishing company. His preferred programming language is Perl (so much so that he identifies with the Perl mascot, hence the camel picture), but also worked on many Java and Objective-C projects.

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The author would like to acknowledge the hard work of the APress editorial team in putting this book together. He would also like to acknowledge the hard work of the Raspberry Pi Foundation and the Arduino group for putting together products and communities that help to make the Internet Of Things more accessible to the general public. Hurray for the democratization of technology!

Introduction

The Internet Of Things (IOT) is a complex concept made up of many computers and many communication paths. Some IOT devices are connected to the Internet and some are not. Some IOT devices form swarms that communicate among themselves. Some are designed for a single purpose, while some are more general purpose computers. This book is designed to show you the IOT from the inside out. By building IOT devices, the reader will understand the basic concepts and will be able to innovate using the basics to create his or her own IOT applications.

These included projects will show the reader how to build their own IOT projects and to expand upon the examples shown. The importance of Computer Security in IOT devices is also discussed and various techniques for keeping the IOT safe from unauthorized users or hackers. The most important takeaway from this book is in building the projects yourself.

Chapters at a Glance

In this book, we built examples of all the major parts of simple and complex IOT devices.

In Chapter 1, the basic concepts of IOT are explained in basic terms, and you will learn what parts and tools are needed to start prototyping your own IOT devices.

In Chapter 2, you'll learn how to sense the environment with electronics and that even the behavior of simple LightSwarm type of devices can be very unpredictable.

Chapter 3 introduces important concepts about how to build real systems that can respond to power issues and programming errors by the use of good system design and watchdogs.

Chapter 4 turns a Raspberry Pi into a battery-powered device that senses iBeacons and controls the lighting in a house while reporting your location to a server.

In Chapter 5, you'll do IOT the way the big boys do by connecting up to the IBM BlueMix IOT Server and sending our biometric pulse rates up for storage and display.

In Chapter 6, we'll build a small RFID Inventory system and use standard protocols like MQTT to send information to a Raspberry Pi, a complete IOT product.

Chapter 7 shows the dark side of the IOT, Computer Security. The way you protect your IOT device from hackers and network problems is the most difficult part of IOT device and system design.

Are you totally secure? You will never know. Plan for it.

The reference appendix provides resources for further study and suggestions for other projects.

CHAPTER 1

Introduction to IOT

Chapter Goal: Understand What the IOT Is and How to Prototype IOT Devices

Topics Covered in This Chapter:

- What is IOT
- Choosing a Raspberry Pi Model
- Choosing your IOT Device
- Characterization of IOT Devices
- Buying the right tools to deal with Hardware
- Writing code in Python and in the Arduino IDE

The IOT is a name for the vast collection of "things" that are being networked together in the home and workplace (up to 20 billion by 2020 according to Gardner, a technology consulting firm). That is a very vast collection. And they may be underestimating it.

We all have large numbers of computers in a modern house. I just did a walkthrough of my house, ignoring my office (which is filled with another ~100 computers). I found 65 different devices having embedded computers. I'm sure I missed some of them. Now of those computer-based devices, I counted 20 of them that have IP addresses, although I know that I am missing a few (such as the thermostat). So in a real sense, this house has 20 IOT devices. And it is only 2016 as of the writing of this book. With over 100 million households in the United States alone, 20 billion IOT devices somehow don't seem so many.

So what are the three defining characteristics of the IOT?

- Networking - these IOT devices talk to one another (M2M communication) or to servers located in the local network or on the Internet. Being on the network allows the device the common ability to consume and produce data.
- Sensing - IOT devices sense something about their environment.

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- Actuators - IOT devices that do something. Lock doors, beep, turn lights on, or turn the TV on.

Of course, not every IOT device will have all three, but these are the characteristics of what we will find out there.

Is the IOT valuable? Will it make a difference? Nobody is sure what the killer application will be, but people are betting huge sums of money that there will be a killer application. Reading this book and doing the projects will teach you a lot about the technology and enable you to build your own IOT applications.

Choosing a Raspberry Pi Model

The Raspberry Pi family of single board computers (see Figure 1-1) is a product of the Raspberry Pi Foundation (RaspberryPi.org). They have sold over 9 million of these small, inexpensive computers. The Raspberry Pi runs a number of different operating systems, the most common of which is the Raspian release of Unbuntu Linux.

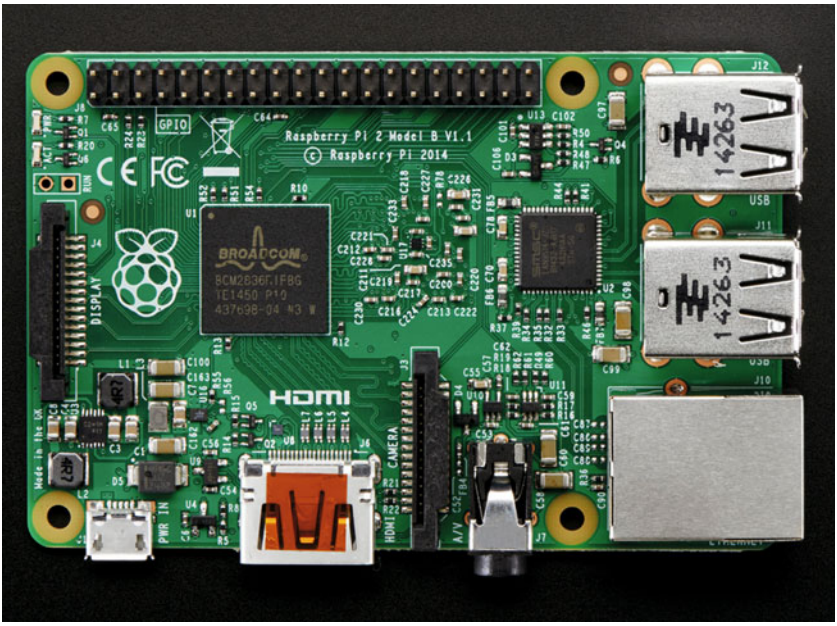

Figure 1-1. *Raspberry Pi 2*

Like Windows, Linux is a multitasking operating system, but unlike Windows, it is an open source system. You can get all the source code and compile it if you wish, but I would not recommend that to a beginner.

One of the best parts of the Raspberry Pi is that there are a huge number of device and sensor drivers available, which makes it a good choice for building IOT projects,