

INTRODUCTION

Have a look around you and try to identify devices that can sense something about their environment. No-matter if you are at work, at your home, or next to a bookshelf, I am sure you will identify many: Temperature sensors, Gas sensors, Thermostats, infrared sensors (used in automatic doors), etc. How many of these devices can communicate with the Internet and interact with Web-based applications? Probably none or just a few of them, but this is soon going to change. The evolution of communication technologies is bringing Internet connection to devices at lower cost, less power consumption and smaller sizes, making devices able to be parts of the so called 'Internet of Things': a global network of smart devices that can sense and interact with their environment using the Internet for their communication and interaction with users and other systems.

The Arduino is a programmable device that can sense and interact with its environment. It is a great open source microcontroller platform that allows hobbyists and electronic enthusiasts to build quickly, easily and with low cost small automation and monitoring projects. It has been so widely adopted that dozens of vendors build several variations of it and various extensions that provide features like wired and wireless connectivity to the Internet. In addition, there is great software support by the open source community: coding an embedded device has never been so easy.

I consider Arduino the best way to be introduced into the Internet of Things (IoT) concept. 'Building Internet of Things with the Arduino' aims to give you exactly all the knowledge you need to start with your own IoT projects.

What You Will Learn

This book will provide you with all the information you need to design and create your own IoT applications using the Arduino platform. More specifically, you will learn:

- About the Internet of Things and Cloud Computing concepts
- About open platforms that allow you to store your sensor data on the Cloud (like Pachube and Nimbits)
- The basic usage of Arduino environment for creating your own embedded projects at low cost
- How to connect your Arduino with your Android phone and send data over the Internet
- How to connect your Arduino directly to the Internet and talk to the Cloud
- How to reprogram your Arduino microcontroller remotely through the Cloud

How The Book Is structured

The Book is divided into three parts. The first part is more introductory and talks about what the Internet of Things is, how it is related to Cloud computing and what are the basic principles behind sensors and actuators that are found in most common IoT projects.

The second part introduces you to the microcontrollers and the Arduino platform: what it is, how you can program your Arduino to sense the environment and make it communicate with the Internet using wired, wireless networks and even your Android-based phone. Projects described in the chapters include programming and using a microcontroller out of the board, using timers, threads and encryption libraries for your IoT projects, extending Arduino, testing your code using an Arduino emulator, interfacing with analog and digital sensors, log air quality data and make tweets through your Android phone, control a relay switch by texting your phone, Internetize your Arduino through various ways and even send your sensor data to your own Cloud-based application.

The third part focuses on the use of existing Cloud applications for managing your sensor data. The Pachube and Nimbits are presented as the most common platforms for storing and visualizing readings from your Arduino board. This part also demonstrates how to reprogram

your Arduino remotely using your own Cloud-based web application. The final Chapter includes ideas of what you can connect to your Arduino and communicate it with the Internet.

How to Use The Book

The main purpose of this book is to introduce you to the concept of managing sensor data on the Cloud. It teaches you the basics of Arduino, how to enable it to communicate with the Internet and web applications on the Cloud. Each chapter serves a specific purpose and starts with a short introduction of the concept it presents. You are advised to read the chapters in the given order, especially those in the first two parts of the book, so that you are smoothly introduced into the concepts of Cloud computing and the Internet of Things. You will be able to familiarize yourself with the Arduino platform and then start building projects that communicate sensors and actuators with the Internet.

Each project presented starts with describing the basic functionality it provides and then with listing the essential hardware components. Circuit schematics and components connections are also illustrated in appropriate figures.

In case you find hard to read connections in figures, you can always look at the **figure repository** at <http://www.buildinginternetofthings.com> that contains full color images at higher resolutions. The software code is presented and explained. The code is initially listed the way it should be programmed, and then explained thoroughly line by line so that you can understand what it does and how it does it. Therefore you are advised to read each project from the beginning, understand what it is expected to do, read about the components you need to build the circuit, and then move to the code listings. Read the complete code once. No matter how experienced you are with coding and the Arduino, you will find some parts (or the whole code) unfamiliar. Then move to the respective code review sections and you will find all the answers to your questions. Collect the essential components and build the circuit. Program your Arduino board (and creating Java and Android applications in some projects) and finally see the expected outcome yourself.

When coming to connecting your Arduino to the Internet, you will notice that there are several ways to do so: using your Android phone or your computer as intermediate gateways or by directly connecting it through a wired (Ethernet) or wireless (WiFi) module. Each way has its own pros and cons and cost. You are welcomed to use whatever way suits best your needs and meets your available hardware. The book contains code samples and instructions that cover all ways.

Knowledge Required

This book assumes that you are already familiar with the general principles of software programming and also familiar with programming in C/C++ and Java. Especially for the latter, it is also assumed that you are familiar with using and creating projects in Eclipse Java IDE.

If you are a total beginner in programming you can still use the book but first you are advised to study any of the following introductory books in Arduino, Java and Android programming:

Java 7 for Absolute Beginners, by Jay Bryant

Beginning Android, by Mark Murphy

Chapters 6 and 8 also describe projects that include Android code. So you also need to be familiar with Android programming and how to set up the Eclipse IDE for Android development.

In addition, you need to be familiar with the basics of electronics and how you can use a breadboard to connect various electronic components together.

What You Will Need

To make your Arduino interact with its environment and communicate over the Internet you need both appropriate hardware and software.

Hardware

For all the projects covered in this book you need at least one Arduino board. You can get either an official Arduino board (see Chapter 4 for more details) or an Arduino-compatible clone (like in Figure 1). In order to program the board you will need a computer (Windows, Mac or Linux), and a USB cable (type depends on the board you have).

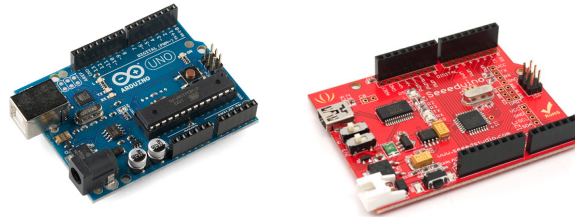


Figure 1. On the left: An official Arduino Uno board (image courtesy of Sparkfun). On the right: The Seedduino v2.21 compatible with the Arduino Uno (image courtesy of Seeedstudio)

In addition, the various projects covered in this book require various electronic components (such as resistors and capacitors), sensors (like temperature and humidity sensors) and actuators (mostly a relay switch).

For the communication with an Android phone you will need either a capable board that connects directly with your phone over USB or a Bluetooth enabled board (more details for both ways on Chapter 6).

For communicating your Arduino directly with the Internet you can use an Ethernet-enabled Arduino board or a WiFi shield (more details in Chapter 7).

All essential parts and the way to connect them together are listed in the project description of each chapter. You are also advised to use a breadboard (see Figure 2) and jumper wires (male-to-male) (see Figure 3) in order to easily connect the various components with each other and with the Arduino.

Places where you can buy online all the components featured in the projects of this book are the following:

- Sparkfun electronics, <http://www.sparkfun.com>
- Seeedstudio electronics, <http://www.seeedstudio.com>

Both electronic stores ship worldwide. Of course you are free to search online for alternative stores that provide the materials you will need (EBay can also another good source).

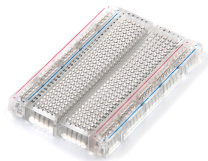


Figure 2. A breadboard (image courtesy of Sparkfun)



Figure 3. A male-to-male jumper wire. It can be easily connected to the breadboard and the Arduino pins (image courtesy of Sparkfun).

Software

In order to program your Arduino board you will need the Arduino development environment (or IDE) that you can freely download from the Arduino web site (<http://arduino.cc/en/Main/Software>) and use it on your Windows, Mac or Linux computer. Detailed instructions on how to setup and use the IDE are provided in Chapter 4.

Some of the projects in the book also teach you how to create standalone Java applications and Android-based applications that communicate with your Arduino. In those cases you will need to have installed and be familiar with the Eclipse Java Development Environment (<http://www.eclipse.org>).

The Code

As of writing this book, Arduino has released the v1.0 that introduces some new features and changes in the way code and especially libraries are written (compared to previous IDE version like 022). The Arduino code (aka sketches) provided in the book can be run and compiled under v1.0. Many of the sketches rely on external libraries that were built for previous Arduino versions. All libraries have been ported to v1.0 and are included in the source code that can be downloaded from the book's **online code repository** found at: <http://www.buildinginternetofthings.com>. The code repository will be frequently updated reflecting any future changes in the Arduino IDE, the IoT platforms presented in the book and potential improvements.

Contacting the Author

You can contact me for questions, comments, corrections and suggestions at ch.doukas@gmail.com

I hope you will enjoy reading this book as much as I did writing it. Much more I hope the projects described will guide you in designing and building your own projects!

Charalampos Doukas
Athens, February 2012