Building a Home Security System with Arduino

Arduinos are open source microcontrollers built on a single circuit board that is capable of receiving sensory input from the environment and controlling interactive physical objects.

This book will demonstrate how Arduino can be used to develop a highly connected home security system by mobilizing a network of sensors that can feed alerts back to Arduino when alarms are triggered. Also, we will look at some current technologies such as NFC, Wi-Fi, and Bluetooth, and will finally create a complete web interface that will allow us to remotely manage our system, and even send daily bulletins with a summary of activity.

Towards the end, we'll develop a wireless home security system by setting up security cameras and motion detectors.

Who this book is written for

This book is for novice programmers and hobbyists who want to understand how an Arduino Uno can be used to program a home security system, as well as for those who want to delve deeper into the world of Arduino.

What you will learn from this book

- Run cables and electricity to support your home security infrastructure
- Connect Arduino to your programming environment
- Learn to interact with output devices such as alarms, locks, and shutters
- Understand the different parts of an electronics circuit (MOSFET, resistor, and capacitor)
- Integrate home monitoring and security notifications with monitoring systems
- Learn how you can use the Raspberry Pi and a camera to achieve face detection for your home security system

In this package, you will find:

- The author biography
- A preview chapter from the book, Chapter 1 'Getting Started with a Home Security System'
- A synopsis of the book’s content
- More information on Building a Home Security System with Arduino
About the Author

**Jorge R. Castro** is a young computer engineer who has specialized in new technologies and open source electronics, with vast experience in software design and programming for mobile devices. He is passionate about open source initiatives.

He also dedicates much of his time to computer security and reverse engineering (seeking vulnerabilities in software and analysis of malware).
Preface

The Arduino Uno is an open source microcontroller built on a single circuit board that is capable of receiving sensory input from the environment and controlling interactive physical objects. It is also a development environment that allows writing software for the board in the Arduino programming language. It is used for a variety of different purposes and projects, from simple projects such as building a thermostat, to more advanced ones such as robotics, Web servers, seismographs, home security systems, and synthesizers.

This book will demonstrate how Arduino Uno can be used to develop a highly connected home security system by mobilizing a network of sensors, which can feed alerts back to an Arduino Uno when alarms are triggered.

What this book covers

*Chapter 1, Getting Started with a Home Security System*, talks about how traditional home security systems work in principle and gives examples of how connected homes interact with home owners. It also talks about what is needed for the system to be installed and properly maintained.

*Chapter 2, Working with Arduino Uno and Arduino IDE*, deals with what an Arduino Uno is, its history, descriptions of different parts of the Arduino Uno, how they work, and how an Arduino Uno can extend its capabilities with Shields.

*Chapter 3, From Code to the Real World*, teaches us to handle technical documentation fluently, understand the types of signals and their main differences, find the perfect component for our needs, and finally apply this to a real project.

*Chapter 4, Designing Your Own System*, shows you the approaches in designing a home automation system with a slight recap on home automation and Internet of Things (IoT). We'll also see what needs to be taken into account when we design a system. We'll define the priorities of the project, budgets, and robustness.
Chapter 5, *Arduino and Sensors*, shows you how to work with the libraries and what to create, import, and modify to increase the power of your code. Furthermore, we'll integrate more sensors and circuit elements, such as MOSFET and engines, and learn to control them.

Chapter 6, *Documentation and Version Control*, shows you how to document your code, share it, keep track of its status, and maintain a backup of your code. Finally, you'll create a simple graphical application that allows you to remotely control your Arduino Uno.

Chapter 7, *Interaction and Connectivity*, talks about how to create a system for detecting people to increase the capacity of our infrastructure. We have a brief introduction to the key elements of this chapter. Finally, we will conclude with a practical example. New concepts and technologies such as real-time detection of faces and people will be introduced (artificial intelligence).
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Getting Started with a Home Security System

In this chapter, we'll cover the following:

• What is home security infrastructure
• How does it work?
• What is needed to install one?
• How to prepare your current home for a security system
• Wired and wireless security systems
• Traditional systems versus the modern home security system

This book comes after the growing trend of hardware devices, which are available around us for a few bucks, and more specifically all talk about the Arduino platform. Today, we find these small boards in such varied and common places like schools, universities, small businesses, or public agencies.

The numerous advantages are well known, such as low cost, open designs, ease of assembly, and ability to make adjustments. That's why almost any project, whether professional or amateur, starts with a small design on a piece of paper and then quickly passes into the physical world using these fabulous boards. We will implement such a technological design to create our domestic security system.

In this chapter, you will be introduced to the world of home security systems. Also, you will be shown the difference between traditional monitoring and home automated systems. You will also learn how they work, the requirements to install them in your home, and how to prepare your environment.
Getting Started with a Home Security System

You should delve into this book only after ensuring that you are familiar with the basic concepts of electronics and computers, and later delve into more advanced principles in the subsequent chapters (but no need to worry as each and every point is carefully explained using examples, and will link a lot of information to facilitate understanding). Remember that this book should not be completely taken as a step-by-step guide on how to create a foolproof system, but as a tool that will give you the knowledge needed to create your own domestic system.

**Safety advisory:** Throughout the projects developed here, you should always observe the highest of safety measures, always be attentive of your surroundings, and never work alone if you do not possess adequate knowledge of higher technicalities. Also, try to reduce or eliminate the use of high tension electrical equipment.

What is home security infrastructure?

Surely, if you were asked about the parts of a security system, you would answer the question without any problem. For example, you would talk about surveillance cameras, motion sensors, alarms, and so on, but do you really know all the different pieces that it comprises of? All the connections? How they work? The differences between traditional and current systems? Don't worry. You will have the answers soon.

Well, we have an answer to one of these questions. The security infrastructure comprises of all these components, hardware devices, software elements, and design of their connections, put together. One example is an access point control infrastructure, where you have a card reader connected to a database that checks the permission from the ID of a card (serial number of the card) and associates it with a latch that allows or blocks the access, which is supported by a webcam, to show you the real time condition of any incident.

In this case, if someone tries to break the security measure, the system will trigger an alarm. Then, you can make a decision on what should follow next.

As you can see in this simple example, we have a lot of elements that work together to keep your environment safe. All of these together make a security infrastructure.

How does it work?

We just discussed what components are, basically, but what are these elements and how do they work? The first point is to distinguish the types that exist. We can find two kinds of elements in a security system.
The hardware

The physical elements that compose an infrastructure must bear all the technical requirements for software. They can be subdivided into three distinct subgroups. This classification should not be understood as something exclusionary because an element can be found in more than one category, but this separation will help you understand the functions performed in the system:

- **Sensors**: They will be the senses of our system, just like the senses a human body has. Their function is to collect information from the environment, transform it into a digital value, and deliver it to a component that is designed to control it. The data obtained will be the input for our equipment. This group includes cameras, sound sensors, proximity sensors, motion detection sensors, smoke sensors, infrared sensors, and temperature sensors among others.

- **Actuators**: If the sensors provide us with all the necessary information from our environment, the actuators will be the muscles that allow us to perform actions on our surroundings. Once we have made the decision to perform an action, we send a signal and force this element to work. Examples of these are alarms, speakers, locks, and switches.

- **Controller**: This is the brain of the system. A clear example is a microcontroller board, such as an Arduino controller, that is able to store a program and run it. It receives the sensory signals, processes them, and then activates and controls the actuator devices and alarms.

The software

As you saw in the last paragraph of the previous point, once we have some input data and want to produce an effect upon its receipt, we need a tool that establishes the rules that set the behavior of our system. This is taken care of by the software resources, which are a set of programs for your system.

More specifically, we will use programming to create our own program and store it on our microcontroller chip. Thus, we get the extracted data that we need (for example, monitor the temperature of a room to detect a fire), process it (calculate the dangers if they exceed a threshold) without our intervention, and implement the necessary measures (trigger alarms and fire extinguishing measures).

At this point, I won’t specify a concrete programming language. Let’s just talk about the software as a block, and later delve into different languages and applications (throughout this book, we will use various programming languages, such as Python).
Getting Started with a Home Security System

At this point of the book, the reader will be able to identify general terms and the elements of a system and understand its functionality. But do you exactly know what you need to begin constructing the system? Where and how to install it? If it is the right place for the installation? You first need to design the system.

The prerequisites for installing a security system

If you are thinking of installing a security system, then most likely it is because there is a crucial need to do so. Hence, the most important thing at this point is to correctly identify this demand. If we fail to do this, we will end up taking the wrong approach and will have a disastrous or maybe incomplete result.

If not provided, and if you have a curious and dexterous mind, you might want to create your own system design just to have fun and learn while you’re at it, or modernize your home with specific customized needs. You can take a look at the websites of the leading companies engaged in this sector for ideas.

We see that most have similar systems but the parts that are different are related to the user needs. For example, many use similar or identical electronic components but what differs in much detail is the Graphical User Interface (GUI), which will be the face of the system, and it also depends on the ease of use and experience required by the end user.) There is no point in having a system if we are not able to handle and understand.

Once you have a design in mind, the next step is to consider the environment in which you want to install the system. Also, consider the material resources at your disposal and the economic cost that you are allowed to take the plunge with.

It may seem simple but the more information you collect, the easier it is to work in successive phases. An illustrative example is to understand the points of light, pipes, and network access that are available to us. Once you have the layout, it then is easy to construct and build our project.

In terms of material throughout this book, we will use one of the most famous Arduino modules—the Arduino UNO, revision 3.0. In the next chapter, I’m going to talk more about it. The other ingredients are easily acquired and do not usually have a very high price, yet many of them are created with free hardware or open source hardware (hardware that are very cheap to source). So if you want, you can build it at home for a very low price compared to the module assembly.
How to prepare your current home for a security system

Once you have selected the site for the installation, there are a number of measurements that you must take to ensure the security, integrity, and reliability of the system components and even people around it.

Since our system is dependent on electricity, in order to optimize the performance and the costs of use, it is advisable to have a separate point of electrical supply, instead of using batteries, which are expensive and short-lived. In addition, Arduino boards, and many other modules, are equipped with just one connection in which case, you can put in a wall transformer.

If you do not have access to electricity or want to have a backup system (such as a UPS (Uninterruptible Power Supply)), you can use rechargeable Lithium-Ion (Li-ion) batteries or even implement a system with solar panels. The latter option can be found on numerous examples, such as road signs, farm monitoring systems, weather stations, and so on.

Caution: Whenever batteries are used outdoors, you have to be aware of the battery limitations in extreme temperatures, such as the reduced current carrying capacity is reduced, the current discharge is lower in cold temperatures, and the risk of heat damage, and maybe even explosion in extreme cases.

We also have to be careful with moisture, condensation, and dew because they can spoil our infrastructure.

A good recommendation is to ensure a network connection, not necessarily internet access, but if possible connection to a router, which is a part of an Intranet from where you can access the individual components, change settings or access services (for example, a GUI that shows whether an alert has been triggered).

It is very important to note that our site is not prone to extreme radio interference, which may generated by the technology we use constantly. Such devices emit radiation at different frequencies and these can alter the behavior of our system.
On the other hand, if installations are performed outdoors, you should keep them safe from inclement weather, including lightning, and from poor grounding conductors. All this can destroy the circuitry of your system and may put you in danger as well.

Finally, if you have pets at home, be aware of it when you install your sensors and actuators that may have been expensive. This is because they may end up damaged and hardly repairable. Besides, if you do not choose the correct orientation, every time your dog or cat goes through the garden, it may activate an alarm. Remember that you have to perform maintenance of your devices periodically. I recommend you to set aside a few days on the calendar to remind you and perform basic maintenance.

**Wired and wireless security systems.**

The last thing that you do is choose how you connect all elements of your system. The market currently offers highly reliable wireless options, despite being easier to deploy, they could raise the overall price of the hardware. An example, which will be discussed in depth in the final chapters, are wireless devices which are able to stand correctly in many places, and allow quick installation (without hardly disturbing the environment with wires).

Also, as mentioned previously, there is the disadvantage of radio interference, as domestic wireless technologies work in very close frequencies. Most popular wireless technologies like Wi-Fi and Bluetooth use 2.4GHz, considering how many devices there are around using that technology, which sometimes coupled with the relative underpowered scoping, it often impedes communication.

For more information, I recommend you visit the official website of the agency that regulates the standards of these technologies, IEEE at: http://standards.ieee.org/

The other tendency may be to use the existing wiring in your home. I am referring to the generic wiring in your house that is used to run household electrical items. There are initiatives such as the X10 technology that connects all the rooms of a building, provided they are on the same electrical phase. It also uses the power lines for signaling and controls. The main disadvantage of this standard of system is the initial economic outlay.
Traditional systems versus the modern home security system

Finally, we will present a comparison between traditional systems and current implementations, noting that each still has a specific use, where confronted is the need to reduce model-complexity to a minimum, to increase their reliability, compared to increased usability and richness of information provided.

Initially, after considering the circumstances such as price, the maturity of the technology, and existing infrastructure (connectivity), it is not possible to have systems that can be managed in real-time for a low price.

Today we have smartphones and tablets with sufficient capacity to visualize, receive, and send data collected by our hardware immediately. We can design a system that is implemented on a server created by ourselves, or even use cloud computing for greater processing power, this setup requires zero maintenance.

We should add that the installation, maintenance, and removal can be done by anyone with a basic knowledge of programming and electronics and if someday you relocate, you can easily reuse the most important pieces.

Finally, note that this data access can be done from any part of the world. With an easy-to-use application on your smartphone, you can check that everything is in order at home.

Therefore, we can say that now we have more intelligent systems with more economical and capable prices, which react and measure at a higher speed, offering greater security to our homes and environments.

Summary

We have reached the end of this first introductory chapter, where we detailed the different parts of a security system without going into the exact specifications thereof, in a theoretical way, knowing their elements and functions to perform the same. With all this, we are ready to fully dive into the next chapter. I assure you, it will be intense and full of interesting content.
In the next chapter, we'll learn about what Arduino is, its history, and descriptions of the different parts on the Arduino UNO. We will also learn how they work, and how an Arduino UNO can be extended with shields.
Where to buy this book

You can buy Building a Home Security System with Arduino from the Packt Publishing website.

Alternatively, you can buy the book from Amazon, BN.com, Computer Manuals and most internet book retailers.

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