Smart Home Automation with IoT

The ultimate DIY guide for making smart homes using open-source softwares

Dipankar Saha

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Dedicated to

All IoT enthusists, professionals and
students who want to learn Smart Home Automation DIY

Foreword

The modern home is rapidly transforming, evolving from a mere living space into an intelligent environment where everyday tasks are seamlessly integrated and automated. This transformation is driven by the advent of smart technology, which has made home automation more accessible, efficient, and affordable. At the heart of this revolution is IoT enabled by sensors, actuators, microcontrollers and the Raspberry Pi, a versatile and powerful minicomputer that has opened up a world of possibilities for tech enthusiasts, hobbyists, and professionals alike.

"Smart Home Automation with IoT" is a comprehensive guide designed to equip you with the knowledge and skills needed to turn your home into a smart home. Whether you are a beginner with no prior experience in electronics or programming, or an experienced tech enthusiast looking to expand your skill set. This book provides step-by-step instructions and practical examples to help you harness the full potential of the Raspberry Pi in creating a smart home environment.

The journey begins with an introduction to the fundamental concepts of home automation and the unique capabilities of the Raspberry Pi. From there, the book delves into the basics of setting up your Raspberry Pi, including installation, configuration, and basic programming. Each chapter builds upon the previous one, gradually introducing more complex projects and integrations.

You will learn how to automate electrical and electronic appliances, and even create a voice-controlled assistant. The book also covers advanced topics such as integrating different smart devices using popular protocols like MQTT, leveraging cloud services for remote control, and ensuring the security and privacy of your smart home network.

One of the most exciting aspects of home automation is the ability to customize and expand your setup according to your specific needs and preferences. Throughout the book, emphasis is given on the importance of creativity and experimentation. By the end, you will not only have a fully functioning smart home but also the confidence and knowledge to continue innovating and expanding your automation projects.

The field of home automation is constantly evolving, with new technologies and innovations emerging at a rapid pace. As such, this book is designed to be a living document, encouraging you to stay curious, keep learning, and continuously explore new

possibilities. The skills and concepts you acquire here will serve as a solid foundation for future advancements and projects.

I hope this book inspires you to embrace the potential of smart home automation with IoT, transforming your home into a dynamic, intelligent space that enhances your quality of life. Welcome to the exciting world of smart home automation!

- Dr. P. R. Wankhede

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Dipankar Saha is an IT Architect for Industry 4.0 & IoT solutions having 20+ years of experience and has worked in several implementation projects and in various product design and developments in this domain.

He is a smart home and IoT enthusiast who has implemented smart home solutions using open-source technologies using Raspberry Pi, NodeMCU, ESP32, relay modules and various sensors.

He is an SAP certified Associate Enterprise Architect and has co-authored several popular books on Industry 4.0 solutions. Currently he works as Principal Architect for Industry 4.0 solution at Incture and is based out of Kolkata, India.

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Acknowledgement

I want to express my deepest gratitude to my family for their unwavering support and encouragement throughout this book's writing.

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Finally, I would like to thank all the readers who have taken an interest in my book and for their support in making it a reality. Your encouragement has been invaluable!

Preface

As a child, I was always fascinated by the world of electronics and how we can use it in our daily lives. In this era of rapid technological advancement, the intersection of Internet of Things (IoT) and information technology have ushered a new paradigm as smart home that transforms the way we live, interact with our surroundings, and experience the concept of "home". The vision of a connected, intelligent home is no longer a futuristic dream but a present reality, with IoT serving as the catalyst for this transformative journey.

As a professional working in this domain for several years as well as an enthusiast for IoT and home automation, I felt the need to a have a guide for the ones who want to learn this subject and want to implement the same, at very low cost using open source-softwares. As a result, it prompted me to write this book, which I believe will help many who want to learn and implement these scenarios, even though they may not have any deep and prior knowledge on this topic.

This book delves into the concepts, design and the knowhow of smart home automation, offering you a comprehensive guide to understanding, implementing, and optimizing IoT solutions to make your home smarter, more efficient, and seamlessly integrated into the digital age.

Whether you are a curious homeowner venturing into the realm of IoT for the first time or a seasoned developer looking to expand your expertise or a student who wants to learn IoT and do hands-on, this book is crafted to cater to a diverse audience. It serves as a roadmap, navigating through the intricacies of IoT technologies, protocols, and platforms, while providing practical insights into designing and building your smart home ecosystem.

The key features of this book are:

- **Foundations of IoT**: Gain a solid understanding of the fundamentals of the Internet of Things, exploring its architecture, communication protocols, and the role it plays in enabling smart homes.
- **Device connectivity**: Learn about the various sensors, actuators, and devices that form the backbone of a connected home, and understand how to seamlessly integrate them into your IoT ecosystem and setup and use Raspberry Pi as the home automation server.

- **Smart Home Platform and software**: Explore open-source IoT platform such as OpenHAB that serve as the central nervous system of your smart home, facilitating communication and control across devices as well as other open source technologies to build your smart home applications.
- **Practical implementation**: Walk through hands-on projects with the circuits and code that demonstrate real-world applications of smart home automation.

The chapters in this book discuss the following:

Chapter 1: Introduction to IoT and Home Automation - This chapter explains what is Internet of Things and how it affects our daily lives with various scenarios and its importance. Also it explains the different scenarios of home automation and IoT with examples and how to use free and open source technologies to implement smart home by DIY.

Chapter 2: Setting up Home Automation Platform on Raspberry Pi - This chapter explains how to and install OS and setup Raspberry Pi and the various open source software such as Mosquitto MQTT Broker, InfluxDB, Grafana and OpenHAB IoT platform on it.

Chapter 3: Using NodeMCU and ESP32 with Relays and Actuators as Control Switch - This chapter explains how NodeMCU and ESP32 is used to connect to relay modules and DC motors and write the program in it to control the power supply through the relay modules and control DC motors.

Chapter 4: Connecting Various Common Sensors using Arduino - This chapter explains how to connect to various common sensors such as Light sensor, DHT sensor, Ultrasonic sensor, sound sensor, etc, using Arduino and write the programs to get and pass data from those sensors to Arduino. It also explains how Arduino sends the data to ESP32 or NodeMCU using serial port to send it to the OpenHAB IoT platform through MQTT broker.

Chapter 5: Connect Sensors and Relays with OpenHAB IoT and Voice Chatbots - This chapter explains how to configure OpenHAB IoT platform installed on Raspberry Pi and connect with NodeMCU and ESP32 through MQTT messaging by connecting to Mosquitto broker to send and receive the data and commands to control the appliances and how to store the data from OpenHAB IoT to InfluxDB. Also explains how OpenHAB IoT platform is integrated with Amazon Alexa or Google Home for voice command enablement as well as how to configure and use the mobile app for OpenHAB.

Chapter 6: Developing Dashboards using Grafana to Monitor Smart Home and IoT Devices - This chapter explains how to use Grafana to easily create monitoring and analytics dashboards for the home automation IoT scenarios querying the data from InfluxDB.

Chapter 7: Get more out of Raspberry Pi - This chapter explains how to enable and use advanced features of Raspberry Pi including connecting with LED and DC motors using GPIO pins, using camera module in Raspberry Pi and develop AI-based Python program for hand, face and gesture detection to control the appliances by connecting to OpenHAB through MQTT messaging and use Docker container for application deployment.

As you embark on this journey through the pages of "Smart Home Automation with IoT" envision the endless possibilities that could arise when technology meets your imagination. May this book empower you to design, build, and enjoy the connected and smart home of your dreams.

Welcome to a future where your home is not just a living space but an intelligent, adaptive companion, attuned to your needs and preferences.

Happy reading and happy automating!

Code Bundle and Coloured Images

Please follow the link to download the
Code Bundle and the ***Coloured Images*** of the book:

https://rebrand.ly/6mgl9gb

The code bundle for the book is also hosted on GitHub at
https://github.com/bpbpublications/Smart-Home-Automation-with-IoT.
In case there's an update to the code, it will be updated on the existing GitHub repository.

We have code bundles from our rich catalogue of books and videos available at **https://github.com/bpbpublications**. Check them out!

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Chapter 1
Introduction to IoT and Home Automation

Introduction

This chapter introduces you to **Internet of Things (IoT)** and home automation and explains what Internet of Things is and how it affects our daily lives with various scenarios and its importance. It also explains the different scenarios of home automation and IoT with examples and how to use free and open-source technologies to implement smart home by **Do it Yourself (DIY)**.

Structure

In this chapter we will discuss the following topics:

- What is IoT
- How IoT affects our daily lives
- Make your home smarter: Scenarios and use cases
- Using open source and free technologies for home automation

Objectives

After studying this unit, you should be able to understand what Internet of Things is and how it can be used for smart home automation scenarios with examples. You will also learn which open-source technologies can be used to enable smart home automation.

What is IoT

We are all familiar with internet and aware of how it affects our daily lives. The internet that we know and primarily use today is a network of computers which originated from World Wide Web. In the traditional internet, computers interact with each other in native communication protocols and typically driven by human users. The consumer and producer of the content in traditional internet are typically human users that is, us. We either use apps or access websites to view the content available in internet or create the same. But over the years objects around us have become smarter and some of them can actually transmit and consume data and behave or operate based on that. The data are typically collected through sensors which can sense and measure its surrounding physical conditions such as temperature, humidity, vibration, luminary brightness, etc., and actuators which can control certain things such as toggle a switch or move an object, based on input voltage or commands sent digitally. The sensors and actuators are connected to the devices and objects such as the machines, home appliances or even human bodies to exchange the data and can transmit or receive the data by connecting to the internet, local WiFi or using local connectivity protocols such as Bluetooth, Zigbee, LORAWAN, etc. This means that a physical object can be smart enough to exchange data with other objects or applications and can behave and operate taking instructions from external sources. Physical objects, machines, appliances connected with sensors and actuators when connected through the network with each other can exchange data intelligently. That is what we call as **Internet of Things**.

Like the traditional internet, which is a network of computers, Internet of Things is the network of physical objects or **things**. Nevertheless, like the traditional internet, humans can still interact with **Internet of Things**, to consume the data generated by the things or to send commands to control the things.

As you may know the internet fueled by **World Wide Web** (**www**) started around mid-1990s, though technology and concept of internet had been around since the 1960s with the research project **Advanced Research Projects Agency Network** (**ARPANET**). Though the widespread usage of IoT has started in recent years, it may be surprising to note that a Coca Cola vending machine was connected to the network in 1982 by a group of students in Carnegie Mellon University in USA to check its inventory level using microswitches, which may be considered as one of the first IoT devices.

The term **Internet of Things** was coined by *Kevin Ashton*, a British technology pioneer in 1999 while working with **Proctor and Gamble** (**P&G**) in the context of using **Radio-**

Frequency Identification (**RFID**) technology to track products and improve supply-chain processes. This laid the foundation of the concept of IoT. Post 2000 with the rise of wireless networks and miniaturization of sensors, among several other factors, IoT implementation and usage have become widespread.

Note: According to Fortune Business Insights, the global market size of IoT is valued at USD 544.38 billion in 2022 which is forecasted to grow from USD 662.21 billion in 2023 to USD 3352.97 billion by 2030 with a CAGR of 26.1% during this period.

The usage of IoT is increasing rapidly in various fields as it opens new potential for individuals and businesses by integrating and collecting data and controlling things remotely. According to Statista the projected IoT devices connections globally is estimated to reach 83 billion by 2024 from 35 billion in 2021.

Industrial IoT though not a very new domain as it exists for quite few years from the time when PLC, sensors and network connectivity have become common, will continue to grow heavily in coming years with a spending estimate globally of USD 1.3 trillion by 2026, according to Business Insider Intelligence.

Consumer IoT devices such as smart watch, smart speakers and IoT enabled home appliances are some of the widespread and most usage of IoT, with millions of units sold worldwide each year.

Usage of IoT can help to enable new business models which were never conceived before. For example, smart home appliance OEMs can provide service instead of product such as air-conditioning a service, where the OEM can monitor manages air-conditioning equipment at customer location using IoT for which the customers will be charged based on their usage. The equipment status and faults can be easily detected remotely through IoT data analysis and OEMs can inform the service providers proactively to carry out the maintenance to avoid downtimes due to sudden faults of the equipment. Essentially, the product selling business models can change to service provider business model by this approach.

IoT is not about a single component or software but a combination of multiple software, components and data that helps to build an IoT application. You need to understand the different building blocks of IoT to get an overall idea and how to design such scenarios enabled by IoT. In the next sections, you will learn about the different building blocks of IoT.

Building blocks of IoT: Sensors

One of the basic building blocks for IoT is the sensor. These are very small electronic devices or instruments which can sense physical conditions around it such as temperature, humidity, vibration, brightness, sound intensity, etc., and can provide the measurement for the same as output, through an electrical signal. The process by which sensors work is called transduction which converts a physical change into electrical signal. The output