IoT Training System Using the Cooja Network Simulator

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Opportunities, as well as challenges, always accompany the development of technology. Without a doubt, the Internet of Things (IoT), which is seen as another upcoming trend in technology after the Internet, is no exception. The development of IoT brings up a meaningful discussion about IoT security.

However, there is a variety of IoT devices, from the small sensor to the home router then to even big factory equipment. In our daily life, every one of us may have several IoT devices but don't know they are IoT devices, let alone to manage these devices without being attacked. Therefore, IoT security education and training are extremely urgent.

This thesis presents IoTrain, which is an IoT training system using the Cooja network simulator. Users can select a tutorial through the interface of IoTrain and complete various training under the guidance of the tutorial, including viewing simulations and doing hands-on simulations in the Cooja network simulator.

The Cooja network simulator is an application included with Contiki OS and used as a tool in IoTrain. The Contiki OS is an operating system for low-power wireless IoT devices. The training content of IoTrain mainly involves wireless sensor networks (WSN), Routing Protocol for Low power and Lossy Networks (RPL), etc.

At the beginning of system development, the IoTrain was designed to meet the following requirements: open-source, parallel, for different level users, content-rich, low cost, and easy to manage. These system requirements are also indicators of the system evaluation.

Before designing the system, training mode, training process, and a structure of IoT training content were proposed.

The training mode and training process solves the problem of how to train users. Because the IoTrain will face many types of users if it is released, it is necessary to research and classify users first. In this thesis, they are roughly divided into three levels.

The first level is beginners. This group of people can be said to have no knowledge about IoT and IoT security, so their training should start from scratch.

The second level is intermediate users who have vague understanding and knowledge of IoT and IoT security, but because of the lack of systematic training, these understanding and awareness have limited help in reducing their probability of being attacked in their daily lives.

The third level is advanced users who have considerable knowledge reserves, such as having studied relevant courses or have the ability to program.

However, due to various restrictions, such as time or money costs, they did not learn more about IoT and IoT security.

Referring to the way that most people usually learn, it is widespread to find a tutorial or material for self-study. Therefore, for all levels of users, especially beginners, tutorials will be presented to them as training content. Users can select the tutorials of interest through the interface and complete the corresponding training. This is the training process mentioned earlier.

When beginners become intermediate users, and then these intermediate users also complete the corresponding tutorials, they naturally become advanced users. At this stage, these advanced users will learn Contiki-based programming, application development, and even modify the source code of the Contiki OS to simulate some attacks under the guidance of advanced tutorials. From the "learning tutorials" to "viewing simulations" to "doing hands-on simulations", this series of training is the "learning-viewing-doing" training mode.

The training content is the core of the entire system. For a person who wants to get IoT training, the first thing is to learn some basic knowledge of the Internet of Things, and then to understand the advanced knowledge of IoT, such as network or security. Because from the basic to the advanced is the law of learning any knowledge. Thus, when designing the training content structure, the training content is first divided into three categories, namely system introduction, fundamental training, and security training.

IoTrain mainly consists of three parts, namely database, function, and interface.

The database is used to store the training content. Due to the entire system currently has only three training file types and the number of these files is small, therefore, the database is built without using professional database management software, and all files are classified and stored in folders and subfolders of the entire project.

Functions include configuring the system environment, displaying interface and options, as well as open tutorials and partial simulation files according to users' options.

The IoTrain interface is implemented as prompt options in the terminal window.

In the whole research, the most important contribution is the proposal of the training content structure. It is the blueprint of IoTrain's development. Besides, it not only has a high reference value for the future development of the IoTrain system but also for the development of other IoT training systems.

The development of the IoTrain system based on the training content structure is the second contribution of this research. After proceeding the

various stages, the system has reached the prototype stage, where the system's training content structure, functions, and interfaces have been implemented.

Using simulation in IoT training is indeed a useful attempt. The use of simulators not only reduces the cost of development but also increases the training content forms, while also making training more interesting and effective.

In this thesis, firstly, I will introduce the research background, motivation, and contribution. Secondly, I will add the background knowledge involved in the whole process of the research. Thirdly, I will introduce the IoTrain, including the system requirements, design, and implementation. Lastly, the system evaluation and conclusion will be presented.

Keywords: IoT, IoT security, IoT education and training, IoT simulation, Contiki, Cooja, WSN, RPL.

Declaration: I hereby declare that this whole dissertation is my own work and that it has not been previously included in any other thesis, dissertation or report.
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