

On Modeling and Simulation of AI-based IoT

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Abstract

Nowadays, the Internet of Things has become one of the essential technologies for connecting devices in the telecommunications, electricity, medical, automotive, and other industries. The Internet of Things includes an infinite set of connections and intelligent endpoints such as sensors, actuators, and so on. IoT devices, which include sensor networks with an unlimited number of sensors, face many problems, including power limitations and hardware limitations. Therefore, simulation is the best solution for changing and extending protocols in sensor networks. Furthermore, AI is becoming an important tool to solve problem related to IoT and hardware and power constraints. In this article, we review existing simulation and modeling tools and discuss including AI in the simulation.

1. Introduction

IoT technologies are creating a new set of challenges with the goal of integrating objects into the communication space. IoT devices are also vulnerable to cyber-attacks, which in addition to violating privacy, cause irreparable financial damage. As a result, how the IoT is developed, deployed, and designed must be carefully considered and researched. Due to technical and financial innovations, IoT innovations must be modeled and simulated before implementation. Modeling and simulation are the most important step in creating an IoT network and is used as a test to validate product performance. Therefore, modeling, simulation, and experimental implementation should be made as a prerequisite for any IoT project. In this paper, we introduced important techniques for modeling and simulation of IoT devices and discuss using AI in IoT.

2. Materials

In this section, we review and study recent articles about the modeling and simulation of internet of things.

2.1 Modeling and simulation of IoT

Today the IoT is an arising topic in the industry. IoT applications are smart homes, smart cities, and smart factories. Modeling and simulation has a wide range of technologies and methodologies. Researchers focus on a specific aspect of modeling and simulation with a different purpose (e.g., discrete event simulation in industrial systems) [1]. In fact, modeling helps IoT designers to show system features in different methods and languages. At the same time simulation helps IoT designers validate their design product and predict behaviors before real system deployment [2]. On the other hand, these challenges should be investigated on modeling and simulation research: stability of simulation, elastically modelling sensor and

actuator crowd, heterogeneity of devices, real parameters of IoT simulation, online decision making [3].

2.2 IoT modeling methods

IoT devices that equipped with sensors and actuators, can give access to information of their environment. Generally, an IoT environment can consist of physical hardware, IoT platform and IoT applications. In [4] the authors divide an IoT environment into two layers, (i) the physical layer that describing hardware IoT devices, sensors and actuator, (ii) the digital layer that is include the digital twin. Digital twin is a program that mirrors a physical device or simulates it. An IoT environment model consists of devices and the connection between them. Some of IoT environment models are: IoT Architectural Reference Model (IoTARM) that works on the physical layer and the digital twin [5]. The homeML is an XML-based open format use in smart home environments proposed by Nugent et al. [6]. IoT-Lite defines objects, system or resource, and services provided by IoT devices [7]. IoT-stream is a model with four classes: IoTStream, StreamObservation, Analyticsprocess, and Event Classes [8].

2.3 IoT simulation

The internet of things (IoT) networks that integrate with their communications layer and other devices related to the IoT such as cloud, edge, and fog are becoming more complex and heterogeneous. Such heterogeneously and complexity make designing and testing challenges for researcher in design area. To overcome these problems researcher used the simulation to decrease deployment cost, test more efficiency, and make better decision [9]. The IoT simulation is a solution that help the IoT developer to create and simulate hundreds of virtual connected devices, without having to configure and manage physical devices. In this

section, we try to introduce some important and practical simulators for simulation of Internet of Things. One of the very useful simulator is NS3 that use C/C++ programming language. NetSim is another network simulator software for network design validation. OPNET is the commercial network simulator support only windows platform. OMNeT++ is discrete event-based simulator that use C++. OPNET is the commercial network simulator, which supports only windows platform that use C++ [10]. Matlab/Simulink is other simulator for IoT. Contiki Cooja simulator use a graphic environment and use C/C++ [11].

2.4 AI based IoT system model

As we know a key capability is missing from conventional modeling and simulation tools. This technology must be able to run analytics in real time, provide accuracy, and integrate data from incompatible sources. To address these problems the researchers are turning to artificial intelligence (AI). As we mentioned previously one of the IoT environment programs used for modeling in digital layer is digital twin that use the AI techniques to make predictions of situations where data is numerous and where the processes being evaluated are relatively simple [12]. Also in [13] the authors use AI techniques in M2M method for IoT modeling.

3. Conclusion

In this paper, we reviewed arising methods for modeling and simulation of IoT. In addition, we showed the important role of AI techniques in the modeling and simulation of IoT. It must be noted that even with the use of AI techniques developers and researchers have to perform some of modification. They have to find algorithms to balance the accuracy, speed, and heterogeneity. However, when needed it is possible to create a new comprehensive method of modeling and simulation that include solution for all if the issues mentioned above.

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