DESIGNING ENVIRONMENT FOR TEACHING INTERNET OF THINGS

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ABSTRACT

One of the new topics taught at technical universities is Internet of Things. In this paper, a workshop for organizing a lab in academic environment for the subject Internet of Things is described. The architecture of the platform, scenario and a description of components used for creating the environment for learning Internet of things are also given in the paper. Students use their knowledge related to creating Android mobile applications and SMS services, as well as given sensors, microcontrollers and microcomputers to create an application for smart home automation.

KEYWORDS

Internet of Things, lab exercise, workshop, microcontroller, microcomputer, sensor

1. INTRODUCTION

Internet of Things (IoT) is a part of the future Internet which consists of billion sensor-based and actuator-based smart devices, with data-processing abilities (Perera et al., 2014). According to the Gartner report, over 26 billion of devices will have been connected to the Internet by the end of 2020 (Gartner, 2013).

Internet of Things deals with smart homes, as well as other smart environments, such as smart offices, smart cities, smart government, smart cites and others (Chan et al., 2008). Smart home enables automation of different areas of home, i.e. smart heating, smart air-conditioning, smart window (Jiang et al., 2004).

In this paper, we propose an environment for teaching Internet of Things at university. A workshop for creating applications for smart home automation is realized and a system for smart home automation is deployed where students use predefined smart home environments as a framework for creating their own applications for automation in order to learn principles of IoT. They are given a scenario and a diagram with connections between system components, as well as web services which manage components of the smart home. During the workshop, students implement a mobile and SMS application for smart home automation.

2. ENVIRONMENT FOR TEACHING INTERNET OF THINGS

An experimental workshop for learning IoT was performed during the laboratory classes of the elective subject “Internet of Things” attended by students of the final (fourth) year of the undergraduate studies within the e-Business Department, Faculty of Organizational Sciences, University of Belgrade. Eight students attended this workshop. The assignment was to create an IoT application for smart home automation.

2.1 A Scenario for Smart Home Automation

The main aim of the workshop is to familiarize students with Internet of Things technologies and smart home automation. The scenario which is given to students is related to automation of one part of a smart home. The scenario includes tracking of sensor status, logic for responding to environmental changes and managing particular components of the smart home. Students should manage the air-conditioning system in a smart home. If a temperature level is higher than defined threshold, an air-conditioning device should be turned on.

The air-conditioning should be turned off if the temperature is below the threshold. For the simulation of air-conditioning, a light emitting diode (LED) is used (which is on when the "air-conditioning device" is on).

2.2 Hardware and Software Infrastructure

Students are given devices which they control using a given web service. In the Figure 1, a diagram with connections between a temperature sensor, LED, Arduino microcontroller and Raspberry Pi microcomputer is shown.

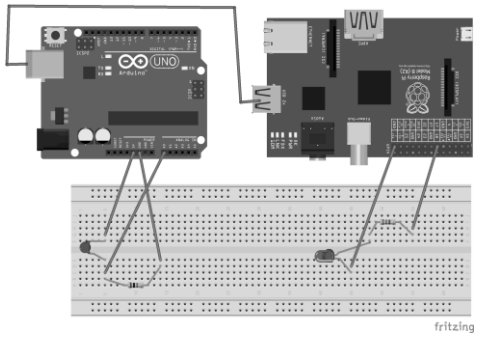

Figure 1. A diagram of component integration for smart home automation.

A temperature sensor is connected to Arduino which is connected to Raspberry Pi. A LED which simulates air-conditioning is also connected to Raspberry Pi. A web service is running at a web server on Raspberry Pi which has a network connection and IP address.

The web service is REST-based and it enables turning the LED on or off and reading the data from the temperature sensor. The web service is connected to scripts written in C++ and Python running on Arduino and Raspberry Pi, respectively.

SMS Cloud platform deployed within the University which is capable of sending and receiving SMS messages is used for creating a SMS application for home automation. The SMS platform contains a REST API with two functions – for sending and receiving SMSs. First, students need to log into the web application for obtaining their own API key. Also, they can obtain their own SMS prefix, which is necessary for receiving SMSs. All messages are obtained via the REST API.

2.3 Deploying Applications for Smart Home Automation

Students deploy Android mobile application and SMS application for home automation according to the given scenario.

Using the Android application, users can view the current temperature and turn the air-conditioning on or off. The final application contains buttons for enabling and disabling the air-conditioning and AUTO button which enables or disables the air-conditioning, according to the current temperature level and defined threshold. Also, the application can read current temperature from the web service and display the value in both Celsius and Fahrenheit degrees. The application logic of AUTO button is deployed on the client side of the application.

The SMS application is based on the SMS Cloud Platform. The SMS application manages the home automation by sending SMS messages with particular contents. The application is connected to the web service for home automation. For enabling and disabling air-conditioning, a sender should send a message with text "prefix on" and "prefix off", respectively. For getting the information about the current temperature, the sender should send a message with text "prefix cel" or "prefix far" for obtaining the current temperature in Celsius or Fahrenheit degrees, respectively. For enabling or disabling the air-conditioning, according to the temperature threshold, a sender should send a message with text "prefix auto". The keyword "prefix" should be changed with student's personal prefix.

3. CONCLUSION

This paper describes environment for teaching Internet of Things. It is based on Cloud PaaS (Platform as a Service) and hardware layer abstraction which enables using hardware components without knowledge of advanced hardware principles. Students generally were satisfied with this workshop. Only one of eight participants thought that the workshop had not been interesting. The main problem regarding the workshop was the lack in practical knowledge. The majority of participants (7 of 8) thought that this workshop had been difficult.

This environment is a good platform for learning about developing software for Internet of Things projects and it provides seamless features for extending applications in the future. After attending the workshop, students are able to create their own applications for automation various aspects of smart environments. Compared to traditional learning, students are more motivated in adopting IoT concepts by using modern technologies in workshops.

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