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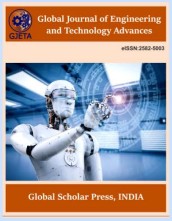

(REVIEW ARTICLE)

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On an application in supporting practical teaching of IoT course and embedded programming

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Abstract

Contributing to digital transformation and improving the quality of IoT teaching for students of Information Technology, Information Safety and Security, Engineering, the author group of the Center for Practical Experiments, Post and Telecommunications Institute of Technology (PTIT) has researched and applied a number of tools such as Wokwi Online [5], Packet tracer [3] to help students perform group discussion exercises and practice testing projects with design, simulation and programming for Arduino embedded system and IoT Modules. Through the application, testing on Wokwi online [5] and Arduino [1] [2] to send data to the Cloud [4], shows that the Code built for the Hardware Module and the Module on Wokwi online have appropriate similarities. So when students program online with the Wokwi tool to program simulation exercises / projects and practice exercises, it will create an environment where students can do it right away without having to wait, find hardware modules. After completing the online simulation, students can copy the code that has been run on Wokwi to Aduino to compile and load the corresponding Aduino and IoT modules so that they can be applied to real problems.

Keywords: IoT teaching; IoT Practical; IoT Modules; PTIT

1. Introduction

The subject of IoT and embedded programming is currently being taught for the University of Information Technology and Information Security at universities. But students in Information Technology including Software Engineering, Information Systems, Computer Science, Computer Engineering and Information Security do not learn much about subjects related to hardware knowledge, programming. Therefore, designing hardware and programming, compiling to load Arduino, ATMega and IoT Modules for students of Information Technology and Information Security will face many difficulties in testing on Hardware modules also known as hot test (powered) will lead to the possibility of fire and explosion causing damage to components. On the other hand, ordering hardware modules for individual exercises and practice will cost money when students perform exercises and projects. Therefore, when the Wokwi application for students of embedded programming and IoT simulation online will be very convenient, students can do it anytime, anywhere, bring high benefits in learning and can apply code products after simulation for real applications on real Modules.

2. Electronic simulation online with Wokwi

With the Wokwi simulation tool, students can use it to program and simulate Arduino, ESP 8266, ESP32 and many other popular boards, components and sensors.

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When using Wokwi online, students do not have to wait to buy circuit boards, components, or download software in large volumes. Students only need to use a browser on an Internet-connected computer, smartphone, or tablet to start coding for assignments, projects, and practice on embedded programming for Arduino and IoT immediately.

In the process of using, students are not afraid of burning or exploding the circuit board due to incorrect connection of the wires on the circuit board during the test connections. Students are not afraid to damage virtual hardware. Using the Wokwi online tool students can program and simulate with circuit boards and sensors just like real hardware. The program code on Wokwi can be copied into the Arduino program or Visual Studio code to compile and load the Atmega embedded module and the IoT Module.

Students can easily get help and feedback from the embedded programming and IoT community, the system will help students get and share links from Wokwi community projects with many new ideas.

Create an environment for students to experience between simulation and reality.

No hardware limitation. No need to search for parts from old projects. Use as many equipment parts as students need, without worrying about buying practice equipment going to waste.

The Wokwi tool has manufacturer-friendly libraries of products. A place for students to share their projects, ask for help, and get inspired in their learning.

WiFi Simulation - Connect a student's simulation project to the Internet. Students can use MQTT, HTTP, NTP and many other network protocols.

Virtual Logic Analyzer - Record digital signals during student simulations (e.g. UART, I2C, SPI) and analyze them on student computer or lab computer.

Advanced debugging with GDB - Pretty powerful Arduino and Raspberry Pi Pico debugger for advanced users.

SD card emulation - Store and retrieve files and folders from student source code.

3. Embedded programming with Wokwi online

To perform programming exercises for embedded systems and IoT on Wokwi [4], students need to create a free account or log in with a Gmail or Facebook or Github account and then log in to the system to participate. Review samples or create a new assignment or project.

Figure 1 Interface for registration/login and Wokwi online

Figure 2 Interface for creating new assignments and projects on Wokwi online

4. Students familiarize themselves with exercises/sample projects on Wokwi online

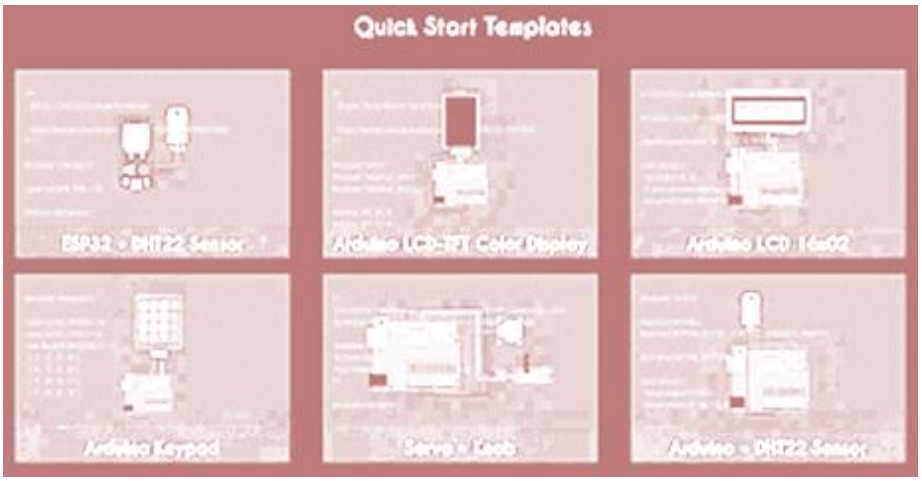

Figure 3 Assignment of exercises/sample projects on Wokwi online

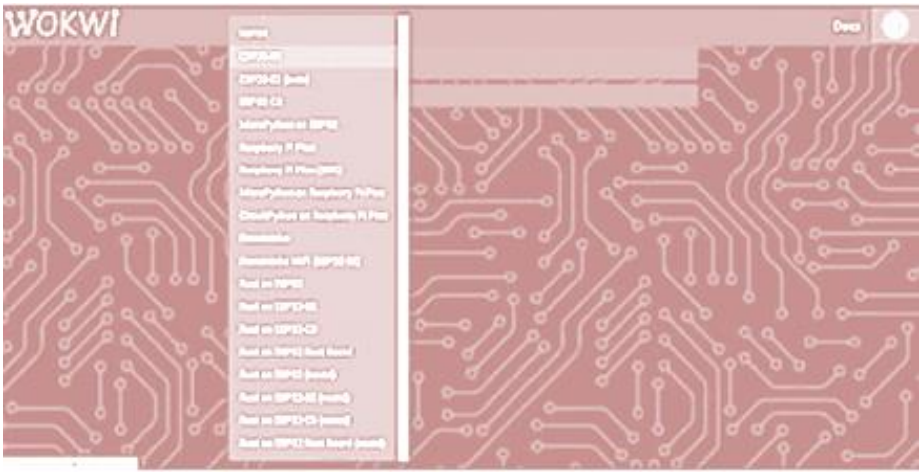

Figure 4 Interface for creating new assignments/projects on Wokwi online

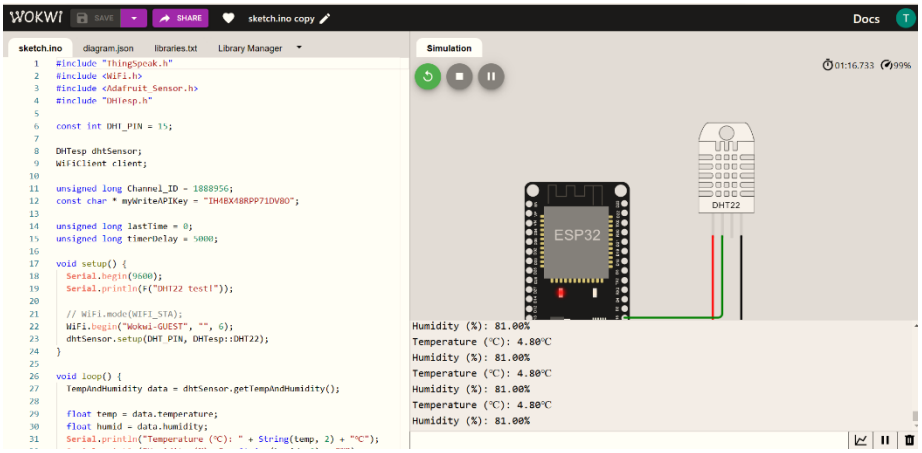

Figure 5 Simulation interface of ESP32 module for measuring humidity using DHT22 online

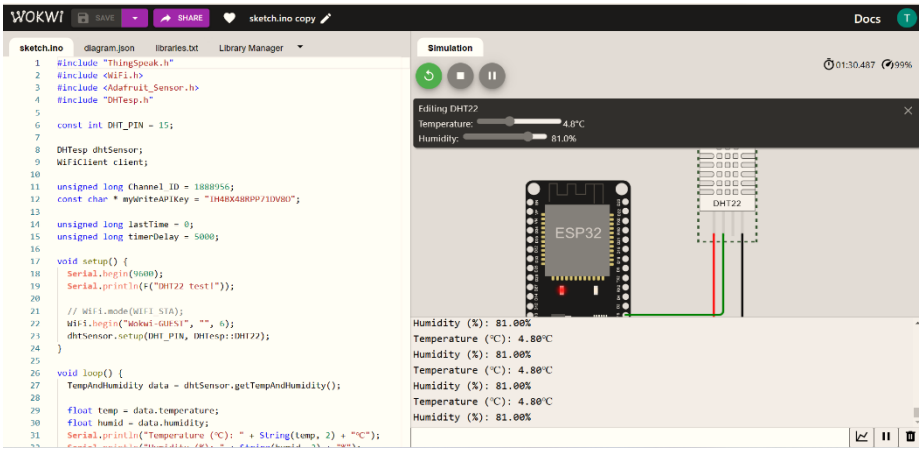

Figure 6 Online temperature and humidity adjustment interface

5. Student simulation results are fed to the IoT Hardware Module ESP

Figure 7 Students load the program for ESP and run it during discussion time

In Figure 7 are the results of students in the Technology block performing a test run of the program after simulating on Wokwi and loading the code for the ESP module for the soil moisture monitoring problem.

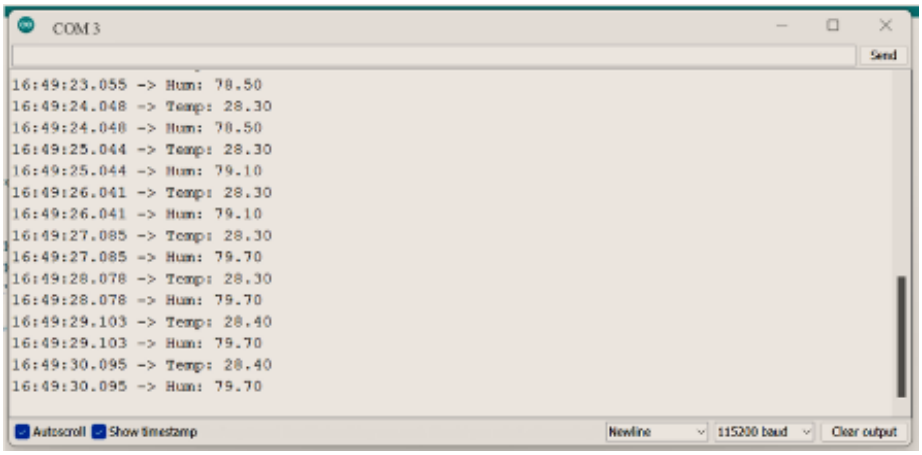

Figure 8 COM display on Arduino

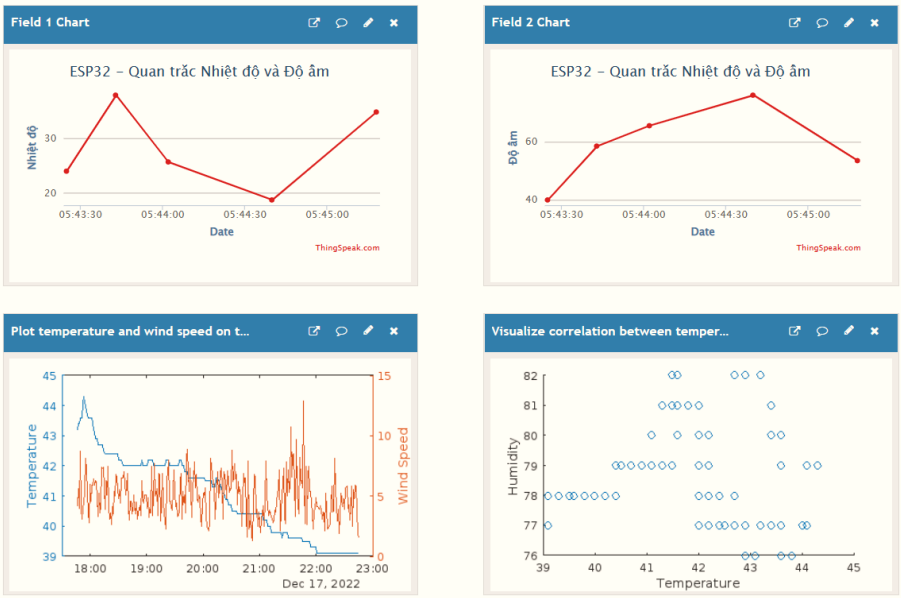

Figure 9 Cloud data display [3]

6. Conclusion

The application of the program will help the academy's students have the opportunity to deploy exercises/projects on embedded programming, IoT anytime, anywhere without having to buy expensive hardware. Especially, learning through examples from the community will create passion for students.

It enables students deploy large exercise content and practice more conveniently, without difficulty in using hardware when performing exercises in embedded programming and IoT due to limited funding and knowledge. In-depth knowledge of hardware, especially for students of Information Technology and Information Security who are not equipped with much knowledge about hardware. With the Wokwi tool, students can practice anytime, anywhere when they have time.

Necessary conditions to apply in teaching for students:

- It is necessary to have the consent and permission of the leaders of the host faculty of the majors, the Practical Experiment Center for common use by students of the Technology and Engineering block of the Academy to use for their study, research and experiment.

- Lecturers need to be disseminated to access the tools in the experimental guide to practice related subjects.
- Students must have a computer connected to the Internet to perform exercises and personal projects when doing assignments and discussing in class.
- Real room, a computer must be connected to the Internet to practice designing and simulating IoT systems.

Compliance with ethical standards

Acknowledgments

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