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Microprocessor On-line Contents using Simulator

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Abstract

With the advancement of the 4th Industrial Revolution(4IR), microprocessor education is on the rise due to the explosive demand for IoT (Internet of Things) and M2M devices. However, it is difficult due to many constraints to efficiently transfer training on hardware assembly and implementation through online training. Thus, we developed a cost-effective online content based on Arduino simulations, Atmel Studio 7, and WinAvr simulator that are required for the utilization of AVR 128. These Camtasia videos overcame the limitation of theory focused on-line education by visually introducing the practical utilization of an actual AVR 128. In this paper, the proposed educational content was provided to university students, and the results of student feedback show that it has a strong effect.

Keywords: *Arduino, AVR128, Microprocessor, On-line content, Simulator*

1. INTRODUCTION

The core of the 4th industrial revolution is the combination of sensors and mobile tele-communication, such as Internet of Things (IoT) and machine to machine (M2M). Within the applying field of it, there are compatible field of M2M such as health care devices, smart home technologies such as light and gas controls, refrigerator and washing machine. Thus, the college educational core of the 4th industrial revolution is an online education of a microprocessor and micro-control. However, the overwhelming portion of online education either involves an electronic chalkboard recorded with a narrative of instructors or recordings of instructors with a presentation using Ready Stream. For the computer programming practicum, the Camtasia recordings of actual hands-on experiments replace the physical practicum and for the microprocessor online education, the recordings of physical assembly and design of hardware parts are provided.

Especially, microprocessor education is a difficult subject even for in-person education for students to fully understand and takes long hours of practicum. Therefore. In this study, we aim to maximize the final learning effect of online microprocessor education by designing two approaches: 1) Towards the beginning of the course, the learning content is maximized with a shortened class time using the Arduino and simulator, 2) Towards the end of the course. The theory of microprocessor utilization is simulated using Atmel Studio 7 and WinAvr Simulator, which are needed for the actual use of AVR 128, and lastly, 3) The recording of the actual AVR 128 utilization is provided for a comprehensive theory and practicum of microprocessor to overcome the

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limitation of the theory based on-line education.

This paper discusses the overall design and characteristics of the developed online content in chapter 2, the detailed explanation of the simulated experiments in chapter 3 and the overall student evaluation on the class and the effect of classes in chapter 4 as a conclusion.

2. The content design of on-line education utilizing simulator

2.1 Overall design and the content

Microprocessor is a single chip, Central Processing Unit with a control unit and a logic circuit such as arithmetic logic circuit, program counter, command decoder and control circuit. Due to this complexity, the education of microprocessor is difficult even for in-person classes. Universities offer advanced microprocessor courses. Yet, the cost of equipment and the limited hours of practicum hinders a big learning achievement for students. In this article, we designed an online microprocessor course of various simulated experiments and practice to overcoming the limitations of theory based online education and avoid the high cost of equipment. Moreover, the simulated experiments are not confided to a finite time but are open to availability of students and numerous repetition. Thus, the course can be taken at the students' convenience multiple time until the students can fully familiarize themselves with the hardware and the software of microprocessor. Lastly, the designed content also includes the recordings of the actual use of Arduino to complete the learning experience of both simulated practice and the actual practice.

There are two major approaches to the designed online content: 1) Arduino simulation and 2) microprocessor simulation. With the Arduino simulation, students learn the basic theory of microprocessor utilization and with the microprocessor simulation, students learn the advanced theory of microprocessor. Also, at the end of the course, students get to simulate a design and development of digital clock Using KeyMatrix program for an advanced Microprocessor application. These educational content is summarized in Table 1 below.

Table 1. Content design and purpose

CONTENT	SUBJECT	METHOD	PURPOSE
Experiments	Microprocessor Activation program	Atmel Studio 7 and WinAvr Simulator	Learning of theory for microprocessor utilization and the practice of using microprocessor
Design of digital clock		KeyMatrix	Text output on LCD and the digital clock output

Education per lecture was sequential. Using the Arduino, students learn the introductory digital theory and then, students' code using microprocessor activation program. The lectures first aim to provide repeated simulation and practice for its corresponding results prior to applying the codes on the microprocessor directly. Figure 1 below suggested the sequential lectures.

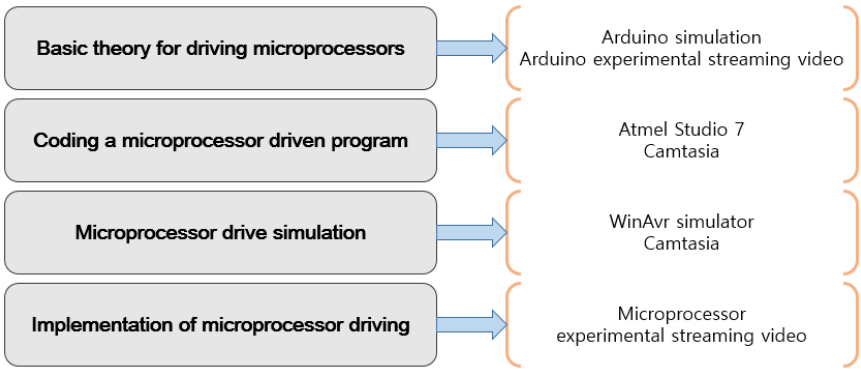

Figure 1. Sequential lecture for the educational content

Looking at the contents per lecture, the introductory theory required for microprocessor involves the comprehension of circuit resistor using LES, serial bus using arrays, the conversion of A/D, the utilization of potentiometer and the utilization of photo resistor. Meanwhile, the microprocessor activation processor lecture involves LED activation program, switch, text on LCD, 7 segments, and the utilization of servomotor. Lastly, the microprocessor utilization lectures on the text output on LCD, English output on LCD by point and KeyMatrix prior to students completing the digital clock.

2.2 Arduino and simulator

Towards the beginning of the proposed online content, Arduino was used to easily learn the introductory theory. As previously mentioned, the fundamentals of microprocessor are very difficult. Therefore, Arduino with easier application and accessibility is used to learn and simulate the fundamentals of microprocessors such as the comprehension of circuit resistor using LES, serial bus using array, the conversion of A/D, the utilization of potentiometer and the utilization of photo resistor. Figure 2 below shows the training of the microprocessor fundamentals of Arduino simulation. After the simulation, the actual application for Arduino was recorded using the same parameters as simulation to evaluate the functionality.

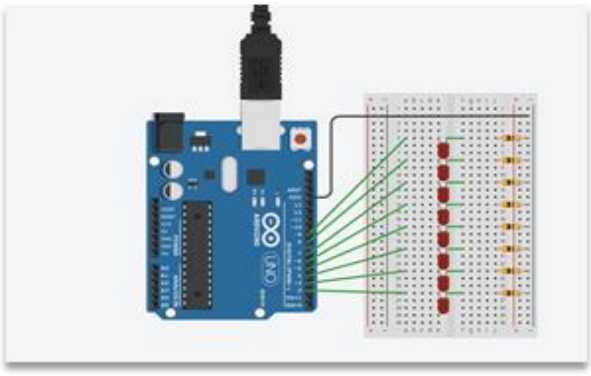

Figure 2. Arduino simulator

The figure 3 is a screenshot of video recording to test the functionality of Arduino.

Figure 3. Recordings of Arduino experiments

2.3 Camtasia recording of Atmel Studio 7 (Activation program)

During the middle section of the educational content, students' code to utilize an actual microprocessor. Atmel Studio 7 is a mandatory program to utilize a microprocessor, AVR 128. The figure 4 shows the Camtasia recordings of coding required for microprocessor. For the actual educational content, the entire process of coding was provided as Camtasia video recordings. Her lies the main hindrance of in-person practicum of microprocessor. Despite the understanding of the theories, it is hard to code correctly after a single practice of coding. Thus, a repetition of coding is necessary but in-peraon lectures cover codings once, unable to provide a flexibility of repetition. On the other hand, on-line lectures have a benefit of providing unlimited practices that match with the student's status of understanding the content. The fugure 4 shows the Camtasia recordings of coding on Atmel Studio 7.

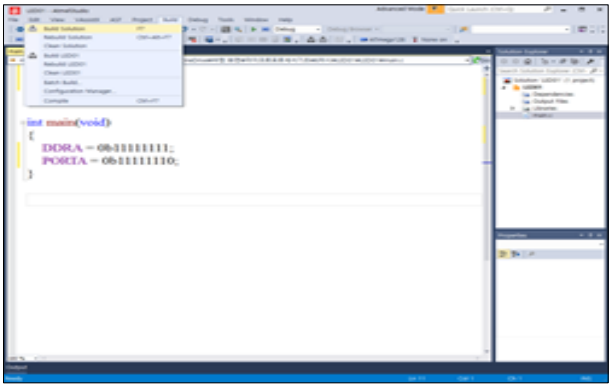

Figure 4. Camtasia recording Atmel Studio 7

3. Practical experiments of microprocessor

3.1 Microprocessor and WinAvr Simulator

Starting lecture 7 of the content, students start on the microprocessor experiments. Typically, for in-person courses, the microprocessor utilization starts after the coding requires for Atmel Studio 7. The amount of time and trouble shoot the actual utilization of microprocessor is very well known to be burdensome for anyone who had instructed an in-person laboratory course. Therefore, the biggest benefit of the proposed online course is the use of simulations prior to the actual utilization of microprocessor. The figure 5 shows the simulation of microprocessor using WinAvr Simulator. The WinAvr Simulator is free from public use, allowing all students

to use the program.

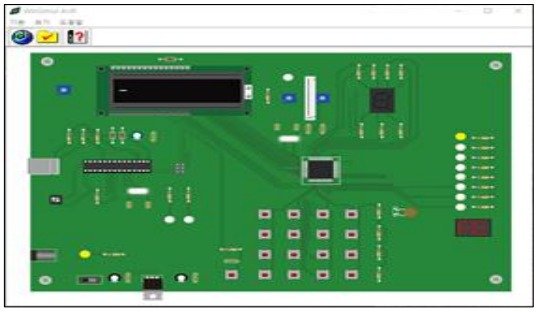

Figure 5. WinAVR Simulator Videos

3.2 Development of digital clock

Designing a digital clock using a microprocessor requires the output of variables as texts on the LCD and the conversion to those texts outputs on LCS using a switch. Thus, Key Matrix was used. The figure 6 is a circuit diagram of Key Matrix.

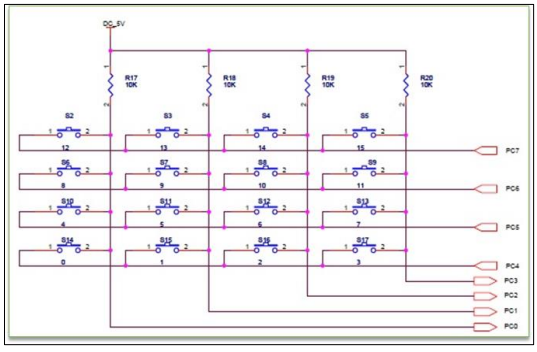

Figure 6. KeyMatrix Circuit Diagram

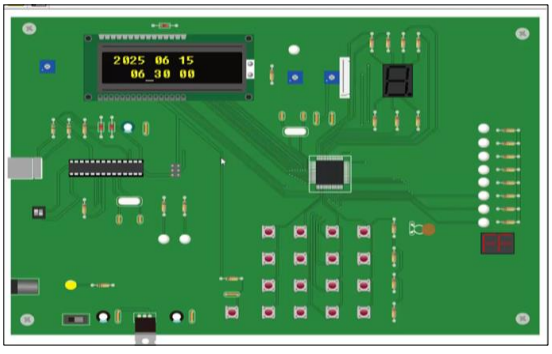

Figure 7. Simulation of the digital clock

From the designed digital clock, Key can change English text, year, month, day, hour and the minute. Figure 7 shows the simulated digital clock.

3.3 Evaluation of on-line experiments and practicum

The proposed educational content was offered to students at the H cyber University. Out 50 students, 45 students have given the feedback; To the question of “the class materials were clearly structured”, 29% replied with “agree" and 51% replied “strongly agree" and to the question of “lectures and contents provided were useful in understanding the material and the

concepts", 31% replied with "agree" and 49% replied with "strongly agree", giving the overall course score of 4.24 out of 5.0. The students also gave numerous positive short feedback of "video recordings of experiments were helpful" and "I was able to understand the fundamentals and the working theory of microprocessor".

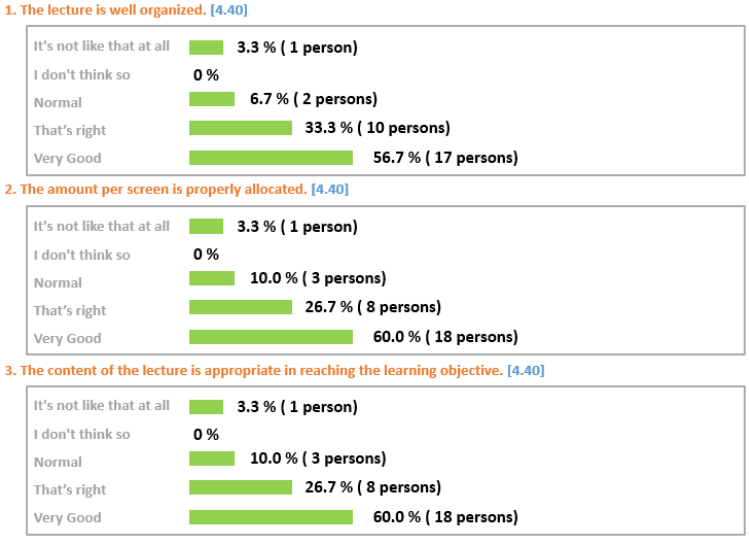

Figure 8. Course evaluation of H Cyber University

For the suggested improvements, students wished for more advanced materials to be a part of course material, endorsing the fact that we aim to completely familiarize students with the fundamentals of microprocessor was achieved.

4. Conclusion

In this paper, we designed an online educational material for the utilization of microprocessor using Arduino and a microprocessor simulator overcoming its complexity and abstrusely of in-person microprocessor experiments. Hands-on experiments of microprocessor can become time consuming due to numerous trial-and-errors. Thus, using a simulator based online course, the repetition of practices and the shortened time spent on experiments favors the genuine comprehension of the course material. Moreover, the course was evaluated to provide an easy learning environment for a difficult subject of the fundamentals of microprocessor. Therefore, a structured development of numerous levels varying the difficulty of the course is demanded.

REFERENCES

[1] HAMRITA, T. K.; MCCLENDON, R. W. A new approach for teaching microcontroller courses. *International Journal of Engineering Education*, 13.4: 269-274, 1997.
[2] KIM, Seong-Yeol. A Study on the Effectiveness of IoT Coding Education Using Microbit. *The Journal of the Korea institute of electronic communication sciences*, 15.2: 363-370, 2020.
[3] KIM, Hye-jin. U-Learning Scheme: A New Web-based Educational Technology. *Journal of the Korea Academia-Industrial Cooperation Society*, 12.12: 5486-5492, 2011.
[4] LEE, Jae-Min. An Approach for Development of Academia-Industrial Cooperation and Design Education-C entered Creative Engineering Education. *The Journal of Korea Institute of Information, Electronics, and C ommunication Technology*, , 12.6: 573-581, 2019..
[5] SAETHER, Kristian; FREDRIKSEN, Ingar; DIRECTOR, AVR Product Marketing. Introducing a new bree d of microcontrollers for 8/16-bit applications. *Atmel Corporation White Paper 7926A–AVR*, 2008.
[6] BongEon Jo, Young Sam Lee, "Development of a Hardware-in-the-Loop Simulator for BLDC Motor Driving Using Microcontroller", Journal of Institute of Control, Robotics and Systems (2018) 24(12):1101-1110, 2018.
[7] Eunsang Lee, " Implementation of Digital Logic Circuits Using Arduino: Focusing on the Adder", Asia-pacific Journa l of Multimedia Services Convergent with Art, Humanities, and SociologyVol.9, No.11, November, 2019.
[8] GONG, Dong-Hwan; SHIN, Seung-Jung. Analysis of Arduino Timer Callback for IoT Devices. *The Journ*

al of The Institute of Internet, Broadcasting and Communication, , 18.6: 139-143, 2018.
[9] LEE, Jongbok. Design and Simulation of ARM Processor with Interrupts. *The Journal of The Institute of Internet, Broadcasting and Communication*, 19.6: 183-189, 2019.
[10] Arduino Playground, http://playground.arduino.cc