Raspberry Pi-Based Solar System Learning Media

M F Wicaksono1*, Syahrul2, M D Rahmatya1, M A F Rahman2
1Program Studi Teknik Komputer, Universitas Komputer Indonesia, Jl. Dipati Uruk 112-116 Bandung, Indonesia
2Program Studi Sistem Komputer, Universitas Komputer Indonesia, Jl. Dipati Uruk 112-116 Bandung, Indonesia
3Program Studi Manajemen Informatika, Universitas Komputer Indonesia, Jl. Dipati Uruk 112-116 Bandung, Indonesia

Email: *mfajarw@email.unikom.ac.id

Abstract. The main purpose of this research is to design and create solar system learning media for elementary school children. This tool will provide visualization related to the solar system so that with this tool the child is expected to be interested in learning. The method used in this study is an experimental method. All DC motors, servo motors, and supporting electronic modules in the system will be controlled using the Raspberry Pi. This Raspberry has supported the process of converting text into sound where this process will be used for the explanation of each planet and the process of feature phenomena that occur in the solar system. The results of this study are learning media for the solar system. All of this is expected to provide knowledge related to planets and phenomena that occur in the solar system and can be applied in elementary schools.

1. Introduction

This paper describes the design and manufacture of instructional media related to simple solar system learning aids using Raspberry Pi for elementary school children. In this learning media, there is an explanation in the form of sound related to each planet in the solar system and the phenomenon that often occurs as eclipses so that it is hoped that elementary school children will be interested and stimulated to learn.

The nature of this interest belongs to extrinsic motivation in learning. As discussed in the journal, early in the learning process can be helped by extrinsic motivation [1]. This extrinsic motivation is needed to complete intrinsic motivation [1]. Other journals also discussed the increasing interest in learning that can be done by utilizing information technology and various media presentations [2]. Other paper also discussed learning motivation that must be supported because this learning motivation is something related to learning that is related to student motivation to be interested and continue to make efforts to continue learning continuously and improve learning outcomes [3]. Therefore in this study, an attempt was made to create a solar learning media that is expected to attract students’ interest in learning.

In a study that has been done related to the role of technology media for the learning process, it is mentioned that learning methods that utilize technology can stimulate learning interest and improve student performance [4]. Research related to the solar system for school children has been carried out using virtual reality and augmented reality technology. One such study is a study conducted in 2017. This study created a solar system learning media using animation and virtual reality [5]. However, one of the most critical deficiencies of virtual reality technology is in terms of costs as mentioned in the 2018 paper wherein the journal paper explained that cost is a problem in the application of this technology because virtual reality is new and expensive technology so that not everyone can afford it.
In addition, VR needs to be connected to devices such as PCs or laptops with certain specifications so that users can experience according to the objectives to be achieved.

With these problems, it is necessary to have a solar system learning media that is relatively easy to reach in terms of cost, but does not lose its main purpose, namely to provide an introduction to solar system learning. In this design, Raspberry Pi is used as the main brain of the system. Raspberry Pi will accept input from buttons pressed by children. Inputs received will be processed in the program and determine which text will be issued by the Raspberry Pi in the form of sound. gTTS text to speech from Google Speech was used as the method to convert text into sound When the child presses the button, the Raspberry Pi will send a signal to the motor driver to rotate the planet display and turn on the appropriate LED. On the web page, there are facilities that can be used by teachers to change text and test tools according to the text that has been stored.

2. Method

The three main parts that exist in the design of this research system are the input part, the process part, and the output part. On the input, there are 11 push buttons connected to the Raspberry Pi. Furthermore, Raspberry Pi is included in the processing part which is the main part of this system. The output section includes 8 LEDs, 4 motor drivers related to the control of 8 DC motors, servo motors and USB soundcards and speakers. These sections are indicated by the block diagram in Figure 1.

Figure 1. System block diagram solar system learning media

Based on the block diagram, it can be explained that Raspberry is used as the main brain of the system. Raspberry Pi is a mini PC, and in this study used Raspberry Pi 3 which has 1GB of RAM. The programming language used for Raspberry Pi is the Python programming language [7]. Inputs received from the push button will be received and processed by the Raspberry Pi. The results of this processing determine the explanation related to the planet whose text has been stored in the Raspberry Pi. The explanation will be issued in the form of sound. For the problem of sound output, the text-to-speech
method is used in this study using Google Text-to-Speech with gTTS library. gTTS can be used as an interface between a system created with Google Translate Text-to-Speech [8]. With gTTS, we can convert text to sound and can be transferred as mp3 files [9]. This mp3 file will be run by Raspberry Pi. Other published controls are controls for whether or not active DC motors are carried out through motor drivers by providing HIGH or LOW logical values. The motor driver used is the L298N module. IC L298 allows us to regulate the motor speed and direction of motor rotation [10]. This motor driver also has a protection function related to overcurrent [11]. Furthermore, in this system, Raspberries can be issued from servo motors that are used to change the phenomenon of solar and lunar eclipses. The servo motor used is the Tower Pro SG90 servo motor. This servo motor has 3 pins namely VCC, GND and control input pins [12]. The movement of this motor can be adjusted by sending PWM signals [13]. Movements can be carried out between $0^\circ$ and $180^\circ$ [14].

3. Results and Discussion

Figure 2 below shows the physical form of a solar system learning tool using Raspberry Pi that has been made. On the device, there are 11 buttons in which 9 buttons are used to explain the planets for each planet and sun, while the other two buttons are used to explain lunar eclipses and solar eclipses.

![Figure 2. Raspberry Pi solar system learning media](image)

In the loop created in the program, the Raspberry Pi will make a connection to the server and all buttons will be continuously checked. When children press a button with the name of a particular planet, the Raspberry Pi will detect it. The next action, Raspberry Pi will make a sound related to the intended planet explanation using Google Text to Speech (gTTS), activate the LED on the intended planet and activate the motor on the intended planet. After all this process is complete, the LED and motor will be deactivated again and the Raspberry Pi will wait for the next push button press.

When the solar eclipse button is pressed, the moon contained in the device is moved by a servo motor to an angle of $0^\circ$ so that the moon’s position is between the sun and the earth. After the position of the moon reaches the specified position, then Raspberry Pi will make a sound-related explanation of the phenomenon. However, if the child presses the lunar eclipse button, then the moon contained in the device is driven by a servo motor to an angle of $180^\circ$ so that the earth’s position is between the sun and the moon and then Raspberry Pi will make a sound-related explanation of the phenomenon. If teachers want to change the planet associated material explanations, then the teacher can log into a web application that is already built. In this web application, the teacher can change the material and then test it directly on the tools that have been made. Figure 3 shows the login page and start page of this web application.
On the home page, there are two main choices, start and edit. The start option is used to test previously-stored text directly to the hardware device, while the edit option is used to change material. The appearance of the edit page in this application is quite simple, where the teacher can choose the name of the planet through the form provided and then can fill new material through the text area that has been provided and then submit it to save it. This edit page is shown in Figure 4.

Figure 5 shows the start page where this page is used to test the text that has been stored and run directly on the learning tools that have been made. On this page, the Teacher can press each picture of the planet to test the material that has been stored and can press the button related to solar and lunar eclipses. When the Teacher clicks the picture of the planet, the Raspberry Pi will make a sound related to the explanation of the selected planet, activate the LED and activate the corresponding motor.
The design of this learning media does not require a large cost because this tool only uses a mini PC Raspberry Pi. However, other previous studies conducted in 2017 [5] require large costs because virtual reality is a new technology and requires several expensive devices such as PCs or laptops with certain specifications [6] so that not everyone can afford it.

4. Conclusion
Solar system learning media using Raspberry Pi can be used in elementary schools has been completed and is expected to be tested directly to primary schools that involve both the teacher and children as the main user, so researchers can get feedback related to the improvement of tools and other features needed. With this tool, it is hoped that children will be more interested in learning about the solar system.

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References
[1] Lin, M. H., Chen, H. C., & Liu, K. S. 2017. A study of the effects of digital learning on learning motivation and learning outcome. Eurasia Journal of Mathematics, Science and Technology Education, 13(7), pp. 3553-3564.
[2] Hockly, N. 2012. Substitute or redefine. Modern English Teacher, 21(3), pp. 40-42.
[3] Shabani, K. 2012. Dynamic assessment of L2 learners’ reading comprehension processes: A Vygotskian perspective. Procedia-Social and Behavioral Sciences, 32, pp. 321-328.
[4] Sakat, A. A., Zin, M. Z. M., Muhamad, R., Anzaruddin, A., Ahmad, N. A., & Kasmo, M. A. 2012. Educational Technology Media Method In Teaching And Learning Progress. Advances in Natural and Applied Sciences, 6(3), pp. 484-490.
[5] Eryanto, D. R. D., & Prestiliano, J. 2017. Design of learning media for the solar system lesson using animation and virtual reality. Open Science Journal, 2(1).
[6] Gandhi, R. D., & Patel, D. S. 2018. Virtual reality—opportunities and challenges. Virtual Reality, 5(01).
[7] Upton, E., & Halfacree, G. 2014. Raspberry Pi user guide. John Wiley & Sons.
[8] Tejedor, J., Toledano, D. T., Lopez-Otero, P., Docio-Fernandez, L., Montalvo, A. R., Ramirez, J. M., ... & Rodriguez-Fuentes, L. J. 2019. ALBAYZIN 2018 spoken term detection evaluation: a multi-domain international evaluation in Spanish. *EURASIP Journal on Audio, Speech, and Music Processing*, 2019(1), pp. 16.

[9] Gharge T, Chitroda C, Bhagat N, Giri K 2019 *AI-Smart Assistant*. International Research Journal of Engineering and Technology (IRJET), Volume: 06, Issue: 01 | Jan 2019, p-ISSN: 2395-0072 e-ISSN: 2395-0056

[10] Maung, M. M., Latt, M. M., & Nwe, C. M. 2018. DC Motor Angular Position Control using PID Controller with Friction Compensation. *International Journal of Scientific and Research Publications*, 8(11), pp. 149.

[11] Yin, L., Wang, F., Han, S., Li, Y., Sun, H., Lu, Q., ... & Wang, Q. 2016. Application of drive circuit based on L298N in direct current motor speed control system. In *Advanced Laser Manufacturing Technology*, 10153, p. 101530N. International Society for Optics and Photonics.

[12] Dagli R 2019 Design and Implementation of Medicine Dispenser. *International Advanced Research Journal in Science, Engineering and Technology*, 6(06), p-ISSN: 2394-1588 e-ISSN: 2393-8021

[13] Orji E. Z, Oleka C. V, Nduanya U. I, 2018 Arduino Based door Automation System Using Ultrasonic Sensor and Servo Motor. *Journal of Scientific and Engineering Research*, 5(4). ISSN: 2394-2630

[14] VanHuy, T., Minh, D. T., Kien, N. P., & Vu, T. A. 2017. Simple robotic hand in motion using arduino controlled servos. *International Journal of Science and Research (IJSR)*, 6(3), pp. 972-975.

[15] Tawari pg T, Nathe A. J 2016 Comparative Study Of Different Frameworks of PHP. *International Journal of Research in Computer & Information Technology*, 1(2), July 2016, ISSN: 2455-3743