Microcontroller-Based Wireless System for Sliding Book Learning Media Tools

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ABSTRACT

This design was performed in the development of the Sliding Book learning media tool by utilizing an Arduino UNO R3-based microcontroller control system. The addition of sensors and controllers in the form of Photodiode sensors and infrared remotes is undertaken with the intention of creating a wireless control system. The data is retrieved in the form of voltage data, current data, and the length of time used in one sliding book viewing. The outcome of this study is a sliding book learning media control design with an Arduino-based wireless control system and the addition of an infrared remote sensor and a photodiode sensor. The test results indicate that the command function of the infrared remote works well to provide wireless control of the motor rotation direction of the sliding book tool on the forward, reverse, and stop displays, and when determining the sliding page position, the photodiode sensor function corresponds to the design position of the page boundary reading. In the final stage, this control system has been able to fulfill the basic functions and recognize sensor readings from the wireless control of the sliding book learning media tool, with infrared remote command reading settings and proximity sensors that can provide direct control to the slide book.

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1. INTRODUCTION

As the world and technology advance, new efforts are made to develop and maximize the potential of tools that make human labor more efficient and streamlined. This study raises the issue objectively because there is still a disparity between the quality of learning delivery and the capacity of children to receive educational knowledge in formal educational institutions. Based on the ratio of the number of teachers (6%) to the number of students (94%) in an educational institution (PAUD Statistics 2019/2020) and the effectiveness of the use of learning media tools, there is an effort to improve communication between teachers and students. From the perspective of learning media in the teaching and learning process, learning media tools can help and foster students' interest, provide psychological influence, and motivate children in their learning. Therefore, it is necessary to instill in children from a young age an understanding of the motto "learning while playing, playing while learning" through the stimulation of learning tools or media containing basic technology as a driver for the development of moral, religious, physical-motor, socio-emotional, cognitive, linguistic, and social aspects, particularly in the technological era of today (Rita Kurnia et al., 2020).

Prior research related to the direction of this study has been conducted on the topic of microcontrollers (Jufriyanto et al., 2020) pertaining the design of learning media for sorting objects based on microcontrollers with conveyor mechanics and the use of sensor functions. The results of their research have inspired the development of a tool design media sliding book that also adopts the mechanical system of a conveyor machine, but in a more compact form. Referring to the mechanics of conveyor machines, the concept of developing a sliding book tool model as a mechanical scroll book that can be moved by an electric motor and sensor readings is presented.

We also discovered additional findings that drew our attention as authors in bringing up this topic in an effort to solve problems deemed crucial to obtaining the best conditions from the technical side of learning media tools. It is hoped that this research will achieve the goals of developing sliding book learning media tools.

Reviewing the relevant literature and references on this topic, we discovered that, in research related to the sliding book learning media tool, there is still room for the development of new features, solutions, and deficiencies that are related to the study's problem statement, which should be referenced in the study's introduction.

Thus, based on prior research pertaining to mechatronic learning media tools (Rita Kurnia et al., 2020), we have identified aspects of the development of an electronic-based wireless control system that have escaped the attention of previous researchers. As a result, we see a need for an additional device in the form of a control system that includes a set of microcontroller-based remote-control devices that can be reprogrammed as needed, as a new innovation in the form of optimally developed programmatic control function settings.

The reference to the design of the microcontroller-based object-sorting learning media (Jurfriyanto et al., 2020) serves as a tool model reference for investigating the form of mechanics and sensor functions that we adapted into a simpler model on a sliding book scroll. However, by removing unnecessary supporting features from the sliding book tool.

Adopting the concept of a microcontroller-based wireless control system and remote-sensor coordination, we began with the design and assembly to obtain the estimated results that are closest to the optimal function of this tool's benefits for educational institutions that require technology-based learning media tools.

2. METHOD

Using design, assembly, and direct measurement techniques, this study's findings are obtained beginning with the design in the form of design, component selection, determining variables, and validating data.

Fig. 1. The sliding book tool's design

The manufacture of the tool's main body or framework, which supports the placement of mechanical components such as an electric motor mount, hollow iron coils for moving picture books, and transmission chains for electric motors, is the first step in its design (see **Fig. 1**). Then, assemble the control system's primary components, which include the remote and infrared receiver module, the microcontroller, the relay module, the DC power supply, the DC motor, and the photodiode sensor.

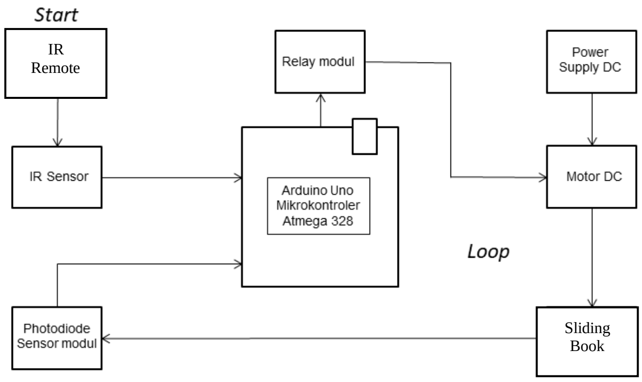

Fig. 2. Block Diagram of Control System

Fig. 2 depicts a general system block diagram with several components that perform the following functions:

a. An IR remote is a wireless communication device that produces infrared waves with a specific code to be received by a receiving sensor.
b. IR Sensor, which may connect with the remote and the receiver module, is a communication receiver of infrared waves generated by the remote.
c. Arduino Uno R3, is a microcontroller-based system control center that can store commands and receive input to issue output as commands based on functions defined in the programming language.
d. A relay module connects to the DC motor's output pin as a connection or voltage breaker.
e. The mechanical sliding book is powered by a DC motor.
f. The photodiode sensor will be the sensor limit for the application limits defined on the mechanical sliding book.

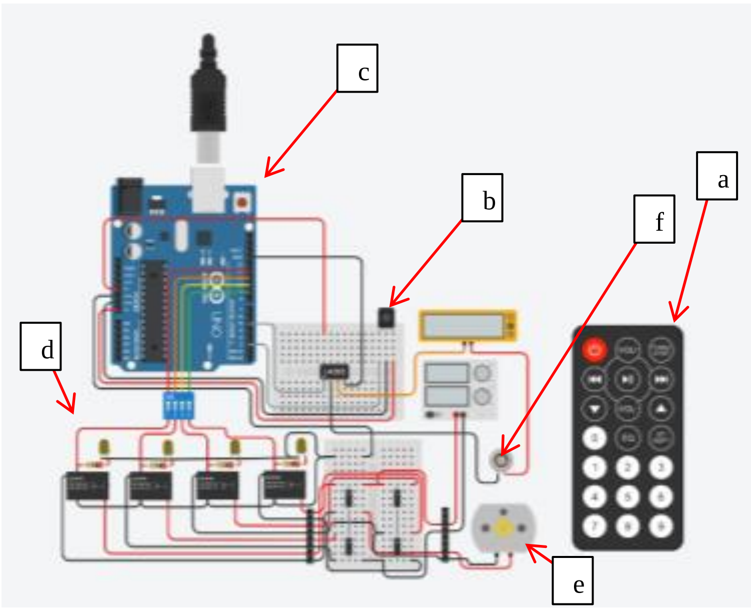

Fig. 3. Schematic of Electronic Design

Fig. 3 shows a design of an electronic system for remote control and wireless communication based on an infrared remote, with various major components and components that complement each other's tasks. This tool is typically used in the form of an electrical and mechanical circuit to test and analyze the results of limit photodiode sensor readings and then to test the overall performance of the tool. In this plan, the author employs an Arduino Uno R3 Series microcontroller.

The data collecting technique employed is direct measurement of the mechanical function of the control system design on the rotational ability of the electric motor to the displacement of the picture book page

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display on the sliding book. The duration of the display page movement in units of time, the electric current that passes through the electric motor, and the amount of electric voltage used are all measured. We use the voltage(V), current (I), and time ratio analysis method to find and validate the design of the ideal components (t). P=V x I x t is the electric power formula, where P is the electric power, V is the voltage used, and I is the electric current, which in this case is measured in Amperes.

3. RESULTS AND DISCUSSION

This discovery has a deeper meaning in the form of a set of controls for sliding book media tools that can be calibrated and reprogrammed. We created it using a combination of electronic components that are linked together, then to support the purpose of the microcontroller-based wireless remote control function (1) and the arrangement of components in a control box made of plastic material loaded with microcontroller components (1) Arduino uno R3, power supply (6) (rectifier) 220V to 5V dc, 5x3cm pcb board (3), relay bridge module (4), data input and output pin connectors, infrared sensor (8) wirelessly connected with infrared remote (2), and a photodiode sensor (7) that reads the distance limit in the light and dark colour difference on the sliding book, as well as an additional cooling fan. Fig. 4 depicts a component load inserted into a 12.5 x 8.5 x 5cm control box that functions as a control box with each output and input pin.

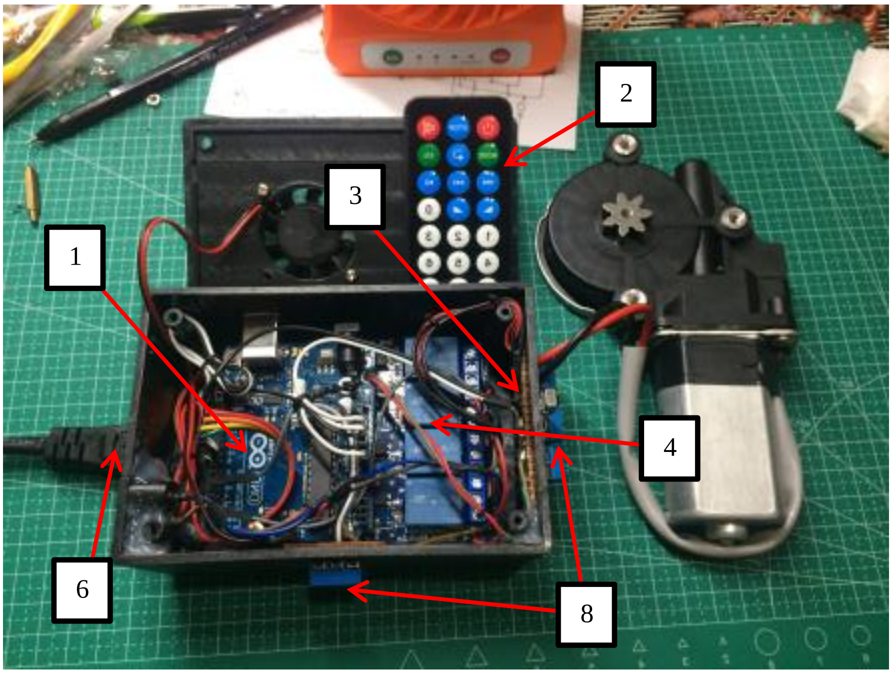

Fig. 4. Control System Box

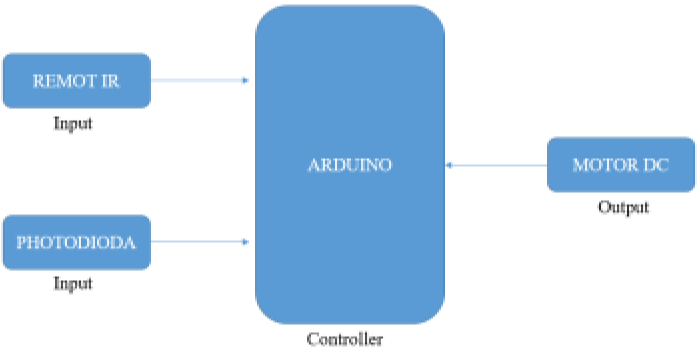

Fig. 5. Block Diagram Control in General

Following that is a redesigned drawing of a sliding book media tool, can be seen in the view of Fig. 6 with claims of technical drawings in 2D and 3D views, as well as units of measurement and a picture of component placement for easy assembly. If seen in Fig. 5, a general control diagram block scheme is depicted with 2 inputs and 1 output.

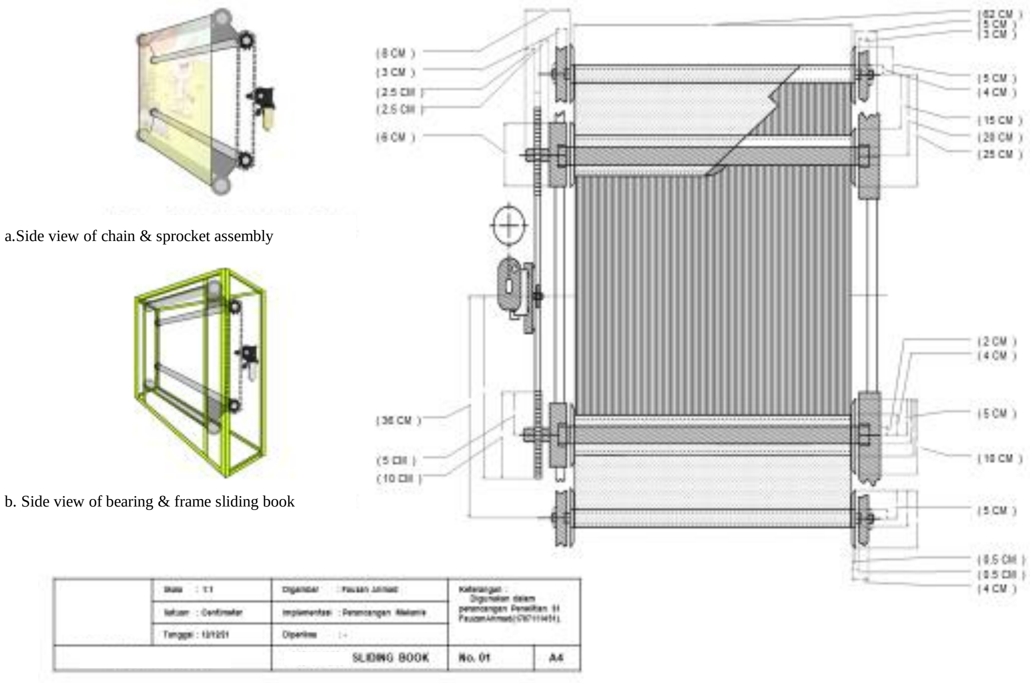

Fig. 6. Sliding book technique

3.1. Test results

Comparison with previous researchers findings in the form of progress in this research is a series of controls in a control box that can be calibrated and reprogrammed according to the needs of sliding book controls for recommendations for future development. In view of Fig. 7, the process carried out is calibration and reprogramming take the form of adjusting the identification button on the infrared remote control, setting the display position on the moving image sliding book with sensor readings that can be calibrated according to the rotation of the electric engine, and adjusting the direction of movement of the motor rotation for electronically controlling the moving image display via the microcontroller I/O.

During the test, the authorised remote buttons are pressed one by one. The serial monitor in the Arduino UNO application can be used to check whether the button is working.

Table 1. Validation of Infrared Remote-Control Buttons

Control Function Test	Monitoring			
	Stage -1	**Stage -2**	**Stage -3**	**Results**
Forward Function	FFE01F	FFE01F	FFE01F	Valid
Reverse Function	FFA857	FFA857	FFA857	Valid
Stop Function	FF629D	FF629D	FF629D	Valid

Table 1 shows that the buttons functioned properly and that the Arduino controller responded appropriately. This indicates that the three registered buttons can function properly and without error. The serial numbers registered on the infrared remote are encoded and decoded for forward function (FFE01F), reverse function (FFA857), and stop function (FF629D).

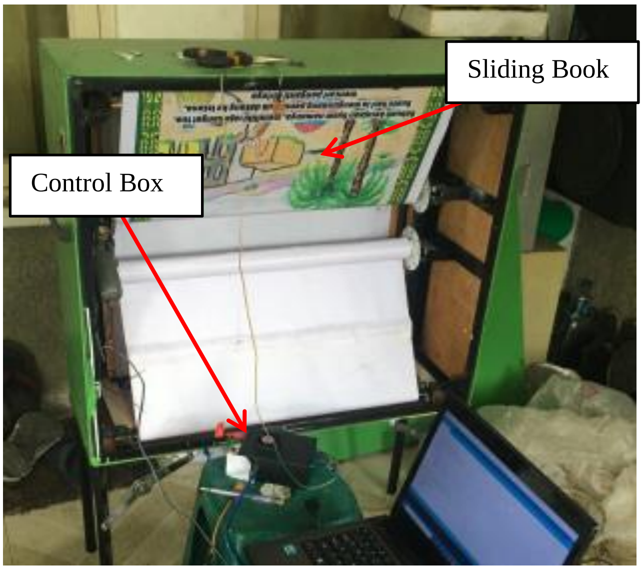

Fig. 7. Sliding Book Test

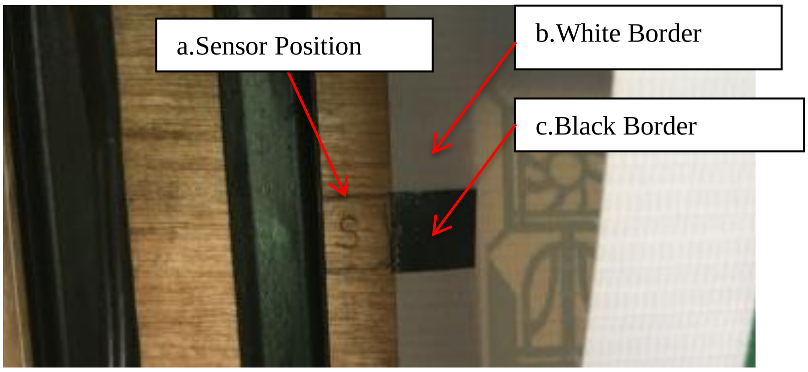

Fig. 8. Photodiode Sensor Positioning

Table 2 shows the results of testing the photodiode distance sensor. Fig. 8 shows the position of the sensor module with a pre-determined dark-bright position reading. Table 2 shows the results of testing the photodiode distance sensor on the pre-determined dark-bright position reading. Based on the photodiode sensor validation test on the accuracy of reading the dark and light position as a distance limit, it generates a measurement requirement in the form of reading the electric current (A) across the electric motor to the speed of moving the moving image display in frames per unit time (second) by testing two voltages, namely 5V and 12V, with the goal of determining the ideal electric voltage and determining whether the designed control system is already working properly or whether there are still unwanted failures.

The first measurement is taken by pressing the forward button while the Sliding Book is installed, allowing researchers to compare the 5V and 12V voltages. At 5V, the current obtained is 0.76A, and at 12V, the current obtained is 0.98A.

Table 3 shows the results of measuring the sliding book media tool with the Sliding Book installed by pressing the backward button.

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Table 2. Test Measurement for Sliding Books Forward Direction

Slide/Page		Condition of Voltage	
		5 Vdc	12 Vdc
Beginning	**End**	**Time (s)**	**Time (s)**
1	2	33.51	10.40
1	3	64.86	20.34
1	4	97.74	29.57
1	5	128.86	39.12
1	6	155.99	48.25
1	7	183.98	56.87
2	3	27.87	10.41
2	4	53.07	19.61
2	5	79.67	29.04
2	6	105.02	37.58
2	7	129.62	46.21
3	4	29.31	9.15
3	5	55.10	18.18
3	6	80.78	26.64
3	7	104.88	34.97
4	5	27.33	9.00
4	6	56.46	17.56
4	7	84.56	26.21
5	6	28.89	9.25
5	7	57.51	18.21

The second stage of measurement is completed by pressing the backward button and obtaining the current measurement data, which is 0.82A at 5V and 1.08A at 12V.

The first stage's power consumption is determined by calculating the total power requirement at 5V and 12V, respectively.

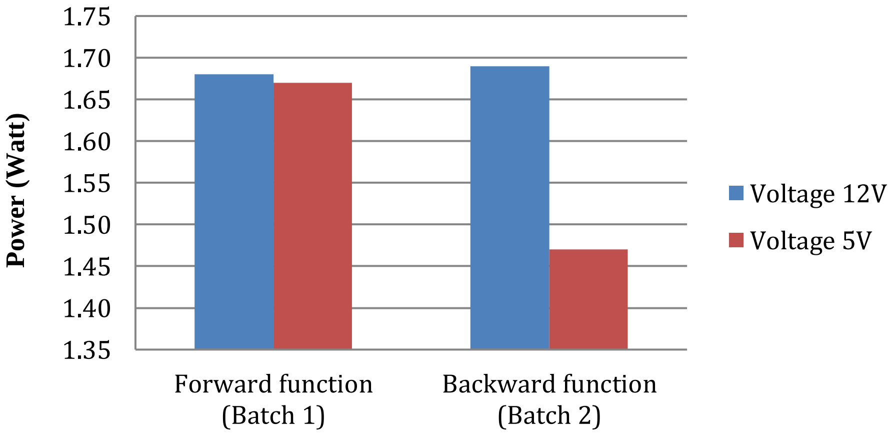

Fig. 9. Voltage (V) and Electric Power Consumption (W)

Table 3. Test Measurement for Sliding Books Backward Direction

Slide/Page		Condition of Voltage	
		5 Vdc	12 Vdc
Beginning	**End**	**Time (s)**	**Time (s)**
7	6	25.97	8.31
7	5	50.39	24.62
7	4	74.72	32.07
7	3	97.17	39.97
7	2	120.98	47.67
7	1	143.04	55.28
6	5	24.43	8.18
6	4	48.51	16.17
6	3	70.79	23.6
6	2	94.59	31.54
6	1	116.92	38.96
5	4	23.81	8.20
5	3	46.25	15.69
5	2	71.06	23.86
5	1	94.69	31.12
4	3	23.01	8.26
4	2	48.48	16.39
4	1	72.54	23.62
3	2	24.75	8.21
2	1	23.73	7.96

The obtained data show a comparison of two voltage magnitudes, namely at 5V and 12V, with each power consumption used by the electric motor in two stages of testing, the forward and reverse functions in moving the sliding book through the control system. On the slide display test/Advanced page, the power requirements of the first stage of the sliding book learning media tool are:

In Fig. 9 is a graph of electricity consumption used in the sliding book learning media tool with wireless control. At a voltage of 5V for the first stage of learning on a slide display/advanced page of 1.67 watts during the average use of a full display of one picture story During a full display of one picture story, the power required to use the sliding book learning media tool at a voltage of 12V in the first stage of the slide display/advanced page is 1.68 watts. In the slide display/back page test, the power requirements of the second stage of the sliding book learning media tool are as follows: The power required to use the sliding book learning media tool at a voltage of 5V in the second stage of the slide display/back page is 1.47 watts during the average use of a full display of one picture story. The power required to use the sliding book learning media tool at a voltage of 12V in the second stage of the slide display/back page test is 1.69 watts during the average use of a full display of one picture story. When compared to similar tools in earlier studies as research references, there are gaps in the old tool control system, where in the previous reference research it was still a standard control that had not been integrated with wireless remote control or a system that could be calibrated and reprogrammed, which was in the previous tool. Only forward and reverse control buttons are found on the tool's body, and no recommendations for the use of ideal components have been found in the assembly.

In the development of tool mechanical systems, it was discovered that there was no concise enough guide in assembly in previous reference research; in this update, we add a reference picture for sizes in 2D and 3D designs to make assembly easier. Furthermore, we want to prioritize the design of a microcontroller-based infrared remote wireless control system that can be calibrated and reprogrammed in a control box, as well as assembly design suggestions in the form of 2D and 3D technical drawings, in this research.

4. CONCLUSION

It is hoped that these findings or updates will be useful for furthering science and technology from further developments to the design of sliding book learning media tools, so that they can be applied to academic institutions especially the educational institutions in potential areas, such as the application of 3T that stands for frontier, outermost, and least developed regions. It requires a 5V source power in the first stage display test with the function of the infrared remote sensor and photodiode sensor, which is 1.67 watts in the forward button test. The power requirement with a 12V source in the first stage of the display test is 1.68 watts for the forward button test, 1.47 watts for the reverse button test with a 5V source in the second stage of the display test, and 1.69 watts for the rewind button test with a 12V source in the second stage of the display test. The power requirements for 5V and 12V input sources did not differ significantly. This demonstrates that using a 12V input source as a reference for the amount of electrical voltage on the device is faster than using a 5V input source. Following research, it was discovered that there are still many things that need to be addressed and developed, with the hope that it can serve as a reference for other researchers to develop a more efficient control system for sliding book learning media tools by selecting more effective types of sensors, the type of electric motor, the type of remote, and so on. So that it can be used as a functional reference for developing alternative learning media tools in areas where this tool has the potential to be useful.

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