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Real Time Clock (RTC) Module Based Dance Humanoid Robot Timer System

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ABSTRACT

The Indonesian Dance Robot Contest (KRSTI) is a competition for the manufacture, design, and programming of dance robots with elements of the arts and culture of the dance department, especially the archipelago. The obstacle faced by the robot is when the robot is required to stop according to time on the music but there is a movement that appears when the time has been declared over. The method used is using the RTC module. The DS3231 type RTC module is a circuit that functions to store time and date with accuracy and precision and is integrated with the AT24c32 eeprom serial for other data storage purposes. The results of time research testing on this robot are running well, the first results obtained are that the robot can adjust the time when it runs. Furthermore, at the time of pause the RTC module does not interfere with the running of the robot. Finally, the success rate of the robot stopping at the specified time is 100%, the robot can be tested with time according to the user's wishes.

1. Introduction

The development of world life over time, is growing very rapidly, one of which is in the field of technology, currently technology has helped humans a lot in various aspects, especially in the field of robots [1]. Robots are a type of technology that helps human work [2], with this idea, the Indonesian state and even the world started a special competition to create robots with special abilities according to the categories that have been contested, one of the categories in the competition organized by the State of Indonesia is shaded by the National Achievement Center (PUSPRESNAS). or commonly called the Indonesian Robot Contest (KRI) [3] is the field of dance or by another name the Indonesian Dance Robot Contest (KRSTI). KSRTI is a humanoid type robot that is specifically designed as a human clone that has two legs, both hands, a body and a head. KRSTI is a competition for making, designing and programming dance robots with elements of art and culture in dance, especially the archipelago. The KRI competition is held every year with a different theme.

Universitas Ahmad Dahlan college (UAD) annually takes part in the KRI event, especially at KRSTI with a team called "Lanange Jagad", the purpose of establishing this team was to take part in the KRSTI Contest competition, founded in 2011, the Lanange Jagad team took part in the competition from the year it was founded the team so far. This dance robot competition is where the robot will move forward by performing dance moves with a different theme each year, determined by the Ministry of Education and Culture (KEMENDIKBUD) which is held by PUSPRESNAS. In 2021 PUSPRESNAS will hold KRSTI with the theme Gambyong Pareanom dance from the Central Java region. In this competition there are several rules that must be followed, namely, when the robot performs a dance move with music, the robot is expected to be able to move and then follow the rhythm of the music, when the competition starts the robot must move according to the time of the music.

The robot moves straight according to the time of the predetermined music, the robot's movement is the dance movement of all humanoid robot limbs with the main mover being a servo which is connected, regulated and controlled via a microcontroller [4]. The movements that are required here are dance movements whose theme is determined by PUSPRESNAS which is under the auspices of KEMENDIKBUD. This humanoid robot aims for dance movements that must be in accordance with the theme, in this study the theme raised is the theme taken at the 2021 KRSTI competition with the theme "Gambiyong Pareanom Dancing Robot" from Central Java.

The obstacle faced by the robot is when the robot is required to stop according to the time of the music but there is a movement that appears when the time is declared over, the movement occurs because of noise or frequency that enters but not from the core music, the frequency enters when the song is over and there is additional applause at the end of the music, therefore to overcome this requires setting the time so that the robot moves according to the time determined by PUSPRESNAS in the music that will be contested. So it is possible to reduce the value because it does not match the specified target time, automatic control when it is needed so that the robot stops exactly as desired, then a Real Time Clock (RTC) module is needed [5], the module is installed on the front of the robot body, how the module works is calculating the time from when the robot is turned on start until the robot will stop according to the specified time regardless of noise or excessive frequency from Bluetooth [6]. The design system is divided into hardware and software, hardware consists of OpenCM 9.04 type c [7], Arduino Mega 2560 pro [8] and Real RTC module type DS3231 [9], software or software consists of Arduino IDE [10] and OpenCM IDE to access the hardware [11].

The DS3231 type RTC module is a circuit that functions to store time and date with accuracy and precision and is integrated with the AT24c32 serial eeprom for other data storage purposes [12]. The RTC module is equipped with a voltage source in the form of a CR2032 type battery so that the module can continue to work or run independently even without a voltage source which is usually from electricity [13]. In practice, this module does not stand alone, but is a part of a larger or more complex electronic device or circuit.

2. Method

This research intends to develop and perfect the technology applied to the researched humanoid robot "Lanange Jagad" to help the robot stop and be able to catch up with the robot by setting the time according to the robot's movements at the KRSTI event using the RTC module. The thing that is done is to determine the speed when the robot is running, so from these two things in this study we get 2 results, namely being able to adjust the speed of the robot and stop the robot at a certain time.

2.1. Diagram Blok

Block diagram Fig. 1 The input section contains the RTC module, which functions to set the time for the robot. Processed on Arduino Mega 2560 Pro mini which communicates with OpenCM 9.04-C using the SPI communication protocol [14].

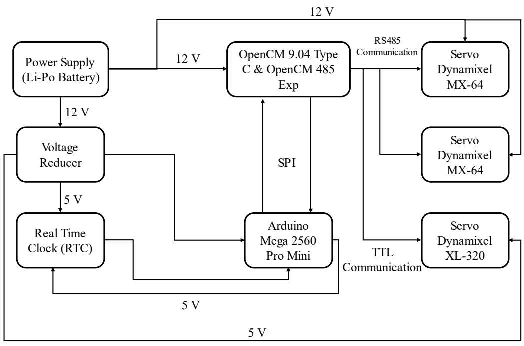

Fig. 1. Block charts

The output is Dynamixel MX-64, Dynamixel MX-28 and Dynamixel XL-320 robot driven servos, servos are processed on Open CM 9.04 and OpenCM 485 Exp using RS-485 and TTL communication [15]. The components get a voltage supply from the Li-Po battery [16].

2.2. Flowchart

The next system design is the design of a flow chart that serves to describe the workflow of a system. Fig. 2 is a flowchart of the Robot Movement System, the process starts when it is ready to stand and then continues with the robot dancing in walking condition, the RTC module will calculate the time output of the robot, then when the robot reaches the specified time the robot will stop, if the robot has not or does not detect the specified time, the robot will continue to run [17].

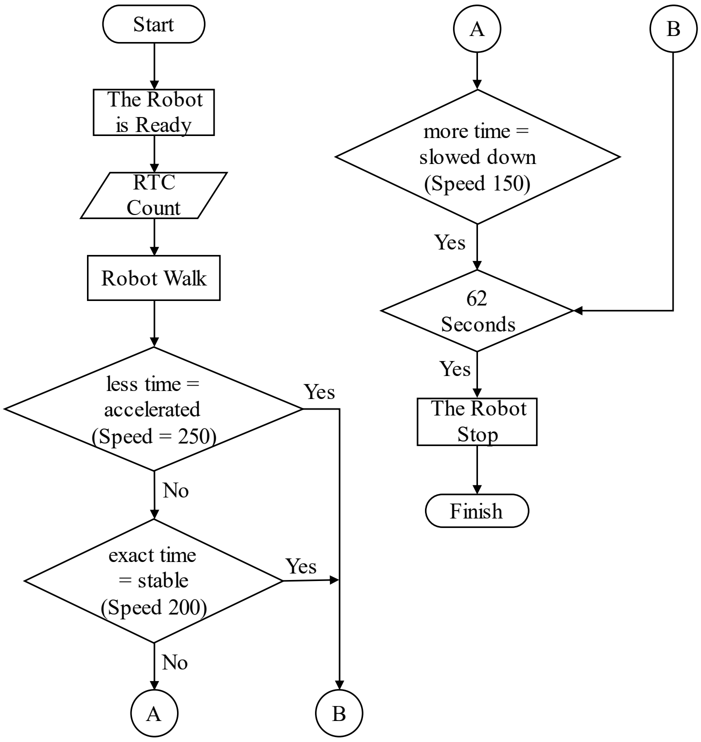

Fig. 2. Flowchart

2.3. Mechanical Design

Assembling the body of the Lanange Jagad robot begins by combining the 1.5 mm and 2 mm aluminum plate frames with the Dynamixel servo motor. The servos on the arms are Dynamixel XL-320, the legs are Dynamixel MX-64, and the waist is Dynamixel MX-28 [18]. The mechanics can be seen in Fig. 3.

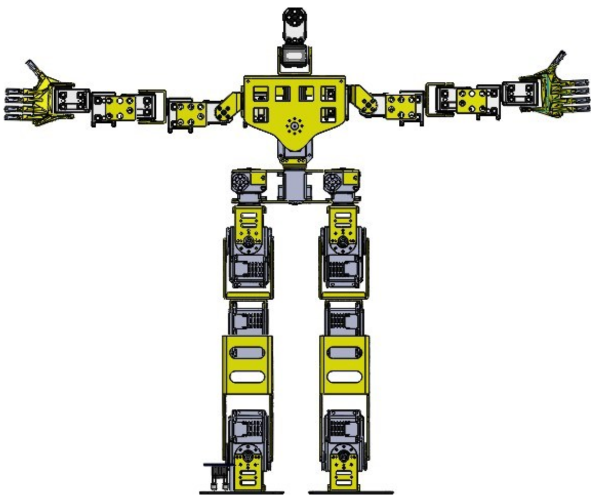

Fig. 3. Mechanical design

2.4. Electrical Design

The electrical design of the robot consists of several parts, the first part is electrical for SPI communication between Arduino Mega 2560 Pro mini and OpenCM 9.04-C. Arduino Mega 2560 Pro mini microcontroller pins used are pin 8, pin 10 and pin 12, while on the OpenCM 9.04 microcontroller the pins used are pin 1, pin 2 and pin 3 for Serial Peripheral Interface (SPI) communication wiring. The communication wiring between Arduino Mega 2560 Pro mini and OpenCM 9.04-C can be seen in Fig. 4.

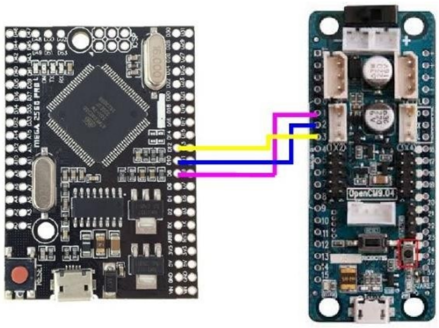

Fig. 4. SPI communication electrical

The second part is electrical for the servo with the OpenCM 485 Exp and OpenCM 9.04 microcontrollers. microcontroller OpenCM 9.04 and OpenCM 485 Exp pins used are the GND pin, VDD pin and DATA pin as well as the Servo Dynamixel MX-64, Servo Dynamixel MX-28 and XL-320 Dynamixel [19]. Servo wiring with OpenCM 9.04 and OpenCM 485 Exp microcontrollers can be seen in Fig. 5.

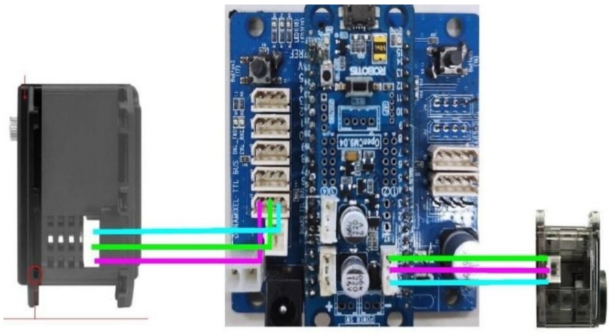

Fig. 5. Servo electrical and controller

The third part is electrical for installing the RTC Module with the Arduino Mega 2560 Pro mini microcontroller. The RTC module wiring pins used on the Arduino Mega 2560 Pro mini are pin 20, pin 21, pin 5V and pin GND, the RTC module pins used are SCL pin, SDA pin, VCC pin and GND pin [20]. The Arduino Mega 2560 Pro mini wiring with the RTC module can be seen in Fig. 6.

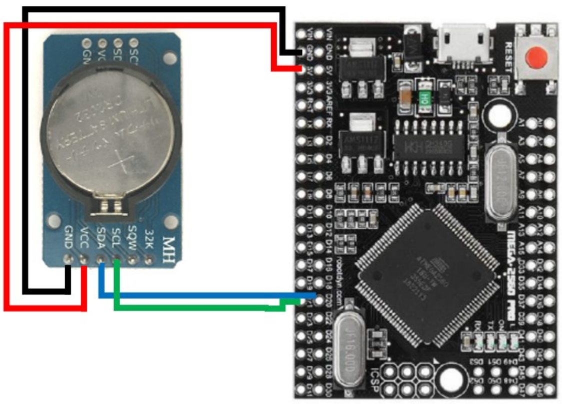

Fig. 6. Electrical RTC module and controller

3. Results and Discussion

In testing this system aims to determine the results of the design made in the previous section. This section describes the results of system testing and a discussion of the designs that have been made.

3.1. Electrical Test Results

Electrical testing on the Lanange Jagad robot consists of several microcontrollers and servo prime movers. Tests were carried out using a digital multimeter to determine the input and output voltage values of the system. Following are the results of voltage measurements in Table 1.

Table 1. Microcontroller voltage measurement

Connection Line	OpenCM 9.04	OpenCM 485 Exp	Arduino Mega 2560 Pro mini
Input	12.6 Volt	12.6 Volt	12.6 Volt
Output	-	-	5.05 Volt

Test data from Table 1 input comes from a 11.1 V/2600 mAh Li-po battery, but the Lanange Jagad robot can charge up to 12.5 volts or 12.6 volts. On the Arduino Mega 2560 Pro mini microcontroller, the measured output is 5.05 volts, coming from the LM7805 voltage reducing circuit. While testing the voltage measurement on the servo can be seen in Table 2.

Table 2. Servo voltage measurement

Connection Line	Voltage			Information
	MX-64	MX-28	XL-320	
Input	12.6	12.6	12.6	Input from battery
Output	-	-	5.05	Output from SBEC
Input	12.6	12.6	5.05	Input to servo

3.2. Walking Robot Test Results

The data results from the test **Fig. 6**, with 12 missions on the y-axis and 62 seconds on the x-axis, and the data corresponds to point 4.5. The orange line is the result of the RTC reading, the blue line is the preset time through the actual time. Seen in mission 4, mission 5 and mission 10 the orange line is higher than the blue line, meaning that the time read by the RTC is faster than the original time, so the speed of the robot must be accelerated, otherwise mission 9 the orange line is lower than the blue line. then the robot is slowed down, so that the robot can move according to the time it returns.

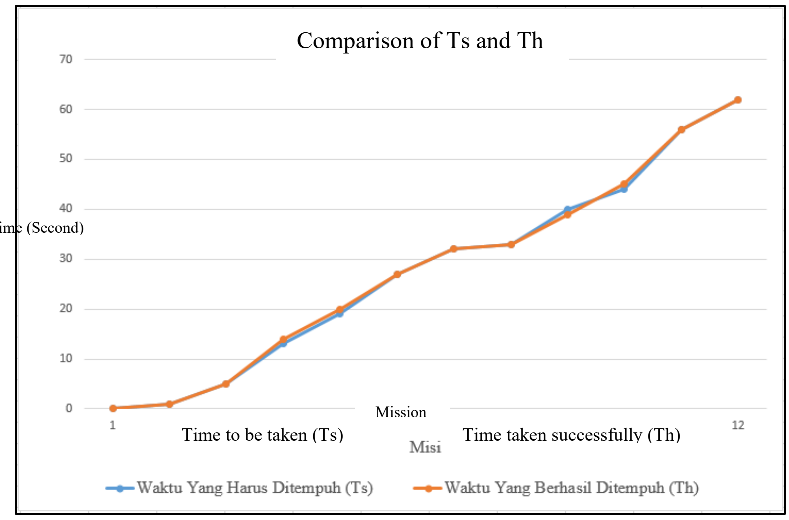

Fig. 7. Walking robot graphics

The robot runs according to the time, from the graph the error value can be calculated which can be seen in the following equation (1).

$$\%\, error = \frac{|Ts - Th|}{Ts} \times 100\% \quad (1)$$

Explanation:

Ts = Time to go

Th = The elapsed time

| | = Absolute value

% = Percentage

Producing each of the percentages listed in Table 3, the resulting value is the percentage error from the graph of Fig. 7 with different error values, the error is when the robot runs not on time, such as slower or faster.

Table 3. Percentage of error values

Mission	Ts	Th	Ts − Th	|Ts − Th|	$\frac{\lvert Ts - Th\rvert}{Ts}$	%
1	0	0	0	0	∞	∞
2	1	1	0	0	0	0
3	5	5	0	0	0	0
4	13	14	-1	1	0.076923077	0.076923
5	19	20	-1	1	0.052631579	0.052632
6	27	27	0	0	0	0
7	32	32	0	0	0	0
8	33	33	0	0	0	0
9	40	39	1	1	0.025	0.025
10	44	45	-1	1	0.022727273	0.022727
11	56	56	0	0	0	0
12	62	62	0	0	0	0

3.3. Pause Robot Test Results

The results of testing the robot in the pause condition aim to prove that if one day the competition is given an additional rule in the form of a pause, the results are as shown in Table 4. It is explained that there were 10 trials with different stopping times and with a longer time difference.

Table 4. Pause condition robot testing results

Num	Time stops (s)	Starting Time Running (s)	Stop Time (s)
1	5	6	3
2	8	9	5
3	13	14	6
4	20	21	8
5	27	28	10
6	32	33	15
7	34	35	20
8	40	41	20
9	53	54	25
10	59	60	30

3.4. Comparison Test Results of Stopping Robots Before and After Using the RTC

The result of this test is that the robot stops at the right time so as not to interfere with the race, when the robot stops according to the time on the song or the time determined by PUSPRESNAS.

A. Before Using RTC

The results of the robot stop only relying on data from Bluetooth or robots without RTC and given a little touch on Bluetooth. Bluetooth data doesn't have to be from music. The data can be seen in Table 5. The percentage of success is 0.16%.

Table 5. Robot test results stop without RTC

Num	Stop Time Provisions (s)	Stop Time Point (s)	Response	Reason
1	10	13	Fail	Entered data
2	20	20	Succeed	Not entered data
3	30	32	Fail	Entered data
4	40	45	Fail	Entered data
5	50	57	Fail	Entered data
6	60	62	Fail	Entered data

B. After Using RTC

Test results (Table 6) are that the robot will stop according to the time we have determined, the time calculation is carried out by the RTC, after the RTC detects at that time the robot will be forced to stop under any conditions. The success rate is 100%.

Table 6. Robot test results stop without RTC

Num	Termination Terms (s)	Stop Time Point (s)	Mission	Response
1	10	10	3	Succeed
2	20	20	5	Succeed
3	30	30	6	Succeed
4	40	40	9	Succeed
5	50	50	10	Succeed
6	60	60	11	Succeed

4. Conclusion

The design of the robot using the RTC module which functions as a timer on the robot has been successful, with a success rate of 100%. The robot can stop at the specified time without hindrance, the RTC module does not interfere with the existing time on the robot, so if the robot is paused at a certain time, the RTC will also stop. When the robot runs and does not comply with the specified time, the robot will re-adjust by adjusting the speed.

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