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Design of Audio Signal Amplitudo Detection System As On Off Control of Bioloid Robot

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Abstract— *The Indonesian Dance Robot Contest (KRSTI) is a robotics competition that involves setting, working, and coding robots with elements of Indonesian art and cultural heritage. The purpose of this paper is to design a frequency-based music detection system to process audio data that will trigger robot movements to move and stop, and synchronize movements between robots with musical. In this paper uses CM-530 robot controller as servo drive, MSGEQ7 module as music audio processor and Bluetooth HC-05 module as robot communication data transmission with audio processor and uses Kalman filter as digital filter to reduce noise. The music detection system using the MSGEQ7 module as audio music detector can be applied properly to the robot with robot synchronization with musical can be applied with an average error obtained of 0.894 seconds. The communication system between the two robots with musical can use the HC-05 bluetooth module as a bluetooth transmitter to successfully send robot motion commands with data transmission received by the bluetooth receiver on the dance robot 100% can receive motion command data sent by the bluetooth transmitter. Robot synchronization testing produces synchronous motion with a success rate of 80% in performing dance and walking movements.*

Keywords— ***MSGEQ7, Bluetooth HC-05, Kalman Filter, CM-530***

1. INTRODUCTION

The Indonesian Dance Robot Art Contest (KRSTI) is a competition robotics held by the National Achievement Center (Pusprenas). This division is a competitive event involves setting up, working on, and coding the robot with elements of Indonesian art and cultural heritage, especially in the art form of dance that has achieved fame in Indonesia [2]. Diponegoro University also participated in this contest, with their dance art robots known as Wisanggeni. KRSTI robot usually displays regional dances from Indonesia accordingly with a theme determined by the committee each year. At KRSTI 2023, the theme raised is Robots Semarang Gambang Dancers, aims to improve love and preserve national cultures. Problems with the Wisanggeni Diponegoro University Dance Robot Team faces challenges in terms of the system music processing. As a result, the robot cannot dance yet in sync with the music being played. If the robot doesn't can hear music, then the robot will not move and considered unable to dance. Therefore, to overcome this problem, robot development is needed humanoid in the context of the Wisanggeni Dance Robot who are able to follow dance movements in synchronization from the rhythm of the song accompanying the Gambang Semarang Dance.

The design of a music processing system has been carried out previously by Amanda Rusdianto (2017), with designing a music processing system is a trigger robot movement. On the robot system, the music received will be processed in an Arduino due microcontroller using FFT (Fast Fourier Transform) algorithm for know the frequency values that make up music so you can determine the trigger for robot movement using CM-530 controller as the robot controller [3]. Another research was conducted by Tio Haryanto Adi (2019) uses an analog sound sensor as a block input, then the sound signal obtained from the sound sensor microphone is continued to IC MSGEQ7 in the form of hardware that can divide the audio spectrum into seven frequencies as movement signals and processed on the Arduino Uno microcontroller provides output in the form of tempo units [4].

On research by Irmawan Anang Maulana (2019) uses FFT (Fast Fourier Transform) algorithm for knowing the frequency range of accompanying music and using the MSGEQ7 module as a frequencies detector that will be processed into robot movement signals which is on the Arduino Pro Micro microcontroller and signals motion will be sent to the Open CM 9.04 robot controller as a robot controller [3].

Based on these problems, in this final assignment, the author carried out system development. Detector amplitude of the audio signal in music as an on-off control premium bioloid robot. This design uses MSGEQ7 module as an amplitude detector able to convert sound input into ADC value data and using a digital filter in the form of a Kalman filter for Minimizes the noise value of the sensor readings processed on the Arduino Mega Microcontroller and sends it to the CM-530 controller as robot controller to control robot

movements. With an audio signal amplitude detection system to this music, it is hoped that the robot can dance to the music spun and danced in sync to the beat accompanying music..

2. METHODOLOGY

2.1 Audio Transmitter System Design

In designing audio sender processing system hardware includes MSGEQ7 module as sound sensor in detecting music music signals accompaniment as input signal amplitude parameters audio. The amplitude of the audio signal is then sent to be processed with an Arduino microcontroller Mega 2560. In this microcontroller processing data the amplitude of the received music audio signal will pass through Kalman filter to remove noise from music signals accepted. The data resulting from this filter is amplitude data The audio signal has been filtered and will be sent to the Bluetooth HC-05 transmitter 1 and transmitter 2. Figure 1 shows a block diagram of the audio sender processing system . Figure 2 is its hardware implementation.

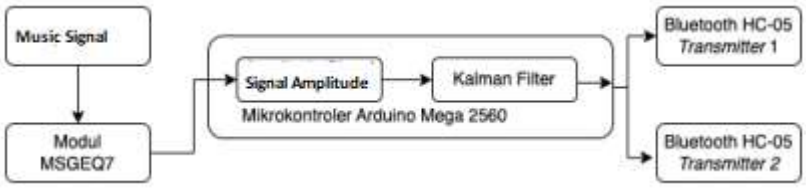

Figure 1. Audio sender processing system block diagram

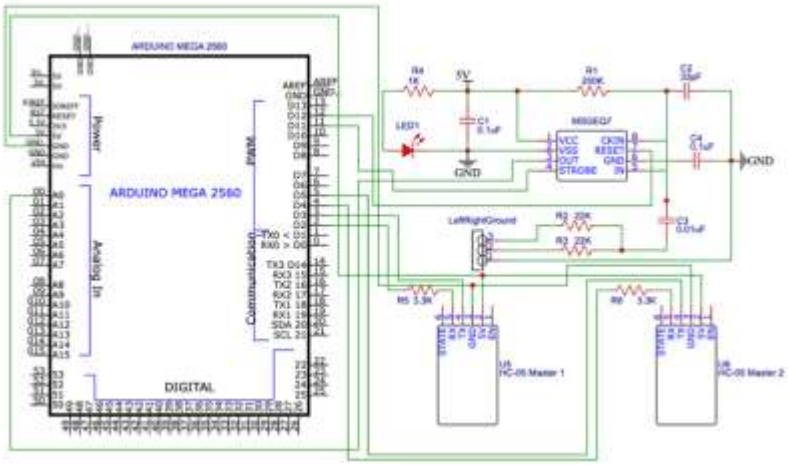

Figure 2. Hardware Implementation of audio sender system

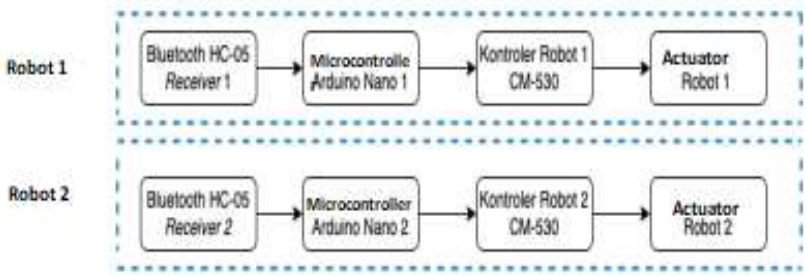

Figure 3. Audio receiver processing system block diagram

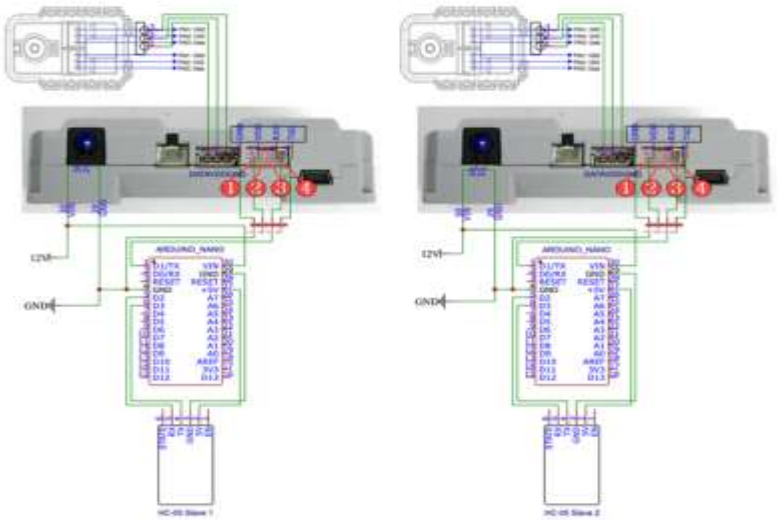

Figure 4. Hardware Implementation of audio receiver system

2.2 Audio Receiver System Design

In designing receiver system hardware on the robot using a microcontroller Arduino Nano and HC-05 bluetooth receiver module used to read data sent from Arduino Mega 2560 microcontroller. Frequency data sent will be received and processed on the Arduino microcontroller Nano as a moving command to be sent to the controller CM-530 to move the robot actuator in the form of a servo motors on the robot to perform dance movements. Figure 3 shows a block diagram of the audio receiver processing system.

2.3 Software System Design

The process carried out in software design music audio sender processing system starts with initialize the variable data first so that can read input accompaniment music signals. Signal the accompanying music will then be read by the module MSGEQ7 to process and read constituent data from accompanying music. The constituent data that has been received is still there is noise so a Kalman filter is needed for it filtering frequency data is carried out on the microcontroller Arduino Mega 2560. Figure 5 shows the flow diagram music audio sender processing system.

The process carried out in software design audio music receiver processing system on the robot begins by receiving filtered data previously via the HC-05 bluetooth transmitter The data will be received back via Bluetooth HC-05 receivers on both robots. The following is Figure 6 in the form of a flow diagram of the audio music receiving system on robot

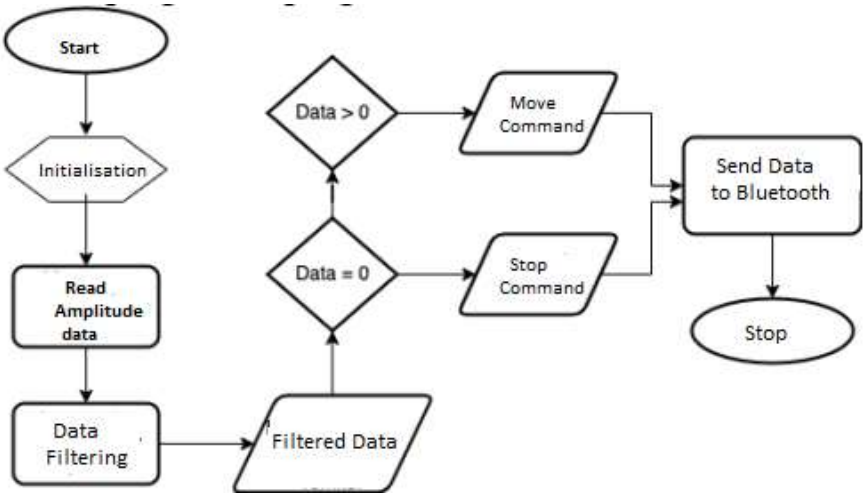

Figure 5. Flow diagram of the audio sender processing system

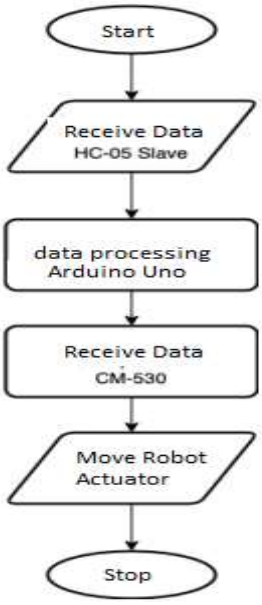

Figure 6. Flow diagram of the audio receiver processing system

Figure 7. Serial data communication

Design of serial communication between microcontrollers Arduino Nano and CM-530 robot controller use UART communication protocol with baud rate 57600bps as shown in Figure 7.

3. EXPERIMENTS RESULTS

3.1 MOVEMENTS SYNCHRONIZATION TEST OF BOTH ROBOTS

Movement synchronization testing on both dance robots is done by playing the accompanying music to the Gambang Semarang on both robots and see the triggering results accompanying music as a movement command for the robot inside do a dance. Testing is done to see suitability and accuracy of movements between the two robots. This test was carried out on both dance robots with 5 tests were carried out on 11 dance movements a robot dance will be performed. Table 1. contains test results synchronization in the form of 'A' and 'NA' with 'A' standing for synchronization testing is appropriate and 'NA' means testing synchronization does not match.

Based on Table 1 it can be seen that triggering the movements of both robots can also precede some late, with the results of movement synchronization testing on both robots can be applied well when perform dance moves and walk at a rate 80% success in performing the dance moves carried out in 5 tests. This inconsistency caused by a delay in servo reading on the 2nd robot which causes the robot's movement to be late so both robots experience incompatible movements.

Table 1: Synchronisation test of both robots

No.	Movement	Testing*				
		1	2	3	4	5
1	Initial Movement	A	A	A	NA	A
2	Walking 1	NA	A	A	A	A
3	Denok Semarang 1	A	NA	A	A	A
4	Walking 2	A	A	A	NA	A
5	Denok Semarang 2	A	NA	A	A	A
6	Walking 3	A	A	NA	A	A
7	Denok Semarang 3	A	A	A	NA	A
8	Walking 4	A	A	A	NA	A
9	Denok Semarang 4	NA	A	A	A	A
10	Walking 5	A	A	A	A	A
11	Denok Semarang 5	A	A	NA	A	A

*A= Accordance, NA=Not Accordance

3.2 ROBOT MOVEMENTS SYNCHRONIZATION TEST WITH MUSIC SIGNAL

Synchronization testing of robot movements to music Gambang Semarang accompanist on the robot and see the results suitability and accuracy of movements between robots. This experiments is done on both dance robots by doing 5 testing of the 11 dance movements that will be performed dance robot. The results of this test will compare the times musical references with robot timing in performing movement so that the average error value can be known The 5 tests will be carried out as shown in Table 2 are the results of movement synchronization testing robot to music.

Table 2: Synchronisation test of robot with music (audio)

Music Duration (s)	Duration of Robot movement (s)					Mean of Error (s)
	1	2	3	4	5	
GP (31)	31.34	33.02	32.45	31.22	31.15	0.836
JI (38)	37.84	38.26	40.06	37.66	38.95	0.754
DS 1 (69)	70.27	72.05	71.67	69.10	70.41	1.7
J2 (76)	77.08	76.84	77.64	76.52	76.89	0.994
DS 2 (107)	107.53	107.25	108.78	108.09	109.66	1.262
J3 (114)	114.46	114.82	115.03	114.74	114.17	0.644
DS 2 (145)	144.90	146.28	145.17	146.07	145.24	0.572
J4 (152)	151.87	154.15	152.31	152.58	153.10	0.854
DS 3 (183)	183.09	183.13	183.93	184.03	183.33	0.502
J5 (188)	188.15	189.31	189.43	189.17	188.01	0.814
GP (227)	226.54	226.95	228.17	228.33	228.55	0.912

Based on Table 2. It can be seen that testing robot movements to music has value small error in adjusting the dance movements designed with timing, with an average error value carried out by 5 tests was 0.894 seconds. Based on this, the robot can move according to the timing of the accompanying music.

4. CONCLUSION

Based on the results of testing and analysis that have been carried out carried out by the author regarding the music detection system frequency-based as control of robot movement on Humanoid dance robot has the following conclusions. Music detection system using a module MSGEQ7 as an audio signal amplitude detector can be applied well to robots with robot synchronization with accompanying music can applied with the average error obtained of 0.894 seconds. Communication system between the two robots with music accompaniment can be applied to robots for sending communication data in the form of movement commands on music audio delivery system with using the HC-05 bluetooth module as Bluetooth transmitter successfully sent the command robot movement with the transmission of received data by Bluetooth receiver on the dance robot 100% can receive motion command data sent by Bluetooth transmitter and can be received well by the Bluetooth receiver on the robot. Based on inter-movement synchronization testing robot, the influence of the music detection system as control of robot movement towards synchronization obtained, the robot can dance synchronously with an 80% success rate in carrying out walking and dancing movements.

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