Design control system using gesture control on the Arduino-based robot warfare

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Abstract. The development of increasingly advanced technology provides a positive side in various fields, especially the military. This research introduces a different control system in the navigation of robots, especially in the military field. Navigation system used are varied, ranging from robots that are driven using cables to wireless communications that are used to move robots. Various control systems on robots using RC (Remote Control), android, and several electronic devices designed for navigation systems such as joysticks and other control system devices. Researchers designed gesture control on the Arduino nano v3 based and Arduino ATMEGA based combat robots on military equipment, because there is no military equipment that uses a gesture control navigation system. Researchers used an experiment method with an Arduino electronic device as a microcontroller, accelerometer module and MPU6050 gyroscope as a sensor that serves to determine the orientation of motion, NRF24L01 module as telemetry, and engine as drive. The results obtained after designing a gesture control navigation system on a combat robot are very good because it is very easy to operate the robot, and a long duration because using the engine. It was concluded that gesture control was appropriate and safe for use in the military.

1. Introduction
A robot is a mechanic or a collection of materials arranged so that it becomes a framework of movement or can be moved by being controlled with a structured electronic system to be integrated into a single unit, in which it is often known as a control system or navigation system. By making this interface wireless using radio frequency, it becomes possible to control the robot very easy and user friendly [1]. Robots have various inputs and outputs. Along with the development of current technology which is advancing rapidly have a positive impact in various fields, especially in the military defense equipment. The military equipment used from year to year will be increasingly sophisticated and modern. With the development of technology in the field of military defense equipment aspects, the researchers have ideas in making the Design of Gesture Control in Automatic Combat Robots.

Gesture control is a far better alternative than the voice controlled activities for controlling the robot as it annihilates the interruption by unwanted noise and interference [2]. In this research, the researchers intend to design a Control System Using Gesture Control on the Arduino-Based Combat Robots. Moreover, the tool is intended for the military, especially for the Army to make it easier to operate so that it does not require a long time in the operation since there are no military equipment that use a gesture control navigation system. In this research, the benefits of a gesture control navigation system
are creating long distance mileage due to the use of engine, creating time efficiency in controlling and facilitating the operator in operating it, as well as producing an effective performance especially in the field of military defense equipment. The current work is implemented with Arduino based devices such as Arduino NANO and UNO processors and programmed through Arduino IDE [3].

2. Methods
Gyroscope is the sensor which is used to capture the position the operator hand when he is working operated vehicle and it is attached with a hand [4]. Using the omnipresent gesture control, the user can control a robot without having to hold any devices, which reduces physical work load and enables seamless cooperation [5]. There are a number of basic electronic component selections used to get maximum results from the design that is made; thus, it can operate as desired. This final project was divided into several stages of writing, of which stages were started from a research on the problems encountered, data collection, system planning to make the tools, researchers used the literature method and the experimental method.

![Figure 1. System block diagram.](image)

The basic working principle of the project involves the accelerometer transmitting the hand gesture measurements to the Arduino microcontroller which processes it and tells the robot to move in the desired direction [6]. Based on the navigation system block diagram in Figure 1, it indicated that the system consisted of two main devices namely TX (transmitter) and RX (receiver). The TX (transmitter) device had a role as a control of the RX (receiver) device. In the TX subsystem (transmitter), it consisted of Arduino Nano V3, MPU6050 sensor, and NRF24L01 TX (transmitter), while the RX subsystem (receiver) consisted of Arduino ATMEGA, NRF24L01 RX (receiver), motor servo, and engine. Each component was divided into three categories namely input, process, and output. The input on the TX (transmitter) was in the form of MPU-6050 sensor as an accelerometer and gyroscope sensor on the hand gesture. Then, the sensor reading data signal would be processed on the Arduino Nano V3 microcontroller. After the data were processed, the data would be transmitted by the NRF24L01 communication module to the RX (receiver) device. The NRF24L01 communication module which acted as the TX (receiver) received the data. The data would be processed at the Arduino ATMEGA to control the motor servo and engine on wheeled combat robots.

2.1. Design stick TX design (transmitter)
The Stick TX (transmitter) was an electronic device that had been structured as a control system used by the operators to regulate the motion of wheeled robots. At this stage contained the TX stick design (transmitter) required by the system. The figure 2 consisted of a TX stick (transmitter) and a control device and both dimensions. For stick TX, the size was 20 x 13 cm and 4.25 x 9.30 cm for the size of the control device. Moreover, for hands-on work such as applied engineering, design or construction,
gesture-based computing may offer new ways to interact with immersive 3D content and allow students and staff to investigate immersive scenarios [7].

2.2. Design of combat robot (receiver)

Wheeled robots or receiver devices were receiver components and objects that were controlled by the system. In the Figure 3, the wheeled robot in this case was a car with four cogs inside. A sensor with accelerometer module has been applied here, which senses the axis of direction of the movements of the hand, then the robot starts moving according to the movement of the hand [8].

![Figure 2. The stick TX (transmitter).](image)

![Figure 3. The combat robot (receiver).](image)

![Figure 4. The flowchart of TX (transmitter).](image)

![Figure 5. The flowchart of RX (receiver).](image)

The conclusion was that the system worked to receive the data signals from the NRF24L01 component. Then, the data would be processed on Arduino Nano V3 microcontroller. The role of Arduino here was to process the signal. Therefore, it could control the motor servo to drive the engine. Moreover, the engine could move according to the input in the hand gesture that had previously been processed in the
transmitter device. For the tools made by the researchers, each of the TX (Transmitter) sticks was used for the wheel control and weapon control.

2.3. Designing wheel and weapon control on robots
Arduino board designs use a variety of microprocessors and controllers, the boards are prepared with sets of digital and analogue input/output (I/O) pins that may be interfaced to various forums[9]. For the design of the control in this system, the researcher made the control system respectively on the robot or control on the weapon, in which it aimed at gaining the desired movement and the test results. There was also a relationship between the hand gestures and wheeled robot motion so that it could make it easier for the users to understand what movements were allowed to control the system. Similar to the design of wheel movement control on the robots, the weapon control system also used hand movements or called as the gesture control. The elevation and azimuth of the weapon were determined by the movement of the hand or in this case the transmitter stick as its control device.

2.3.1. Stick silent and parallel to the ground. In these conditions, the robots and weapons were at rest because the angel changes resulted was 0°. This served to stop the speed of the robot or wanted to stop the control process.

2.3.2. The stick was tilted forward. At that time, the wheeled robot would move forward and the weapon would move downward according to the input in the hand gesture. The resulting angle was from 0° to -90°.

2.3.3. The stick was tilted back. At that time the robot wheel would move backward and the weapon would move upward according to the input in the hand gesture. The resulting angle was from 0° to 90°.

2.3.4. The stick was tilted to the left. At that time the, the robot on wheels would maneuver to the left and the weapon would rotate to the left according to the input in the hand gesture. This resulted on the robot turning or turning, and also caused the weapon to spin. The resulting angle was from 0° to -90°.

2.3.5. The stick was tilted to the right. At that time, the robot on wheels would maneuver to the right and the weapon would rotate to the right according to the input in the hand gesture. This resulted in the robot turning or turning, and also caused the weapon to spin. The resulting angle was from 0° to 90°.

2.3.6. The push button on the Transmitter stick of the weapon was pressed. When the push button was pressed, the weapon would shoot and issued ammunitions.

3. Results and discussion

3.1. Overall analysis and testing results of the device functionality
The purpose of this test was to determine the overall movement response of the combat robot, it could be seen that the table 1 was the results of tests on the response of movements in the robot and the table 2 was the result of the test on the response of movements to the weapon (elevation and azimuth).

| No | Movements            | Functions | Responses |
|----|----------------------|-----------|-----------|
| 1  | Stick still and parallel | Stop      | Good      |
| 2  | Stick Forward        | Up        | Good      |
| 3  | Stick to the left    | Turn left | Good      |
| 4  | Stick to the right   | Turn right| Good      |
| 5  | Stick backwards     | Back off  | Good      |
Table 2. The testing results for elevation and azimuth weapons movement.

| No | Movements                        | Functions     | Responses |
|----|----------------------------------|---------------|-----------|
| 1  | Stick still and parallel         | Stop          | Good      |
| 2  | Stick Forward                    | Down direction| Good      |
| 3  | Stick to the left                | Left direction| Good      |
| 4  | Stick to the right               | Right direction| Good     |
| 5  | Stick backwards                  | Up direction  | Good      |
| 6  | Button (push button) pressed     | Shoot         | Good      |

3.2. Distance testing results on the robot gesture in open space and closed space
In testing this range, it was done so that the users could find out the capabilities of gesture control that had been designed so that the robot control design could be known for the advantages and disadvantages. Therefore, the testing was done by measuring the response of the control of combat robots in the open space and in closed spaces.

Table 3 and table 4 are the results of trials in open and closed / blocked room. After testing with some distance in open and closed / blocked room, the data obtained can be seen in table 3 and table 4.

Table 3. Testing of distances in open space.

| No | Distances (by estimated) | Responses | Information |
|----|--------------------------|-----------|-------------|
| 1  | 50 meters                | Move      | Good        |
| 2  | 100 meters               | Move      | Good        |
| 3  | 150 meters               | Move      | Good        |
| 4  | 200 meters               | Move      | Less        |

Table 4. Testing in a closed / blocked room.

| No | Distance (by estimated) | Responses | Information |
|----|-------------------------|-----------|-------------|
| 1  | 50 meters                | Move      | Good        |
| 2  | 100 meters               | Move      | Good        |
| 3  | 150 meters               | No        | Less        |
| 4  | 200 meters               | No        | Less        |

3.3. Mileage test results on robots using engines
This test was carried out to analyze the extent of distance that could be traveled on the robot, in this case, it used the engine. Therefore, the researchers conducted several experiments to find out and obtain the results by using the engine. Table 5 was the results of trials conducted by the researchers.

Table 5. Testing robots using engines.

| No | Distances | Responses | Fuel oil | Information |
|----|-----------|-----------|----------|-------------|
| 1  | 4 km      | Move      | 0.5 ltrs | Good        |
| 2  | 8 km      | Move      | 1 ltrs   | Good        |
| 3  | 16 km     | Move      | 2 ltrs   | Good        |
| 4  | 20 km     | Move      | 3 ltrs   | Good        |
| 5  | 21 km     | No        | 3 ltrs   | Less        |
4. Conclusion

Based on the research that has been done, namely the design of control systems in combat robots using gestures, some conclusions can be drawn as follows:

- Robot control system using gesture control can control the robot motion by using NRF24L01 on the accelerometer sensor.
- The sensor can communicate with the robot through the NRF24L01 network as a medium for sending the control commands to the robot.
- The gesture control navigation system in a combat robot is very good because it is very easy to operate the robot.
- Longer duration since it uses an engine specifically to support the main tasks of the Army.

References

[1] Mishra A, Malhotra S and Pradesh U 2017 Design of hand glove for wireless gesture control of robot Int. J. Pure Appl. Math 114 69-79
[2] Nayak S, Nalini J and Deepak B B V L 2016 Development of gesture controlled robot using 3-axis accelerometer JoCI 23 34
[3] Sridevi V, Ishwarya P, Chandra P S and Kumar N S 2019 Automated Gesture Based Wireless Wheelchair Control by Means of Accelerometer International Journal of Engineering and Advanced Technology (IJEAT) 9(1) 879–883
[4] Gobade S, Tarbani N M, Bakshi K, Kalne P and Shahale S 2018 Hand gesture controlled robot International Journal for Emerging Research and Development 1(1) 20-23
[5] Tang G and Webb P 2018 The design and evaluation of an ergonomic contactless gesture control system for industrial robots Journal of Robotics 2018 1-10
[6] David N, Udengwu C and Onyia O 2015 Engineer a Gesture- Controlled System International Journal of Scientific and Engineering Research 6(294) 397–405
[7] University of Birmingham 2016 "Gesture control technology: An investigation on the potential use in Higher Education," [Online] Retrieved from: https://intranet.birmingham.ac.uk/it/innovation/documents/public/Gesture-Control-Technology.pdf
[8] Gautam P K, Pandey S and Nanda V K 2018 Robot Control by Accelerometer Based Hand Gesture using Arduino Microcontroller International Journal of Recent Technology and Engineering 7(4) 24-27
[9] Adithya N and Chitti S 2019 Hand gesture controlled robot Int. J. Recent Technol. Eng. 8(1) 75–77