Eduvest – Journal of Universal Studies
Volume 3 Number 3, March, 2024
p- ISSN 2775-3735- e-ISSN 2775-3727

DESIGN AND CONSTRUCTION OF A REMOTELY CONTROLLED MULTY-TASKING CHAIN-WHEEL COMBAT ROBOT

Nur Rachman Supadmana Muda[1], M.Faisal Fadilah[2], Bilqis Faranadila[3], Dinar Safanabila[4]
[1,2,3,4] Department of Weapon Systems Electronics Engineering, Politeknik Angkatan Darat, Indonesia
Email: nurrudal@gmail.com

ABSTRACT

Troops in the context of reconnaissance or search tasks to find out the enemy in difficult, protected and disguised terrain is an element of vulnerability that needs to be taken into account. If you insist on finding out the enemy's condition, there is a possibility that contact will occur early and cause casualties which could thwart the main task. Therefore, a tool or robot is needed to help obtain data about protected enemies by diverting the enemy's attention and providing resistance. The aim of this research is to create a prototype chain-wheeled combat robot platform system that is capable of maneuvering, firing SS2 and rockets, detecting mine-prone areas, and detecting body thermals. The robot control system consists of a mobile controller and a base station. The mobile controller functions to control robot movements such as forward, backward, right turn, left turn, weapon azimuth movement, weapon elevation movement and shooting using 2.4 GHz radio control and target monitoring using FPV ((First person view) directly in the field on a frequency of 5.6 GHz, base station functions to control the robot's movement and monitor targets using a laptop via the internet. The robot system is equipped with GPS and a metal detector, so that the robot's position can be monitored and report the presence of mines to the base station. Thus, the robot created is expected to be able to help to combat duty in the context of war military operations

KEYWORDS *Robot, rocket, SS2, metal detector, mobile controller, base station*

How to cite: Muda, N.R.S et al. (2024). Design and Construction of A Remotely Controlled Multy-Tasking Chain-Wheel Combat Robot. *Journal Eduvest*. 4,3), 723-740
E-ISSN: 2775-3727
Published by: https://greenpublisher.id/

INTRODUCTION

Industry 4.0 and society 5.0 are characterized by increasing digitalization of manufacturing such as processing big data systems, speed of sending and receiving data, computing power, the emergence of artificial intelligence, new interactions between humans and machines, the use of robotic technology in all sectors of life (Duan et al., 2024). The era of Industrial Revolution 4.0 has occurred discovered a new pattern, namely disruptive technologies, which are appearing very quickly in all fields which have changed some of the work, industry and business arrangements in the digital world by using computer and internet technology. This causes dynamics in global, regional and national environmental strategies, thereby demanding and encouraging countries in the world to improve their protection technology systems. The influence of technology in the era of modern warfare has encouraged a change in thinking patterns from "humans being armed" to "weapons being manned", because in the future, as science and technology improve, weapons technology will become the dominant element and adaptive control will either use operators or be autonomous. Soldiers will face robotic-based war machines such as fire and forget smart missiles, armed Unmanned Aerial Vehicle (UAV) drone technology, Unmanned Ground Vehicle (UGV) combat robots, ocean robots for spying and Unmanned Under sea bombs. water Submarine Vehicle (UUSV) (Cheng et al., 2023). Robotic technology is a product of multi-disciplinary knowledge including mechanics, electronics and other engineering fields. The implementation of robot technology in the Industry 4.0 era is a requirement for both civil society and military industry (Wamba et al., 2023). New innovations in the field of robotics based on artificial intelligence are urgently needed to facilitate work that can replace human tasks. By using artificial intelligence, the control system is expected to reduce the resulting error value compared to conventional control systems. In the military sector, several developed countries have implemented robots as a modern warfare threat to assist in combat because they are considered more effective and efficient in detecting and destroying targets, saving personnel energy and the opponent does not know who is controlling them (Rashid et al., 2023). Facts show the use of robots for fighting by developed countries, for example the USA used the MQ-9 reaper drone to shoot Iranian warlord General Qassem Soleimani in the Baghdad area of Iraq, and was involved in several battles in the Middle East, China once sent a sea glider drone (Sayler, 2020).

as a spy robot that entered Indonesian waters, Russia once used unmanned tanks placed on the border when facing Ukraine, as well as the conflict between Israel and Palestine, Hamas' use of rockets was very intensively directed at Israel's vital targets, but Israel used Iron dome technology to protect it. its territory by automatically releasing missiles to ambush the use of robot technology which is very effective and tactical on the battlefield. If on land robot technology is applied to help troops for reconnaissance, these rockets have a success rate of up to 95%. This shows that for breakthroughs, city battles and helping to detect mine-prone areas, the use of robot technology is very appropriate.

RESEARCH METHOD

To complete the entire workflow, a total of four steps have been carried out: data collection, design creation, component selection, construction creation, assembly of a series of components, static testing in the Army Polytechnic electronics laboratory to determine component performance, dynamic testing to test the robot system as a whole. As shown in figure 1. Robot manufacturing flow diagram

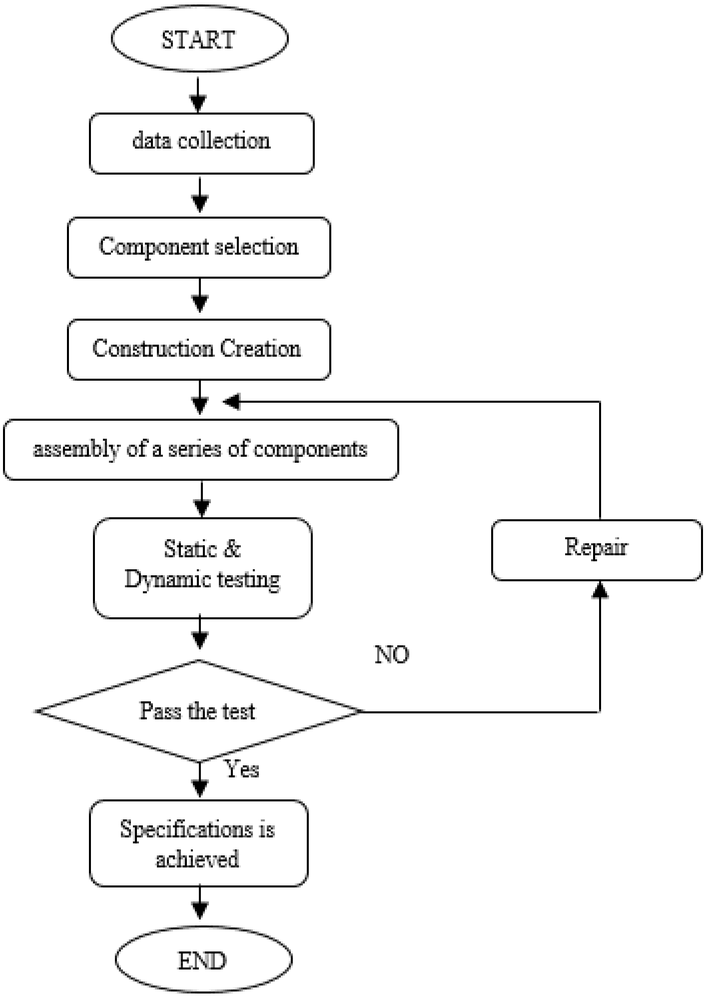

Figure 1. Robot Manufacturing Flow Diagram.

RESULT AND DISCUSSION

The beginning of this research is collecting data and making a robot design. The design used in this research uses the 2016 version of 3D smax consisting of several platform designs, namely the weapons platform has two rocket launchers as shown in figure 2, the top platform. Complete platform of chain-wheel drive combat robot, as shown in figure 3.

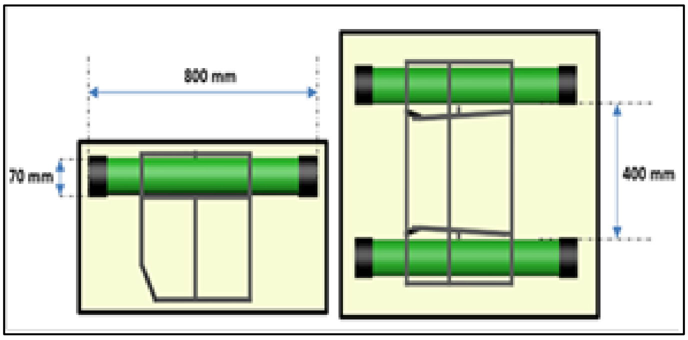

Figure 2. Upper platform

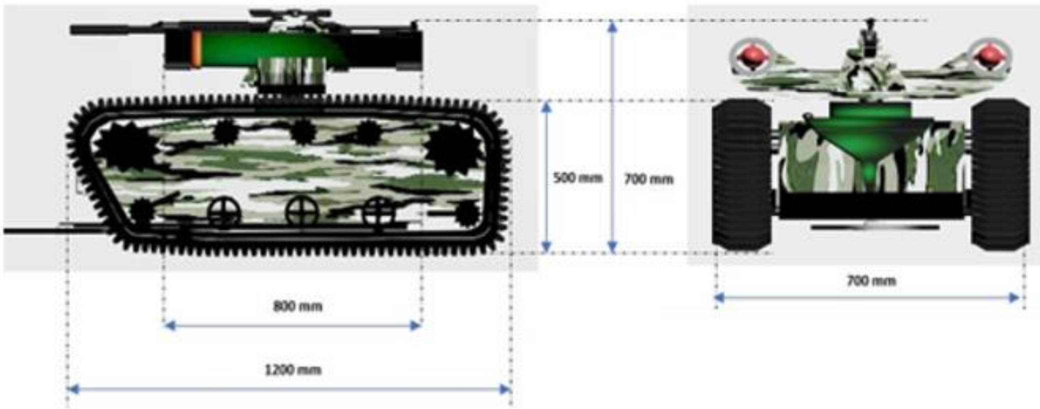

Figure 3. Complete Platform Design of Chain Wheel Combat Robot

The controller design consists of monitor glasses used by the operator as shown in Figure 4 First Person View (FPV) designs. FPV as Monitor glasses design and base controller system (bCS) design as shown in Figure 5. Design The electronic circuit of the control system, as shown in Figure 5, consists of a transmitter block and a receiver block. The transmitter block consists of a mobile controller and a base station. The receiver block consists of a Frsky 8 Channel receiver module, Arduino Uno MCU components, L298N Driver, GPS Neo 7.

Figure 4. FPV designs

Figure 5 bCS design

Design The electronic circuit of the control system, as shown in Figure 6, consists of a transmitter block and a receiver block. The transmitter block consists of a mobile controller and a base station. The receiver block consists of a Frsky 8 Channel receiver module, Arduino Uno MCU components, L298N Driver, GPS Neo 7. Drive motor, trigger motor, camera, video sender, Modem, IR 240 Thermal Camera, Metal detector, motor, Block diagram of a robot system consisting of a robot part and a controller part. The robot part consists of a receiver, microcontroller, modem, driver, video sender, motor, solenoid, metal sensor, camera, thermal camera, Gyro and GPS. The controller section consists of radio control, FPV monitor, TV turner, video receiver, laptop and program. As shown in Figure 5, the robot system block diagram depicts the robot's movements which are controlled by controllers in the field and base station. TX/RX 1 shows that data communication occurs between chain wheel combat robots, where the robot's movements starting from forward, backward, left turn, right turn, azimuth movement, elevation and shooting are controlled by RC which sends a 2.4 GHz carrier frequency received by the receiver and the data forwarded to the MCU or microcontroller to be processed into motion data. Meanwhile, the camera will capture the target object and sent by the video sender to be received by the FPV monitor at the 5.8 GHz frequency. TX/RX 2 shows that data communication occurs between chain wheel combat robots, where the robot's movements starting from forward, backward, left turn, right turn, azimuth movement, elevation and shooting are controlled by a laptop which sends control data via the modem, received by the modem and The data is forwarded to the MCU or microcontroller to be processed into motion data.

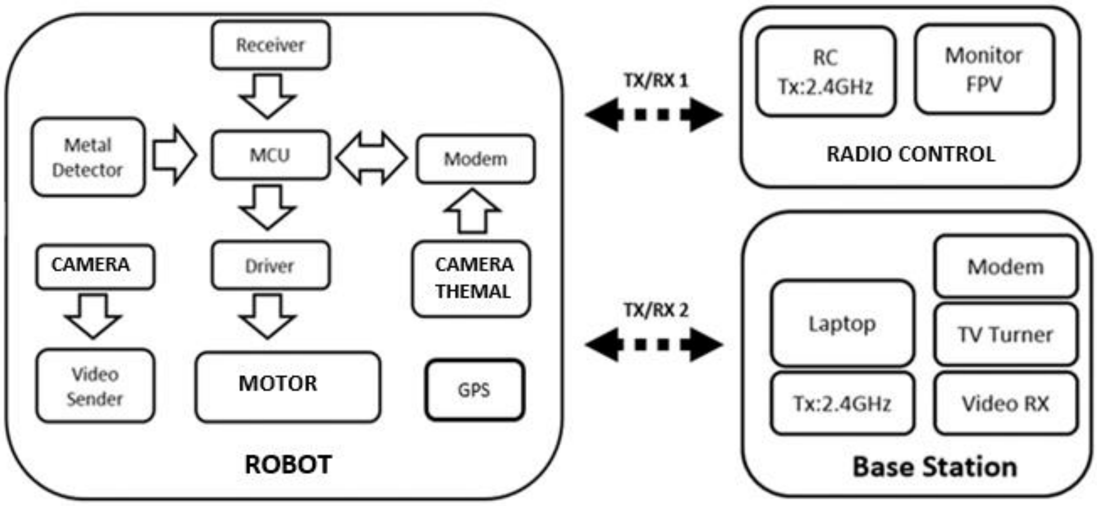

Figure 6. Block Diagram of the Control System Electronic Circuit

Construction Manufacturing and Robot Mechanics

The construction made is adjusted to the conceptual design including: body shape, chain wheel shape, size, weight, component layout, the platform is made of a 3 cm x 3 cm iron frame and a 3 mm iron plate (this is to support the robot's weight of up to 70 Kg). The mechanics used to move, maneuver and fire the robot platform with a total weight of 70 kg, consist of: two 24V 40 A DC motors and a 1:10 gearbox for wheel drive or forward, backward, left-right, incline up to corner maneuvers. 20°, and chain wheel drive type. 12V 10A DC motor and 1:40 gearbox for azimuth movement from -90° to +90°, weapon elevation movement 0° to 50° and 1kg weapon trigger mechanical capability. The robot chain is a replacement for wheels made from a thick chain with a diameter of 3 cm x 2 cm and a length of 2 meters made in a circle, placed on a bearing wheel. On the chain is placed a rubber tread made with the size of each tread 10x2x3. Meanwhile, the chain drive system uses a 24 Volt 20A DC motor, which is placed on the right and left of the robot. With a chain wheel drive system, the robot is able to move on rough terrain and slopes, as shown in Figure 7. Robot construction and mechanics.

Figure 7. Robot Construction and Mechanics

Manufacture of Robot Casings and Weapon Platforms

As shown in Figure 8, the weapons and rocket launcher platforms are adjusted to the characteristics of the shape, weight and size of the weapons and rockets as well as the propulsion mechanics used. The weight characteristics of the components used consist of: weapon weight of 4 kg, 2 rocket launchers and weapon mounts of 4 kg, and weapon recoil of 8 kg, so that the azimuth and elevation drive mechanics are made capable of supporting and moving weapons and rocket launchers with a total weight of at least 16 kg. The trigger is made from a solenoid component which is capable of pulling the SS2 weapon trigger up to 10kg/cm (Mahendra et al., 2020; Marwanto & Budijono, n.d., 2013; Nuhgraha & Selasri, 2019). The robot's casing or body cover is made from 3 mm plate, so it is impact resistant and sturdy when moving and shooting.

Figure 8. Robot Construction and Mechanics

Installation of Metal Detector and Setting of metal detector on robot body

The metal detector is placed on the front of the robot which can be controlled by moving the arm via a remotely controlled switching system. The metal detector used has the ability to detect metal elements with a capacity of 500 bulks, meaning it can detect heavy metals with a cross-sectional diameter of 20 cm planted at a depth of 30 cm (according to the technique of installing anti-personnel mines and Tank planted at a depth between 10 cm to 30 cm). This is in accordance with the procedure for installing anti-tank mines which are planted to a depth of 30 cm, as shown in Figure 9 metal detector (Bryakin et al., 2021).

Figure 9. Metal detector

The Control Circuits and GPS Programs

The control circuit for the left and right motor drives uses components, namely Arduino Mega as a microcontroller to control motor movement and speed, the L298N module component is used to regulate motor movement. The Arduino program is used according to pins A0, A1, A2, A3. Pin A0 and Pin A1 are used to control the left motor and Pin A2 and Pin A3 are used to control the right motor, As shown in figure 10. the control circuit..

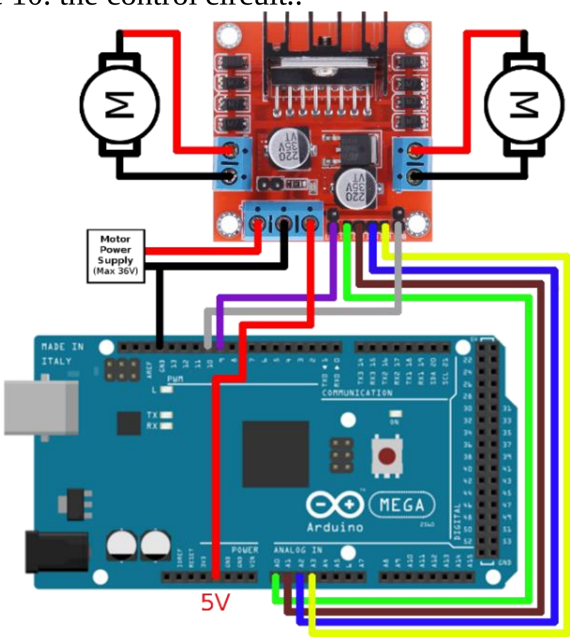

Figure 10. Control Circuit

The type of motor used is brushed type 5A, 24V. The control circuit uses 2 motors to move the robot body to move forward, move to the right, move to the left, and move backwards. The control circuit is also used to move the azimuth of the weapon and the elevation of the weapon to direct it to the target to be shot. The minimum battery capacity required to drive the robot body and weapons platform is 5A X 24V x 4 = 480 watts. The type of battery used is 12V x 80 AH = 960 VAH battery power. With this battery capacity, the duration of continuous use of the Robot is more than 1 hour.

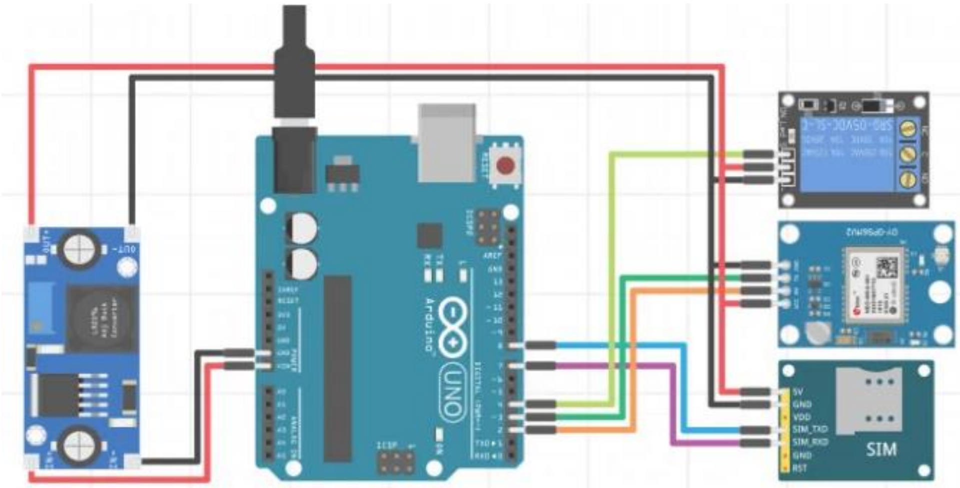

Figure 11. GPS Circuits and Modem

The program used is Embarcadero Every time the robot coordinates will be sent via modem to the Base Station Controller (BSC). The results are displayed by the Delphi program on the monitor so that they can be seen visually in real time. As shown in figure 11, the GPS tracker that will be created here is capable of sending the latest coordinates and we can automatically see them on Google Map when we click on the link sent from this GPS tracker via SMS. The tools required are an Arduino Uno, GPS NEO Module, Relay Module, GSM SIM800L Module, 3A step down switching module, jumper cables. As shown in figure 12. gps program (Golsorkhi et al., 2016; Qian et al., 2020).

```
-
void setup() {
pinMode(nyala,OUTPUT);
delay(10000);
digitalWrite(nyala,LOW);
pinMode(led,OUTPUT);
pinMode(relay, OUTPUT);
digitalWrite(relay,HIGH);
Serial.begin(9600);
GPRS.begin(9600);
neo.begin(9600);
GPRS.listen();
delay(5000);
digitalWrite(led,HIGH);
Serial.print("GPRS ready...\r\n");
GPRS.print("AT+CMGF=1\r\n");
delay(1000);
   GPRS.print("AT+CNMI=2,2,0,0,0\r\n");
delay(1000);
digitalWrite(led,LOW);
-
```

Figure 12. listing program of GPS

Thermal Cameras

Thermal cameras are used to detect target temperatures which can be operated day and night. Characteristics of the thermal camera used by SupCor1280, made by Ithermal Technology China, resolution used is 1280x1024 pixels, continuous digital zoom: 65x - 400x, Small size: 48 x 48 x 44.8 mm (w/o lens), Light weight <170g (w/o lens), Time to image < 8s, pseudocolor analog output, HDMI digital video output, Auto-focus, driver integrated, Cameralink interface optional, Expansion board available, Variety infrared lens optional, as shown in figure 12. thermal camera.

Figure 12.Thermal Camera (Bryakin et al., 2021)

Components Measurements

Component measurements using an oscilloscope to determine signal response, carrier frequency and information frequency. Meanwhile, to measure voltage, current and resistance, use an AVO meter. Measurements are needed to determine whether the working function of the control sub unit and motor driver is in accordance with the component specifications. If it is not appropriate then adjustments are made, namely for the active logic voltage level to high 5 volts and low conditions 0 volts. The control system between the transmitter and receiver must be connected based on the carrier frequency used, namely 2.4 GHz by binding. The robot motion control system uses PWM signals or pulse width modulation to regulate the rotation speed of the motor used for maneuvering, azimuth and elevation of the robot. As shown in Figure 13. Measurement of sensor and control system components in the form of a pwm signal. The results of this measurement are used to determine motor speed and send data which is converted to the Delphi program.

Figure 13. PWM Signal

Synchronize shooting direction and camera

This synchronization aims to ensure that the camera viewing the target is in the same line of sight as the aiming direction of the SS2 weapon or rocket. The direction synchronization system or zeroing point, using military terms, is carried out to achieve precise and accurate shooting results. As shown in figure 14. Zeroing Point System

Figure 14. Zeroing Point

Robot Control System Test

The robot control system uses double frequency anti-jamming and anti-noise radio control on the 2.4 GHz MSB and LSB data encryption frequencies. This RC system has data security from the possibility of frequency jamming or frequency tapping from opposing parties. The RC used has a transmit power capability of 2 watts or around 2 km LOS. As shown in Figure 15. Radio Control and its function (NRS Muda, N. Gumilar, RDA Navalino, T N, 2020).

Figure 15. Radio Control and its functions

The receiver used on the FRSky double encrypt data robot has 8 channel connectivity with RC according to the number of controls and data functions used to control the robot. How the robot motion control works is shown in Figure 15, the robot moves forward, backwards, turns left and turns right according to RC control. Explanation of the 8 channels in the receiver: channel 1 is used for throttle, channel 2 is for forward motion, channel 3 is for reverse motion, channel 4 is for turning left, channel 5 is for turning right, channel 6 is for azimuth, channel 7 is for elevation, channel 8 is for firing.

Table 1. Robot Movement Mechanism

No	M1	M2	Output
1	0	0	STOP
2	1 (FWD)	1 (FWD)	FORWARD
3	1 (BWD)	1 (BWD)	BACKWARD
4	1 (FWD)	1 (BWD)	TURN RIGHT

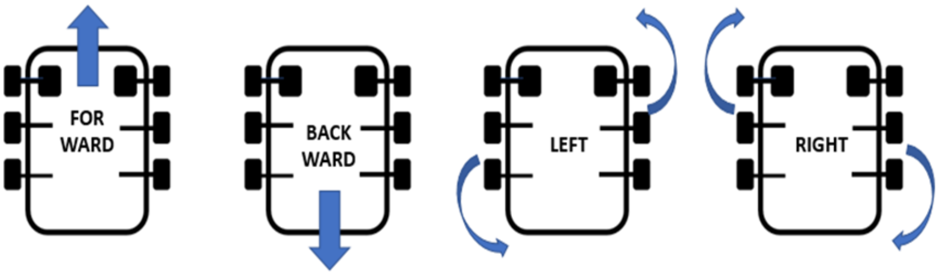

Figure 16. Robot motion Mechanism

The workings of robot movement, azimuth and elevation movement controllers for weapons and rockets are as shown in Table 1 robot movement mechanism, Table 2 azimuth and elevation motor movement. As shown in table 1 of robot movement, if M1 (Motor 1) on the robot has a logic value of 0, and M2 (Motor 2) has a logic value of 0 then the robot is silent or stopped. If M1 has a logic value of 1 forward and M2 has a logic value of 1 forward then the robot moves forward. If M1 has a logic value of 1 backward and M2 has a logic value of 1 backward then the robot moves backwards. If M1 has a logic value of 1 forward and M2 has a value of logic 1 backward then the robot turns left. If M1 has a logic value of 1 forward and M2 has a value of logic 1 backward then the robot turns right. As shown in Table 2 of the gun azimuth motor, if the motor is given logic 0 and 0, then the azimuth motor is stationary or does not rotate. If the motor is given logic 0 and 1, then the azimuth motor rotates to the left and if the motor is given logic 1 and 0, then the azimuth motor rotates to the right. The drive system is determined by two DC motors which have a capacity of 24 Volts, 5 Amps with a maximum power consumption of 150 Watts. The rotation speed of the motor and gearbox reaches 2000 rpm. If applied to a tank chain, the speed of a robot with a heavy load can move back and forth on flat terrain reaching 20 km/hour. The switching system for the current driver uses a 30 Ampere relay which is capable of transmitting maximum power loads when going uphill, so that the components used are safe from thermal factors due to high absorption capacity. As shown in table 2 Weapon elevation motor, if the motor is given logic 0 and 0, then the elevation motor is stationary or does not rotate. If the motor is given logic 0 and 1, then the elevation motor rotates up and if the motor is given logic 1 and 0, then the elevation motor rotates down. As shown in figure 17, the robot climb test is able to climb up to an incline angle of 20°, in figure 18 the maneuver and azimuth elevation test of the weapon shows the ability to move in accordance with table 1 of robot movement, table 2 of azimuth and elevation movement. The results of testing the position of the robot at rest showed that the robot was able to shoot precisely and accurately at the target at a shooting distance of 100 meters, 100% accuracy regarding the number 10 (best value), at a distance of 200 meters, 100% accuracy regarding the number 10 (best value). If the robot shoots at a speed of 10 km/hour, the average shooting distance is 100 meters, hitting the target 100% (best value), at a shooting distance of 200 meters hitting the target 90%, experiencing a 10% decrease in accuracy. This is influenced by the camera sensor factor when aiming at a distance of 200 meters with the robot moving transversely at a speed of 10km/hour, the zeroing point shifts which results in 10% of shooting results hitting the number 9 on the shooting target.

Table 2. Azimuth and Elevation Weapon Movement Settings

No	M1	M2	Output
1	0	0	STOP
2	1	0	TURN UP
3	0	1	TURN DOWN
4	1	1	STOP

Figure 17. Robot Climb Test

Figure 18. SS2 Shooting Test Results

Figure 19. Rocket Firing Test Results

The rocket was fired with the characteristics of composite AP propellant as oxidizer, HTPB as binder and Al as fuel. The rocket size is 20 mm cal with 50 mm fins, the rocket length is 500 mm and the throat nozzle diameter is 6 mm, the propellant mass is 100 grams producing a thrust of 40 N (Muda et al., 2018). The firing system is by directing the rocket launcher azimuth -90° to +90°, rocket elevation movement 0° to 50°, igniter for ignition or rocket activation by pressing the rocket button on the RC which is received by the receiver on the robot so that it works actively high (+ 5V), activates the igniter which can burn the rocket fuse. There are 2 rocket launchers measuring 70 mm in diameter, the rocket launcher material is made of iron with a thickness of 2 mm which is able to withstand the heat of the rocket fire that is generated when it burns. As shown in figure 17, rocket firing test and table 4, rocket firing results. The results of rocket fire being tested 5 times show that the furthest rocket shot distance is an average of 401 meters at an elevation angle of 45°, this shows that the rocket thrust and rocket aerodynamics are in accordance with the expected characteristics where the F (thrust) produced by 40 N does not experience instability and the accuracy of the shot results is grouped so that the rocket is able to reach a good distance with an average error (< 1%) according to standards [6].

Table 3. Rocket Firing Test Results

	Firing Angle					
Rocket Fire	10^0	20^0	30^0	40^0	45^0	50^0
	Range (Meter)					
1	150	250	310	370	396	380
2	155	245	320	370	400	380
3	157	248	315	375	405	380
4	158	245	315	375	405	385
5	156	240	320	375	400	382
Mean	155.2	247.6	316	373	401	381.4

Mine Detection Test.

The mine detector used in combat robots is a metal detector type which has the ability to detect metal embedded to a depth of 30 cm, as shown in figure 9. metal detector. The mine detection test mechanism is as shown in Figure 20, by scanning areas where mines are suspected. If when scanning an area the detector is active, the robot will mark the area with a red liquid spray and at the same time send warning data to the command post via internet data communication which is displayed on a visual monitor as shown in figure 18 mine detection test and robot tracks.

Figure 20. Mine Detection Test and Robot Tracks

In Figure 21. shows the robot control mechanism, where the robot control system for maneuvering, shooting SS2, rockets and mine detection can be carried out simultaneously in two ways, namely using a mobile controller directly in the field and a base station controller (Poskodal). The difference is that the base station can monitor the movement of the robot and the location of mine detection if the metal detector installed on the robot is active.

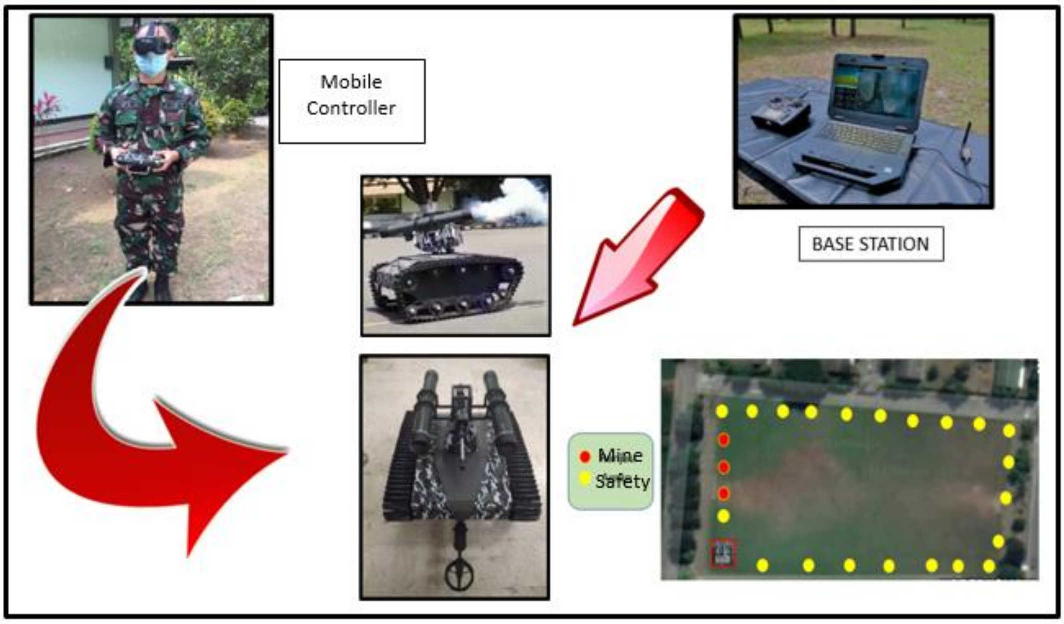

Figure 21. Robot Control Mechanism

The robot control mechanism can be done using manual and autopilot control modes using a program on a laptop. If the operator uses manual methods, to control the robot remotely using Taranis radio control with a frequency of 2.4 GHz, the camera sees the target and is transmitted to the receiver using a video sender placed inside the robot. If a mine is detected by the metal detector on the robot, information about the presence of mines is sent to the operator via the 2.4 GHz carrier frequency to the laptop display. Meanwhile, the robot's Autopilot System can be programmed by waypoint mapping plot coordinates using the Google Map Delphi application, so that the predetermined plotting coordinate route can be traversed by the robot to the target and return to home automatically [7].

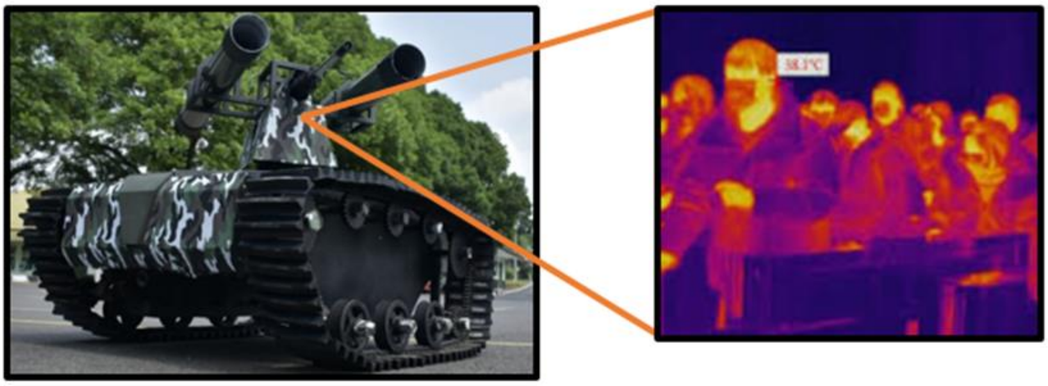

Figure 22. IR thermal camera test to detect body temperature

As shown in Figure 22, the robot system can be moved remotely to be directed at a target to detect the body temperature of a crowd of people or personnel and the results can be directly monitored from the controller. The robot's ability to detect body temperature can be used for combat operations at night. The robot's thermal camera is capable of detecting targets up to a distance of 400 meters during the day and 100 meters at night. Robots equipped with thermal cameras can be operated during the day and night, thus the task of combat operations robots is to really help troops to increase the efficiency of combat operations..

CONCLUSION

Based on the tactical aspect, reconnaissance using a chain-wheel robot system is more effective, efficient and reduces personnel loss factors. The robot can be controlled remotely up to 2 km LOS, is able to maneuver to see protected targets that are difficult to see, can be shot and destroyed. Based on technical aspects, this robot system, in terms of its construction and ability to use chain wheels, can maneuver and fire at targets using SS2 weapons or remotely controlled rockets. The robot system is also equipped with a mine detector so that it can assist the advance of troops in mine-prone areas. The robot is also equipped with a thermal camera that can be operated during the day and night, thus the task of the combat operations robot is to really help troops to increase the efficiency of combat operations

REFERENCES

Bryakin, I. V, Bochkarev, I. V, Khramshin, V. R., & Khramshina, E. A. (2021). Developing a combined method for detection of buried metal objects. *Machines*, *9*(5), 92.

Cheng, C., Li, X., Xie, L., & Li, L. (2023). A Unmanned Aerial Vehicle (UAV)/Unmanned Ground Vehicle (UGV) Dynamic Autonomous Docking Scheme in GPS-Denied Environments. *Drones*, *7*(10), 613.

Duan, X., Mu, A., Guo, H., & Zhao, X. (2024). A Manipulator Pose Planning Algorithm Based on Matrix Information Geometry. *Journal of Robotics*, *2024*.

Golsorkhi, M. S., Savaghebi, M., Lu, D. D.-C., Guerrero, J. M., & Vasquez, J. C. (2016). A GPS-based control framework for accurate current sharing and power quality improvement in microgrids. *IEEE Transactions on Power Electronics*, *32*(7), 5675–5687.

Mahendra, H. D. A., Hertavianda, K., Wicaksono, L. F., Wandi, J., & Yuandari, A. (2020). Rancang Bangun Lengan Robot Penggambar Bidang Datar Dua Dimensi. *IMDeC*, 200–207.

Marwanto, D., & Budijono, A. P. (n.d.). *Rancang bangun modifikasi mekanik robot lengan*. JRM.

Marwanto, D., & Budijono, A. P. (2013). RANCANG BANGUN MODIFIKASI MEKANIK ROBOT LENGAN. *Jurnal Rekayasa Mesin*, 89–94.

Muda, N. R. S., Wardana, I. N. G., Hamidi, N., Yuliati, L., & Witjaksono, G. (2018). Electron spins coupling of coconut shell activated nanocarbons in solid propellant on improving to the thrust stability and specific impulses. *Journal of Mechanical Engineering and Sciences*, *12*(4), 4001–4017.

NRS Muda, N. Gumilar, RDA Navalino, T N, M. H. (2020). “Implementation of Autonomous Control System of The Chain Wheel Robot Using the Backpropagation Artificial Neural Network (ANN) Methods”,. *International Journal of Innovative Science and Research Technology (IJISRT)*, *5*(8), 1230–1235.

Nuhgraha, Y. A., & Selasri, E. (2019). RANCANG BANGUN PESAWAT LATIH LENGAN ROBOT. *Jurnal TEDC*, *13*(3), 319–323.

Qian, H., Xu, Q., Zhao, J., & Yuan, X. (2020). A robust GPS-based control scheme for power sharing and quality improvement in microgrid. *International Journal of Electrical Power & Energy Systems*, *123*, 106324.

Rashid, A. Bin, Kausik, A. K., Al Hassan Sunny, A., & Bappy, M. H. (2023). Artificial intelligence in the military: An overview of the capabilities, applications, and challenges. *International Journal of Intelligent Systems*, *2023*.

Sayler, K. M. (2020). Artificial intelligence and national security. *Congressional Research Service*, *45178*.

Wamba, S. F., Queiroz, M. M., & Hamzi, L. (2023). A bibliometric and multi-disciplinary quasi-systematic analysis of social robots: Past, future, and insights of human-robot interaction. *Technological Forecasting and Social Change*, *197*, 122912.