ASRO JOURNAL
http://asrojournal-sttal.ac.id/index.php/ASRO

Volume 15, Number 03, pp.1-10
July-September 2024
ISSN: 2460-7037
E-ISSN: 2722-5763

THE CONTROL SYSTEM DESIGN ON *TACTICAL GROUND VEHICLE* (TGV) FOR AKSUS TEAM PASKHAS COMMAND BATTALYON

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DOI: https://doi.org/10.37875/asro.v15i02.552

Manuscript received 22nd July 2024, Revised 26th July 2024, Published 1st August 2024

ABSTRACT

The Paskhas Command Battalion is the implementing unit of the Korpaskhas whose main task is to carry out operations for the seizure and defense of TNI AU strategic objects in military operations. In carrying out its duties, there is a PDR Team that carries out indoor combat tasks. However, in practice, the PDR Team still lacks data that will be used in the battle. So we need a tool that can present visual data in the room and can paralyze the enemy without having direct contact with the PDR Team and can destroy vital enemy objects to support the main troops. Therefore, it is necessary to make a supporting tool in the form of a Tactical Ground Vehicle (TGV) with remote control. By using a design method that unifies several supporting components both in mechanical and electrical systems, hardware and software as well as control systems. The control system uses wireless with a transmitter on the remote control that is integrated with the receiver at a frequency of 2.4 GHz. Utilizing a DC Brushed motor as a driver and an ESC (Electronic Speed Control) as a movement controller. Equipped with an FPV camera with a frequency of 5.8 GHz so that it can find out visual data in the room through the display screen, as well as a weapon mechanical system and weapon trigger suppression and detonator trigger that utilizes a servo motor connected to the receiver. Based on the results of the design and testing that has been carried out so that it can be used and functions properly with a success rate of 89%.

Keywords: *Aksus Team, Commando Battalion, Paskhas, Tactical Ground Vehicle.*

1. INTRODUCTION

The Paskhas Command Battalion is an implementing unit of the Indonesian Air Force Special Forces Corps (Korpaskhas) which has the main task of carrying out operations for the seizure and defense of TNI AU strategic objects in military operations. In the organization in the Paskhas Command Battalion unit, there are 3 Rifle Companies, 1 Assistance Company and 1 Headquarters Company. Each soldier in the Rifle Company must always hone his land, sea and air combat skills, including: raids, Indoor Battles (PDR), infiltration (infiltration into the opponent's area), fighting in buildings and urban areas (Purbangkota), Anti Guerrilla Battle Tactics (TPRAG), and so on. So that the operational tasks can be carried out properly as expected by the top command and can reduce losses both personnel and material.

In Rifle Company, there are 3 rifle platoons and 1 support troop. In carrying out operations, each rifle platoon is appointed by 1 team as a Special Action (Aksus) team in charge of overcoming targets in the room/building so that PDR tactics and techniques must be implemented properly so that optimal results are achieved. Therefore, special equipment is needed called the Integrated Personnel Protection Set (IPP Set). In addition, the PDR team also needs information in the form of visual data about spatial planning, buildings and enemy positions as well as hostages, so that the assigned tasks can be carried out properly and smoothly and reduce losses both personnel and material.

At this time, the PDR team only gets data from intelligence which only provides the location/place of the enemy without knowing the enemy's strength, weapons, plans/spatial planning and the position of the hostages, so that in carrying out PDR operations it is still very difficult to carry out and can also endanger the personnel in the team. especially the first person (pioneer) because the enemy's position is unknown. If during a destruction raid operation, the PDR team must infiltrate directly into the enemy's vital area/object that must be destroyed so that the confidentiality and security of PDR personnel is not guaranteed.

Therefore, it is necessary to design a tool called "Tactical Ground Vehicle (TGV) for the Special Task Force Battalion Command Team". In this case, we took part in making it under the title "Design of a Control System for a Tactical Ground

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E-ISSN: 2722-5763

Vehicle (TGV) for the Special Task Force Battalion Team". This tool is expected to be able to infiltrate buildings without the enemy knowing so that secrecy is maintained and can provide visual data in the room displayed on the display screen, also equipped with a short-barreled weapon with a caliber of 9 mm which is controlled remotely which can paralyze the enemy without having to direct contact with PDR troops.

2. LITERATURE REVIEW

2.1 Radio Communication Transceiver

Transceiveris a combination of electronic devices consisting of a transmitter (transmitter) and a signal receiver (receiver). The range of the transceiver itself depends on the frequency and the environment (weather, temperature, and obstacles).

2.1.1 Transmitter

Wireless communication that functions to transmit data to other places in the form of radio waves is part of the system, also known as a transmitter. The working principle and function of the transmitter is that there is an induced magnetic field from a potential source which then generates a current and induces a connected circuit.(Rahman & Harjani, 2020b) In Figure 2.3 is one form of the transmitter.

2.1.21Receiver

Recipient *(receiver)* is a device that functions to receive the transmitted signal. (Rahman & Harjani, 2020a)The receiver of the signal from the signal given from the transmitter (remote control) can then be controlled according to our wishes without cables. Figure 2.4 is one of several types of receivers that are widely used by the public.

2.2 DC Electric Motor (DC Motor)

A DC Electric Motor (DC Motor) is a device that converts electrical energy into kinetic energy or motion (motion) and in the process uses direct electric current (DC), so it is also called a Direct Current Motor. This type of motor produces revolutions per minute called RPM (Revolutions Per Minute) and can also be made to rotate clockwise (CW) or counterclockwise (CCW) if the polarity of the electricity supplied to the DC motor is reversed. If the applied voltage is lower than the operating voltage, it will slow down its rotation. However, if the voltage is less than 50% of the operating voltage, the motor will not rotate. Meanwhile, if the applied voltage is higher than the operational voltage it will make the DC motor rotation faster.

2.3 Electronic Speed Control (ESC) Brushed

Electronic Speed Control (ESC) is an electronic circuit used to change the speed of electric motors, routes and also functions as a dynamic brake with a PWM (Pulse Width Modulation) system. PWM is a method for manipulating the pulse width between Low or High (0 or 1) which is expressed in the duty cycle or from 1 high to 0 low. The brushed ESC used in the RC model for brushed DC motors, essentially provides a 1-phase electronically generated low-voltage energy source for the motor.

In practice, if the RC joystick is moved a little, the motor will rotate slowly, and vice versa. That's because, in the RC there is a potential that responds to every movement and is forwarded to the microcontroller which is then continued to the transmitter to be used as a frequency wave and sent to the receiver. After being received by the receiver, the frequency will be separated from the carrier wave and signal wave and responded by the ESC based on the response of the potential on the RC.

ESC in carrying out its functions will be influenced by 2 factors as follows:

a. The current given to the motor to control the ESC must be greater than the current in the motor.
b. Robot load, if the robot load is very heavy, the ESC current must also be greater.

On the working principle of the ESC, the Mosfet Transistor is used as a mechanical device switch switch, with the amount of about 2000 times per second. So, the power to the motor varies with the amount of time*On*, against the Off time in a given cycle.

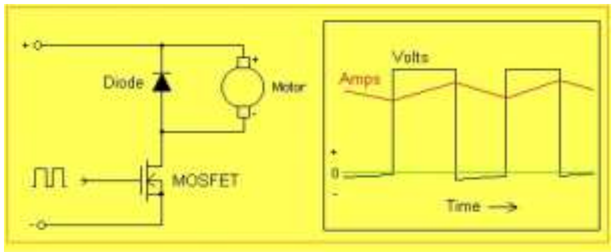

Figure 1. ESC Circuits and Diagrams

2.4 Electric Detonator

Detonator is a device that serves to trigger explosives. In other terms it is also called Blasting Cap (blasting cap). To start detonating detonators can be chemical, mechanical or electrical, the most widely used today are electric detonators. For primary explosives the detonator is a material called an ASA compound which is formed from Lead Azide, Lead Styphnate and Aluminum and is pressed into place over the base charge. Another material used as the main charge of the detonator is DDNP (Diazo

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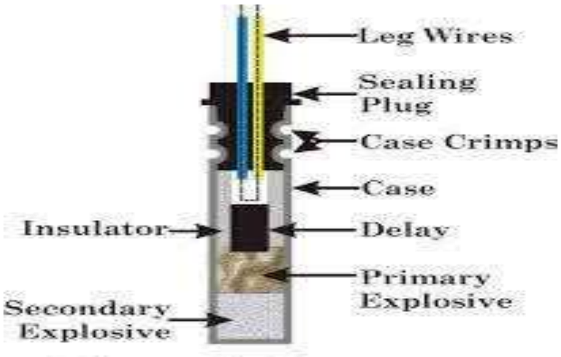
dinitro phenol) which is used to reduce the amount of lead.

An electric detonator is a detonator that uses an electric current as a trigger. The current is delivered from a voltage source into the detonator tube through a special cable with a fine wire at the end. If there is an electric current passing through it, it will glow and will burn the primary explosive (stuff) of the detonator, causing a shock wave that will create a secondary explosive outside. the detonator exploded. Figure 2.15, describes the main parts of an electric detonator.



Fugure 3. Main Parts of Electric Detonator

In detonating an electric detonator, an electric current of at least 1 Ampere to 1.5 Ampere is required. This depends on the type of detonator used and the length of the cable to connect the electric current from the current source to the detonator.

3. RESEARCH METHODS

3.1 Research design

Research design is a system or framework that will be used to carry out a research, and is also a stage carried out in research. The research design provides procedures on how to make a tool and also prepares a plan before carrying out research in the hope that it can be used as a guide in solving all problems in a research.

3.2 Research procedure

The research procedure is a sequence of steps and an explanation of a research process that will be carried out, starting from diagram of the work system design to the expected or expected system inputs and outputs.

3.2.1 Research Time and Place

The time for the research for the final project is from July 2021 to December 2021. Meanwhile, the place for the research is STTAL (Surabaya) and the 464th Wing II Pakhas Command Battalion, which is in Malang.

3.2.2 Research Tools and Materials

In the implementation of this research, there are several tools and materials to facilitate the design and research trials. The tools and materials needed in the implementation of this research include:

a. Short-barreled weapon (Glock 26) and its ammunition.
b. Remote control with a frequency of 2.4 GHz and Receiver.
c. Battery (Accumulator).
d. Brushed DC motor.
e. Servo Motor.
f. ESC Brushed 80 A.
g. Electric Detonator.
h. Cooling fan (Fun cooler).
i. Laserpoints.

3.2.3 Research design

In the process of designing a control system on this Tactical Ground Vehicle, it requires a mature concept so that it can support the success of this research. In terms of hardware selection that makes an implementation of the mechanical system and control system greatly affects the design of the tool. In its implementation, it requires a basic concept that becomes a guide in carrying out the design, where this concept contains steps and instructions that can support a design process (design).

3.2.4 Hardware Design

In the design of system hardware, it describes all the devices needed to realize ideas in solving problems that arise into a system described in the form of block diagrams.

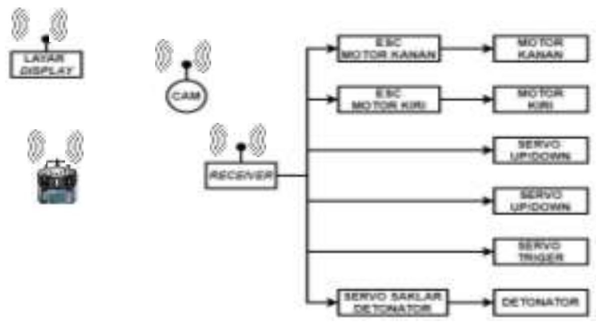


Figure 3. Hardware Design

3.2.4.2 Tool Schematic

The scheme of this tool aims to facilitate the design of the components that will be used and their supporting tools so that they can drive a series of electrical system mechanisms and DC motors that have been installed.

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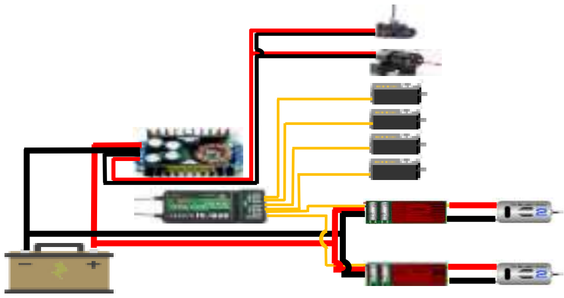


Figure 1. Tool Schematic

3.2.4.2 Electrical Schematic

As a voltage source in this tool, using a battery (Accumulator) with a voltage of 12 Volts. To supply the ESC, the cable is connected in parallel between the battery with the ESC 1 and ESC 2 (the positive pole of the battery is connected to the positive pole of the ESC, the negative pole of the battery is connected to the negative pole of the ESC). And forwarded to the electric motor (ESC 1 is connected to the motor 1 (Right), and ESC 2 is connected to the electric motor 2 (Left)), with the information that the positive pole of the ESC is connected to the positive pole of the motor, and vice versa.

To supply the receiver, it is taken from the BEC (Battery Eliminator Circuit) generated by the ESC with a voltage of up to 7 Volts, so no batteries are needed anymore. As for the cooling fan (Fun cooler), the positive pole of the battery is directly connected to the positive pole of the cooling fan, and vice versa (connected in parallel between fans 1,2 and 3). Because the cooling fan used works with a voltage of 12 V. For more details, can be seen in Figure 3.5 about the electrical scheme.

3.2.4.3 Circuit Diagram

The circuit diagram is made with the aim of simplifying the process of designing components that will be used in this design. In this circuit diagram, there are two system diagrams to be made, namely the control system diagram for the DC motor and the control system diagram for the servo motor. This aims to support the work of the Tactical Ground Vehicle so that it is better and avoids errors in its control.

a. Control System Diagram on DC motor

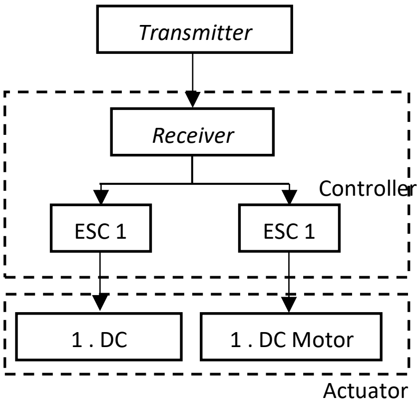
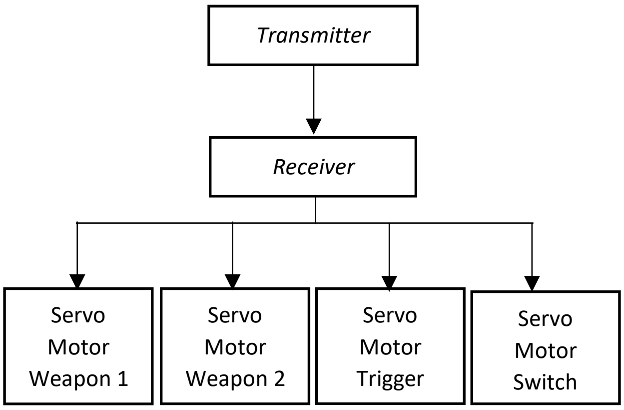


Figure 2. Control System Diagram on DC Motor

b. Weapon and Detonator Control System Diagram



Picture 3. Weapon and Detonator Control System Diagram

3.2.4.4 Receiver Electronic System Design

The 2.4 GHz radio signal waves emitted by the transceiver antenna are received by the receiving antenna, then carry out the next command.

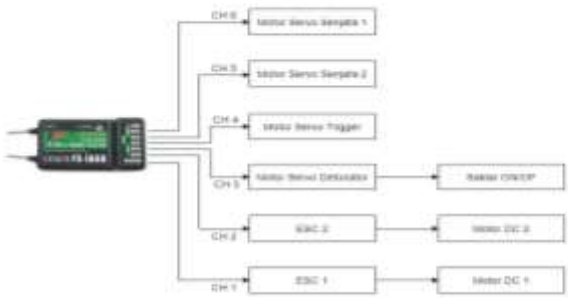


Figure 4. Receiver System Design

3.2.4.5 Software Design

This software design serves to determine whether the software that has been made can run according to the algorithm that has been created.

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E-ISSN: 2722-5763

This is done with several stages of activities that are carried out sequentially.

3.5 Electrical Voltage Source Planning

In the discussion of electric voltage sources, the author uses an electric voltage source with direct current (DC). namely the voltage source on the remote control and on the Tactical Ground Vehicle. Below will discuss the consumption of electrical power and voltage sources on the device designed and the plan for using the battery (battery).

Calculates the Total Electric Power required by the Tactical Ground Vehicle to operate.

Based on the specifications for each tool, the following data are obtained:

a. Electronic Speed Control (ESC)

The TGV uses 2 ESCs which have a voltage specification of 12 Volts with a constant current of 80 A and a resistance of 0.0014 , and a V Loss of 0.112 Volts. Then the power dissipated is:

PLoss = VLoss . Constant Current ESC .2

PLoss = 0.112 . 80 A.2 = 17.92 Watt

b. DC Motors.

From the results of calculations carried out by Serma Supriadi who designed the robot's mechanical system. It can be seen that the power required by the motor to move at a speed of 1 m/s or 3.6 Km/hour is 83.66 Watts and the motor voltage is 12 Volts. With a strong current required is 6.97 Ampere.

In moving the wheels on the TGV it takes 2 DC motors so that the power required is 167.32 Watt.

c. Receiver

In the product specifications listed, to run *receiver* requires a voltage of 4.0 to 6.5 Volts with strong current 2 ampere. Then it can be calculated the power required is:

P = V . I = 6.5 . 2 = 13 Watts

d. Servo Motor

In assembling this tool, there are 4 servo motors used. Among them are 3 servo motors of 25 kg and 1 servo motor of 10 kg.

e. Servo motor 25 kg (3 pieces)

Has a voltage specification of 4.8 to 6 Volts with a current of 1.2 A. Then the power used can be calculated:

P = V . I . 3 = 6V . 1.2A. 3 = 21.6 Watt

f. Servo motor 10 kg

With a voltage specification of 6 with a strong current of 2.4 Ampere. Then it can be calculated the power used is:

P = V . I = 6 V . 2.4 A = 14.4 Watt

g. FPV Camera

Based on the product description, FPV cameras require a voltage of 2.5 to 5.5 Volts and a current of 300 mA equals 0.3 Ampere. Then the power can be calculated is:

P = V . I = 5.5 . 0.3 = 1.65 Watt

h. Laser *Point*

Based on the manufacturer's specifications, laser *point* requires a voltage of 4.5 to 5 Volts with a current of 30 mA or equivalent to 0.03 Ampere. Then the power can be calculated is:

P = V . I = 5 . 0.03 = 0.15 Watt

i. Fun Cooler

In tool design, there are 3 *fun cooler* which has the manufacturer's specifications, working on a voltage of 12 Volts with a current of 0.09 Ampere. So the power can be calculated as follows:

P = V . I . 3 = 12 . 0.09 . 3 = 3.24 Watts

Based on the above calculation, the total electrical power required to operate the TGV is as follows:

Ptotal = Pa + Pb + Pc + Pd + Pe + Pf + Pg + Ph

Ptotal = 239.28 Watt

From the total power above, it can be calculated for the required current strength:

P = V . I

I = = = 19.94 Ampere$\frac{P}{V}\frac{239,28Watt}{12V}$

When carrying out observations and data collection when the 464 Paskhas Command Battalion was carrying out PDR exercises, it was known that the exercise lasted 27 minutes. Thus it can be assumed that the use of TGV must be able to operate for at least 30 minutes. Therefore, the selection of batteries must have a minimum capacity of 12 Ah. Thus, the author decided to use a battery with the Kayaba brand with a capacity of 12 V 18 Ah and DOD (*Depth of Discharge*) 75% of the battery capacity. So the usable capacity is

I = 18 . $\frac{75}{100}$ = 13.5 Ampere

By using the battery, the operating time can be determined as follows:

Operating Time = 0.68 hours or equivalent to 41 minutes.$\frac{13,5Ah}{19,94A}$

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E-ISSN: 2722-5763

4. RESULT AND DISCUSSION

4.1 Implementation

Implementation is the activity of applying the equipment used which is the result of the design. Starting from analyzing the problems faced by the unit and becoming an idea, then a research was carried out. The implementation of the tools and systems that have been planned in this final project has been adapted to the needs of the field of work. The plan has been prepared, detailed and calculated carefully as it should be. The application of the tool is carried out in order to get results in accordance with the plan for better results and pay attention to the safety aspect, whether it is the system made, equipment or operation so that Zero Accident is achieved.

4.1.1 Implementation of Control System

For the implementation of the remote control system, the author uses a Flysky FS i6 remote control as a transmitter with a frequency of 2.4 Ghz, for receiving signals from the transmitter, we use a Flysky FS i6B receiver with 6 channels. This remote control is equipped with a holder as a place for monitoring tools.

The controller control scheme is designed to facilitate the preparation, operation and operation of the controller. So in process*settings* adapted to remote control conditions and needs in the field.

Figure 8. About settings on the Flysky FS i6 remote control

Table 1. Button Description Remote Control Flysky

KNOB	ORDER	DESCRIPTION
A	Right and left wheel control	Up
B	Right and left wheel control	To the right
C	Right and left wheel control	Neutral
D	Right and left wheel control	Back off
E	Right and left wheel control	To the left
F	Weapon Servo Control	Down
G	Weapon Servo Control	Ride
H	Servo Trigger Control	Pressing the Switch
I	Detonator Switch Servo Control	Pull Trigger
J	Servo Trigger Control	Neutral (Return to initial position)

4.1.2 Receiver Implementation With DC Motor

In this implementation, the receiver is connected to the ESC which functions as a DC motor speed controller, a DC motor rotation direction controller, and as a dynamic brake. The receiver uses a frequency of 2.4 GHz and works at a voltage of 6.5 VDC which is obtained from the BEC ESC output voltage.

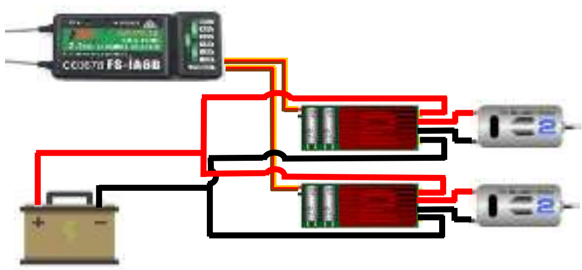

Figure 9. Receiver implementation with ESC and DC motor

The PWM ESC 1 cable is connected to the *receiver* on channel 1 it is forwarded to the DC motor 1 and the PWM ESC 2 cable is connected to the receiver on channel 2 it is forwarded to the DC motor 2. As for the ESC voltage source, it is taken from a 12 Volt battery. At the assembly stage, the battery as a voltage source is connected to the ESC 1 and ESC

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2 in a parallel circuit, for the voltage source at the receiver an ESC is taken by utilizing the BEC (Battery Eliminator Circuit) with an output voltage of 6.4 Volts to 7.4 Volts with a maximum current 5 A, so the receiver does not need to use a separate voltage source. The ESC output is connected to a DC motor (ESC 1 for motor 1, ESC 2 for motor 2). For on/off each ESC we add a switch so that in disconnecting or connecting current, it is enough to press the switch.

Figure 10. Receiver Circuit Schematic, ESC and DC motor

4.1.3 Receiver Implementation With Servo Motor

In this implementation, there are 4 servo motors used, namely 2 servo motors for the Up/Down mechanical system of the weapon, 1 servo motor for pulling the trigger of the weapon and 1 servo motor for the switch on the detonator. In the mechanical servo of the weapon (servo motor 1, pwm cable and tension cable are connected to the receiver on channel 5. Meanwhile, servo motor 2, pwm cable and tension cable are connected to the receiver on channel 6), and servo motor 3 (trigger gun) is connected to channel 4 receiver, while the servo motor 4 (for the detonator switch) is connected to channel 3 receiver.

At the assembly stage, the servo motor gets a voltage source from *receiver* Furthermore, servo motors 2 and 1 act as levers for weapons, while servo motors 3 act as triggers for weapons, and for servo motors 4, it is in charge of pressing the switch so that current from the battery can flow to the detonator.

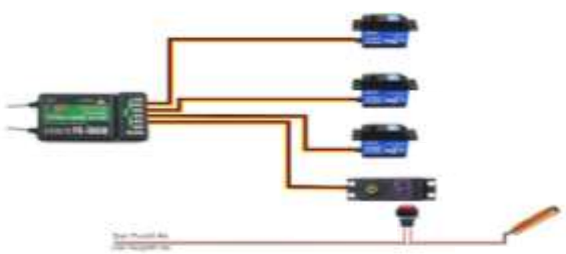

Figure 11. Receiver and Servo Motor Circuit Schematic

4.2 Testing Tool

In the following, the author will discuss the results of system testing according to the results of the application. The results that the authors report are based on trials that have been carried out in STTAL and the 464th Paskhas Command Battalion (Malang) which were carried out repeatedly so as to produce data as progress reports and reports on the application of the tool.

4.2.1 Button Testing (Joystick)

The following is a test of the navigation buttons on the joystick on the Flysky FS i6 remote control, to give orders to the Tactical Ground Vehicle. The process carried out is to move the analog button and see how the movement on the TGV is, whether the response is in accordance with the settings or not. In Table 4-2 which explains the results of the test on the condition of the navigation buttons for TGV movement.

Table 2. Joystick Button Test

No	Control	Function	Description	Results
1	Analog A	DC Motor Control	Wheels Move Forward	Good
2	Analog B	DC Motor Control	Wheel Moves to the Right	Good
3	Analog C	DC Motor Control	Wheels Don't Move	Good
4	Analog D	DC Motor Control	Wheel Moves Back	Good
5	Analog E	DC Motor Control	Wheel Moves Left	Good
6	Potential F	Servo Control	Weapon Down	Good
7	Potential G	Servo Control	Weapon Rise	Good
8	H . analogue	Servo Control	Pressing the Switch	Good
9	Analog I	Servo Control	Pull Trigger	Good
10	Analog J	Servo Control	Back to Starting Position	Good

The results of testing the movement of the wheels on the Tactical Ground Vehicle using a joystick aim to determine whether the movement of the wheels can move according to the length of emphasis on the joystick and its speed. The results

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E-ISSN: 2722-5763

of this test can be concluded that the tool can work according to the commands given via a wireless joystick.

4.2.2 Voltage Source Test

This test aims to find out how long the battery can last in supplying the robot to operate. By knowing the results of this trial, when this tool is used, it can be anticipated to replace the battery so that the exercise can be carried out smoothly. In this test, it is carried out in several ways, including::

4.2.2.1 Power consumption calculation

In carrying out this test, it will be measured with a digital multimeter and the power consumption of each component will be calculated. The measurement is carried out by disconnecting the positive cable (V+) and connecting it to the multimeter cable, the measurement is carried out 5 times to get more accurate results. With the following results:

a. Receiver
Voltage 6.5 V and average current 0.98 A. then Power = 6.37 Watt

b. ESC (*Electronic Speed Control*)
There are 2 ESCs with a voltage of 12 V and an average current of 0.18 A. So Power = 4.32 Watt

c. DC Motor
There are 2 DC motors with a voltage of 12 V and an average current strength of *throttle* 100% is 9.32 A, then power = 223.68 Watt.

d. Weapon Mechanical Servo Motor
There are 2 servo motors with a voltage of 6 V and an average current of 1.01 A, so the power = 12.12 Watts

e. Towing servo motor *trigger* weapon
The voltage is 6 V with an average current of 0.96 A, then the power = 5.76 Watts

f. Detonator servo motor
The voltage is 6 V with an average current of 0.07 A, then the power = 0.42 Watt

g. Stepdown (Laser point and FPV camera)
The voltage is 12 V and the average current is 0.12 A, so the power = 1.44 Watt

h. Fun Coller
There are 3 *Fun cooler* with a voltage of 12 V and an average current of 0.01 A, then the power = 0.36 Watt

From the calculation results above, it can be obtained that the total power required is:

P = Pa+ Pb+ Pc+ Pd+ Pe+ Pf+ Pg+ Ph

P = 6.37 W +4.32 W +223.68 W +12.12 W + 5.76 W+0.42 W+1.44 W+ 0.36 W

P = 254.47

Then the required current strength is

$I = \frac{254{,}47W}{12A} = 21.21$ A

By using a 12 Volt 18 Ah battery with a DOD of 75%, the battery capacity becomes 13.5 Ah. Thus it can be calculated the length of use of the tool is as follows:

TGV Operating Time = $\frac{13{,}5A\ h}{21{,}21\ A}$

TGV Operating Time = 0.64 hours or the equivalent of 38 minutes 24 seconds.

4.2.2.2 Measurement On Battery Output

At this stage of testing, measurements will be made on the current issued by the battery (current *output*) with a digital watt meter (Power Meter) 150 Ampere DC. To find out the power consumption of the tool when all components are operated simultaneously. For the results obtained will be used as a comparison of the results of calculations and measurements that have been done with 100% throttle. These measurements obtained data on the average current strength of 20.19 A.

With these data, it can be calculated usage time using 12 Volt 18 Ah battery with 75% DOD then the battery capacity to 13.5 Ah is as follows:

TGV Operating Time = $\frac{13{,}5Ah}{20{,}19A}$

TGV Operating Time = 0.67 h or equivalent to 40 minutes 12 seconds

Control System Test

Control system testing (*remote control*) is done to determine the response of the receiver in receiving signals from the transmitter so as to give orders to other components such as ESC (Electronic Speed Control), DC motors and servo motors. Testing the control system is testing the controller in carrying out its duties, with the aim of measuring the extent to which the capabilities of the device that have been made in receiving the signal sent by the transmitter can be measured. Among them are knowing the strength and quality of the command signal that has been sent from the controller to the receiver. This test is done by operating the button (joystick) that is already on the Flysky FS i6 remote control and seeing the response of the tool that has been made.

The test was carried out at the Mess Arjuno STTAL with the results that the connection between the transmitter and receiver outdoors without any obstructions from buildings and trees, can be connected properly at a distance of less than 150 meters, starting to falter (intermittent) at a distance of 151 to 154 and at a distance of 155 the signal is disconnected (not connected).

For indoor testing, the instrument is placed in room 01 on the 1st floor (on the right *lobby*) mess Arjuno. From these tests, it was found that the transmitter and receiver can be connected properly

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ISSN: 2460-7037
E-ISSN: 2722-5763

at a distance of 0 to 61 meters, at a distance of 62 to 64 the signal is intermittent (intermittent) and at a distance of more than 65 the signal has been disconnected.

4.2.4 Shooting Accuracy Test

In this test, it is intended to determine the accuracy of the TGV in carrying out shooting at static targets (not moving). Before carrying out the shooting, the activities are carried out first*zeroing* with 3 bullets, namely aligning the laser point positions (laser point on the target with a distance of 10 meters).

Figure 12. Position of Laser Point on Body Lesions

This test was carried out at the firing range of the 464th Paskhas Command Battalion (Malang), at 10.20 WIB with cloudy weather conditions, using body massage with an exposure value of 1 to 5. 3) on the target with the number 5. It is hoped that at the time of shooting, the bullet will hit the number 5 on the body lesion. For testing the accuracy of shooting, it was carried out after carrying out zeroing using a Glock 26 short-barreled weapon (pistol) with 5 9 mm caliber bullets.

Figure 13. Shooting Test Exposure Results

4.3 Discussion

In the discussion in this sub-chapter, discusses the results of the research that has been carried out. The discussion covers the existing system, both software and hardware that are integrated in one set of tools. Based on the tests that have been carried out and the data that has been collected, the following analysis can be carried out:

a. On the button function test (*joystick*)

Settings and functions of the buttons (joystick) on *remote*control is as expected. this is evident when the operator gives input to the remote control and the device responds. This is indicated by the movement of the tool according to the length and depth of the throttle on the remote control being pressed by the operator. However, the operator's expertise in manning the tool must still be trained, so that the tool can work according to the operator's objectives.

b. In testing the mains voltage source.

In this test, it is carried out when the tool is operating at maximum speed (throttle 100%) and all components are working at the same time so that the tool can only operate for 38 minutes with a full capacity battery. However, if it is carried out in a real field, the speed will be adjusted by adjusting the conditions of the place and other components (servo motors) will be used only when it is used. So that the operating time of the tool will be longer than the test results.

c. Control System Test

In this test carried out outdoors (without *obstacle*) with a distance of less than 150 meters and indoors (with obstacles) with a distance of less than 61 meters, so that it can be seen that the operation of this tool should not exceed the distance during the test. Which will result in lost contact on the device.

d. Shooting accuracy test

In this test, the TGV can shoot and hit targets with an average value of 2.4 at a distance of 10 meters. This is because in the process of installing the gun to the*box*there are still some things that need to be improved, including the position of the gun still shifting during the shooting process, because in the manufacture of the box there is space (distance) between the top holder of the gun and the top of the gun. The existence of this distance is intended so that when the gun is reloading the ammunition from the magazine, it is not hampered by friction between the retaining part of the gun and the top of the gun. Likewise, on the side there is still a distance between the top retainer and the side of the weapon.

Volume 15, Number 3, pp.1-10
ISSN: 2460-7037
E-ISSN: 2722-5763

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

Based on the results of the design, and testing and analysis during the preparation and manufacture of the final project Design of Control System in *Tactical Ground Vehicle* (TGV) for the Special Task Force Battalion Command Team. So it can be concluded that the robot can be controlled remotely using the Flysky FS i6 remote control and Flysky FS iA6B receiver. In its movement, the robot moves according to the commands sent by the operator using the remote control according to the length of time and the percentage of the operator pressing the Joystick button. In the shooting process, the shot is carried out by moving the mechanical servo of the weapon up/down and shifting to the right or left is done by moving the wheel via the remote control. Meanwhile, in detonating explosives, it can be carried out with the servo command pressing the detonator switch, so that the current from the battery can be connected to the electric detonator.

From some of these tests, it can be concluded that research on Control System Design in *Tactical Ground Vehicle* (TGV) for the Special Task Force Battalion Team for the Paskhas Command has been successfully implemented with a success rate of 89%.

5.2. Suggestions

Based on the results of trials on Design and Build a Control System on a Tactical Ground Vehicle (TGV) for the Special Task Force Battalion Command Team Paskhas, some suggestions can be given as follows:

a. In the making *body* TGV, to choose a material that is strong and light. So that it can reduce the burden of the robot which will have an impact on decreasing the power used by the motor to operate, thus saving more battery power.

b. In the design of the control system, in order to create a control system that becomes a single unit with the screen *display* so that it can make it easier for the operator to control the tool and become more efficient.

c. This design is expected to be developed further which in the end can support operational activities in the field for TNI units and can support independence in the manufacture of the Main Equipment of the Indonesian Armed Forces Armament System.

ACKNOWLEDGEMENT

The authors greatly acknowledge the support from Indonesia Naval Technology College STTAL Surabaya Indonesia for providing the necessary resources to carry out this research work. The authors are also grateful to the anonymous reviewers and journal editorial board for their many insightful comments, which have significantly improved this article.

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