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Remotely Operated Weaponized Robot Control System and Vehicle

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--*ABSTRACT*--
This paper is mainly concerned with the ground-based robot vehicle, which can easily perform a dangerous and delicate task confidentially where humans can easily target. The lightweight and less complex designed system is easy to handle/operate through the smartphone. The various semi-automatic weapons can set up into the system and fired remotely. This research aims to develop the weaponized robot system and develop a suitable vehicle for war and surveillance, where human life is at high risk. The vehicle can easily operate remotely and done the required task easily. The system developed accurately that it can operate in any critical scenario. All the parts (weapon system and vehicle) are divided into the group that attachment and detachment can be performed easily.

KEYWORDS; -*Weaponized Robot, Robot vehicle, Control system, Robot, War robot, War vehicle, Control system and vehicle, Weapon control system, Weapon system, Weapon robot, System robot, War system, Surveillance robot, Surveillance system.*

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I. INTRODUCTION

Lives of soldiers are every day at risk in the naxalite region and the terrorism area. The armed men/enemy suddenly attack military men and supervisors that the military or officers have no chance to take action and have lost their valuable life. The news channels show every 2nd-3rd day that a soldier died, and the country lost his son/daughter. Also, some critical and sensitive missions that take on the enemy are tough, and the lives of soldiers are highly at risk. Some vulnerable areas are protected by hard to conquer land mines, and life risk ratio is at its highest. To conquer enemies and complete sensitive and vital mission unmanned ground vehicle implemented to conduct the operation confidentially and save soldier's lives. But available autonomous vehicles are costlier and difficult to use. The robotic technologies are readily accessible, and there is growing regular demand for the vehicle loaded with the arms. Military and surveillance agencies want weapons vehicles to deploy and willing to send less human to the dangerous situation a robot can secretly perform easily. According to research, robots would be useful in inspecting potentially dangerous areas from 80% to 100%. And that almost any respondent felt a robot would be useful from 40% to 100% in such an operation. Robots trained by law enforcement to handle risky scenarios and send back information about the scenario to their human team members required. Robot replacement for the critical task is good for humanity, multiplying the effect of being a team, allowing for a more efficient and comprehensive investigation in a shorter time frame. After all these observations and scrutinization of data, we developed the "Remotely Operated Weaponized Robot Control System and Vehicle" which is cheaper, lightweight, and easy to use.

II. OBJECTIVE

To design and develop a robust electro-mechanical weaponized robot control system and vehicle which can withstand at any critical scenario, compact in design, easy to handle, can operate any semi-automatic weapon, and less complex.

III. APPROACH

1. Methodological approach

An action plan was needed to complete each well-implemented project. The first approach of the project was to conduct background research and secondly, to maintain control of overtime management. Then, the entire project was carried out from a process viewpoint and has been planned mechanically. The final step was electronic hardware and its software programming

2. Systematically approach

The design and subsequent implementations of the device were not divided into sections such as "mechanical, electrical and software" but were regarded as a whole system consisting of its physical structure, electrical components, and software schemes.

IV. DESIGN

To better understand the specification of each design, let it brake into 05 parts: vehicle, scissor mechanism, weapon control system, controlling device (smartphone) and electronics components.

1. Vehicle (carries the scissor mechanism and weapon control system):

The vehicle bears the scissor mechanism and weapon control system with a weapon. The Smartphone monitors the moment of the vehicle. The vehicle has an individual motor driven 02 front wheels and 02 rear wheels. 02 Additional wheels fitted to front wheels attached by a crawler belt to maintain the vehicle's stability and durability on rugged surfaces. All 4 motors are servo motors that can provide the vehicle with sufficient speed to complete the task.

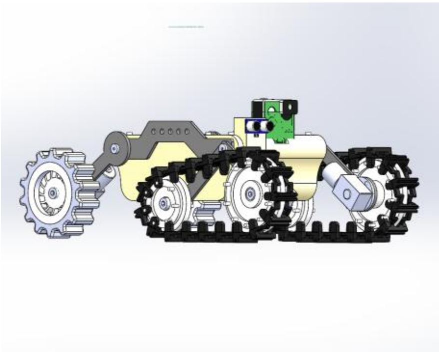

Fig.1. *Isometric view of vehicle*

One provision is provided to the vehicle where Arduino Uno, Bluetooth module/Wi-fi, relay module, motor driver module, ultrasonic sensor, camera, 02 batteries are installed.

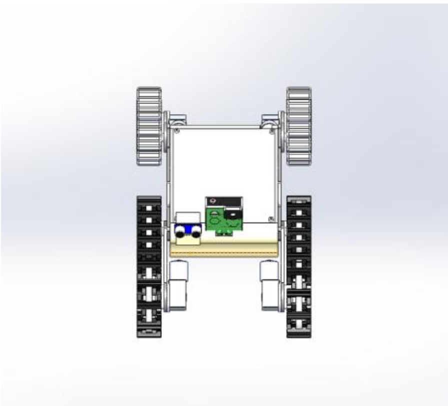

Fig.2. Top view of vehicle with closed provision

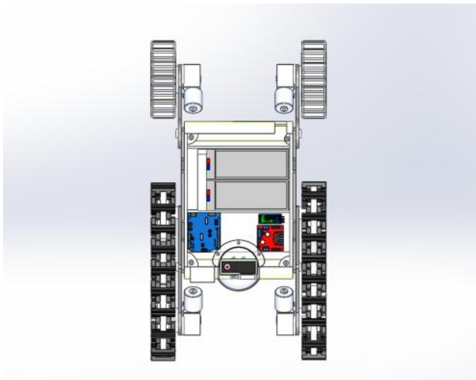

Fig.3. Top view of vehicle with open provision

2. Scissor mechanism (installed between vehicle and weapon control system):

The scissor mechanism is installed between the vehicle and the weapon control system. It helps to move the weapon control system in an upward and downward motion. A smartphone operates its function.

The Scissor mechanism contains a top-bottom frame. On the top frame, the weapon control system is attached, and the scissor mechanism is connected to the vehicle via the bottom frame. The Scissor mechanism is a servomotor (metal gear) driven. Slider crank mechanism is provided between scissor arm and servo motor which helps to convert rotary motion from the servomotor to linear motion to the scissor arm and it also helps to sustain on its achieved height.

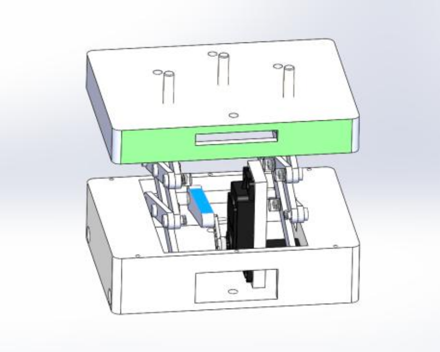

Fig.5. Scissor mechanism

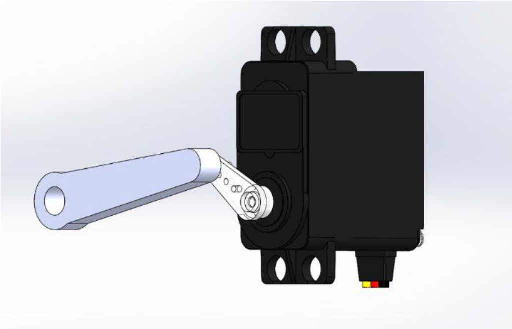

Fig.6. Servo motor and slider-crank mechanism

Through the aid of the studs, the scissor mechanism is attached to the robotic frame and gives it additional strength to withstand the variable load and also the weapon's recoil power.

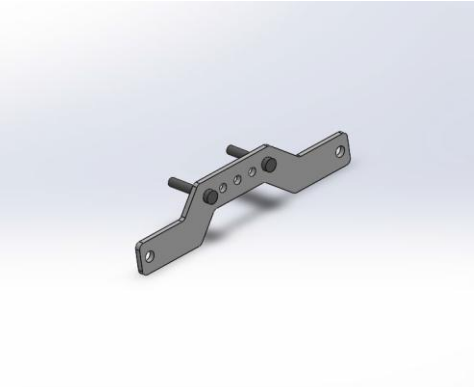

Fig.7. *Frame and studs to hold scissor mechanism*

The scissor mechanism is equipped with linear guidance, which directs and protects the top framework of the system of scissors throughout their travel.

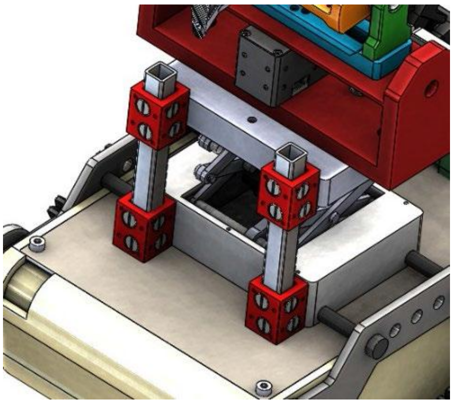

Fig.8. *Linear guides*

3. Weapon control system

The Weapon control system is a mechanism for the handling and targeting of weapons. This can push the arm in either direction and also tilt the up-down movement. It can additionally activate the arm. This system allows the arm yaw and pitch motion. The weapon control system designs the way it can detach and fixed to any robot and vehicle type. A smartphone handles the motion and movement of the weapon control system.

In the targeting system, two heavy torque stepper motors are used to achieve potential yaw and pitch movement towards the arm. One stepper motor mounted under the frame delivering rotational motion (yaw) and the second stepper motor mounted near the weapon to provide tilt up and down motion (pitch) for the firearm. To fire the firearm, a solenoid actuator was placed near the weapon. Initial research work carried out with an airgun since weapons in our region are illegal. A camera mounted near the arm to see the target inside the smartphone.

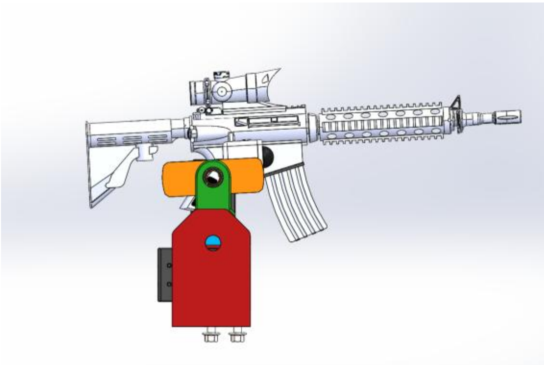

Fig.9. *Side view of weapon control mechanism*

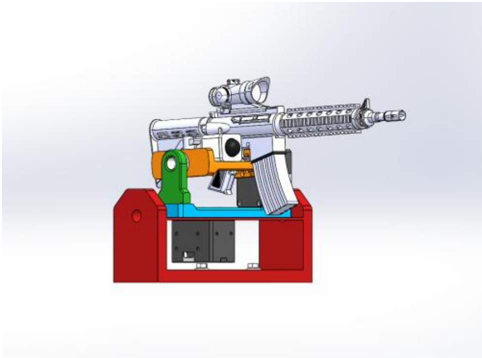

Fig.10. *Isometric view of weapon control mechanism*

A. Weapon holder

Weapon holder provides a properly built trapper and the regular gape to catch and keep the grip on the weapon. The weapon can fasten to the bar at any location. Another holder gives to keep the firearm in the optimal location and to minimize the weapon's recoil power, which centred on a flanged nut-threaded rod system. The holder supplied with numbers of grooves, such that the user may add the requisite flanged nut-threaded rod device to keep the firearm in still position. Standard M5 x 0.8 tap sized threaded rod, and the flanged nuts have been used in the weapon holder.

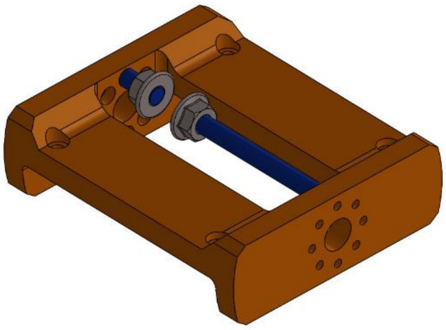

Fig.11. *Extra grooves and flanged nut-threaded rod to hold the weapon*

4. Controlling device (android smartphone)

The smartphone is a controller device. We have developed the specific android application to control all the moment of the vehicle as well as scissor mechanism and weapon control system. We mainly used an android smartphone as a controlling device. UI crafted and designed the way that it is too simple to use.

Two programming language is used.
(i). C++ = C++ language is used for Arduino UNO programming. Arduino UNO is the brain of our project.
(ii). JAVA = JAVA language is used to develop the specific android application for this project. And XML is used to make UI.

Fig.12. 1st Screen – Login Screen

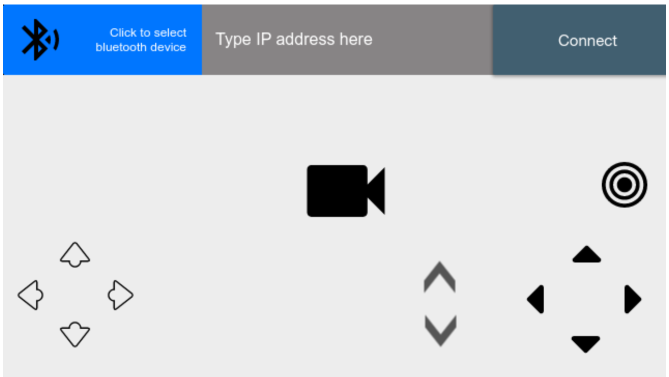

Fig.13. 2nd Screen – Controller Screen

5. Electronics components

The main and important hardware is the Arduino Uno. It handles all the other electronic equipment and the wireless communication through smartphone.

1. The whole system is connected with a controlling device (smartphone) via Bluetooth (HC-05)/Wi-Fi. For small range and high-security level Bluetooth is used, while for large distance Wi-Fi is used.
2. All the motion and movement of the whole system is done by the servo and stepper motors.
3. The camera is connected to see the scenario into the smartphone. We can use any type of camera as well as a smartphone camera that has the IP address. The IP address needs to be entered in the android application to see the live footage/scenario. 02 cameras are installed in the system, one with the vehicle portion and another one near to the weapon
4. Ultrasonic sensor is used which intimate the beep sound and vibration to the controlling device (smartphone) when someone crosses the system from a near location. It also provides how far the crossing object is from the vehicle. The use of sensors is for aware of the user/controller from the nearby danger object/enemy.
5. The 02 batteries are provided to give power sources to the system. When all the systems are used as a stationary system or to the fixed spot, the external power source (from the main electricity) can use which connects to the Arduino Uno directly.
6. The relay module is used, which helps to turn on and off the power supply and manage operations of (control the power supply) all the electronic equipment individually.
7. The 02 motor driver modules are used to control 04 servo motors of the vehicle individually to guide the system in the required direction.
8. The solenoid actuator is used to trigger the gun.

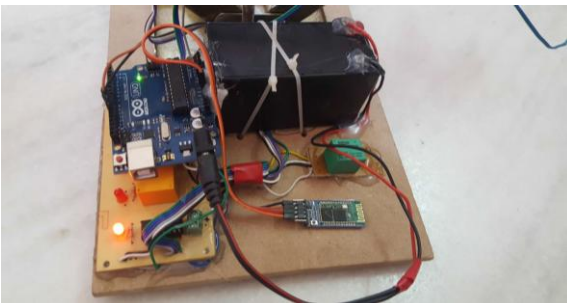

***Fig.14.** Circuit*

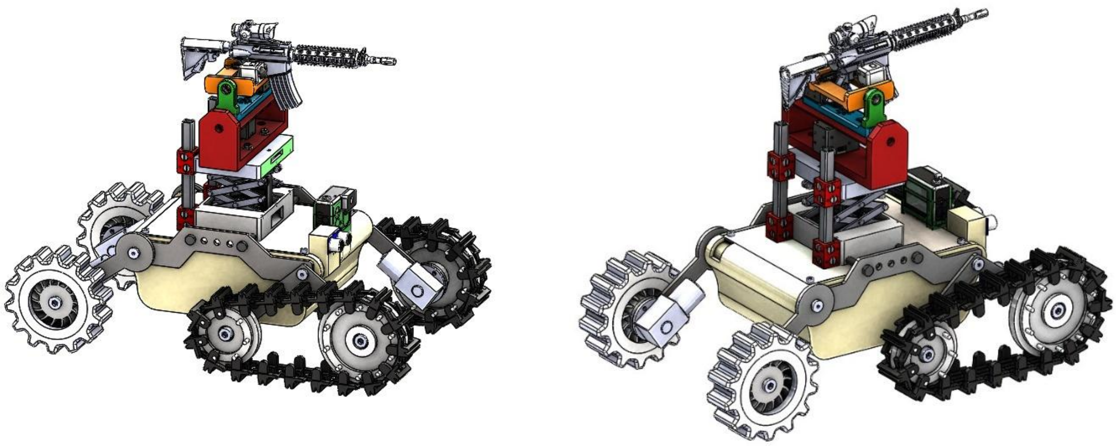

Fig.15. *Remotely Operated Weaponized Robot Control System and Vehicle*

V. DIMENSION AND CALCULATION

1. Pitch motion calculation

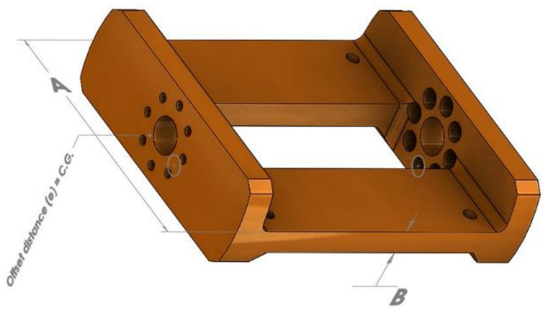

Fig.16. *Pitch motion provider*

⊳ Mechanism Specification:

$A = 150mm$

$B = 10mm$

$C = na$

$e = 0mm$

Arm Mass $= m = 5kg$

Other Moment of Inertia: $J_e = 47.083 \times 10^{-4} [kg \cdot m^2]$

Transfer Mechanism Primary Side Diameter :

(*We haven't used any transfer mechanism)

Secondary Side Diameter $= D_{g1} = na$

Primary Side Mass $= D_{g2} = na$

Secondary Side Mass $= m_{g1} = na$

Belt Mass $= m_{gb} = na$

Gear Ratio $= i_g = na$

Efficiency $= \eta_g = na$

Moment of Inertia $= J_g = na$

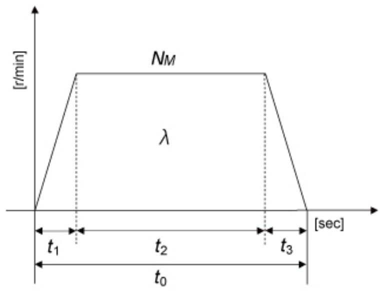

Fig.17. *Operation Pattern*

▹ Operation Pattern:

Travel Amount = λ = 1.8 [mm (deg)]

Rotation Speed = NM = 0.6 [r/min]

Acceleration Time = t_1 = 0.001 [sec]

Constant Speed Operation Time $= t_2 = 0.498$ [sec]

Deceleration Time $= t_3 = 0.001$ [sec]

Positioning Time $= t_0 = 0.5$ [sec]

• Calculation of Inertia

→ Moment of load inertia of the arm / frame

$$J_a = \frac{1}{12}\rho ABC\left(A^2 + B^2 + 12e^2\right) = \frac{1}{12}m\left(A^2 + B^2 + 12e^2\right) = 94.167\times10^{-4}[kg\cdot m^2]$$

→ Moment of inertia of the transfer mechanism

$$J_g = \frac{1}{8}m_{g1}D_{g1}{}^2 + \frac{1}{8}m_{g2}\frac{D_{g2}{}^2}{i_{g2}{}^2} + \frac{1}{4}m_{gb}D_{g1}{}^2 = 0[kg\cdot m^2]$$

→ Total Load Inertia

$$J_L = \frac{J_T + J_m n}{i_g{}^2} + J_e + J_g = 141.25\times10^{-4}[kg\cdot m^2]$$

• Calculation of Required Torque

→ Load Torque(External Torque)

$T_e = 0[N\cdot m]$

→ Number of Operating Pulses

$$A = \frac{\lambda}{\theta s}\times i_g = 90[\text{ Pulse }]$$

*If it is not an integer, an error will occur in the actual traveling amount

→ Operating Pulse Speed

$$f = \frac{A}{t_0 - t\mathrm{i}} \text{ or } \frac{A}{t_0} = 180[Hz]$$

→ Acceleration Torque T_a Rotor inertia J_o $n = (3.6^\circ / \theta s)\cdot i$

$$T_a = \left(J_0\cdot \mathrm{i}^2 + J_L\right)\frac{\pi\cdot\theta s\cdot f}{180^0\cdot t_1} \text{ or } T_a = \left(J_0\cdot \mathrm{i}^2 + J_L\right)\frac{\pi\cdot\theta s\cdot f^2}{180^0\cdot n} = 2.144[N\cdot m]$$

→ Required Torque

$T = T_a + T_e = 2.144[N\cdot m]$

•Calculation of the selected motor judgment item

(Safety Factor $S_f = 1$)

→ Safety factor S Motor torque of the rotation speed Tr = 12[$N \cdot m$]

$$S = \frac{Tr}{T} = 5.6$$

→ Inertia ratio β

$$\beta = \frac{J_L}{J_0 \cdot i^2} = 1.18$$

→ Acceleration/Deceleration Rate T_R

$$T_R = \frac{t_i}{f} = 5.54$$

2. Yaw motion calculation

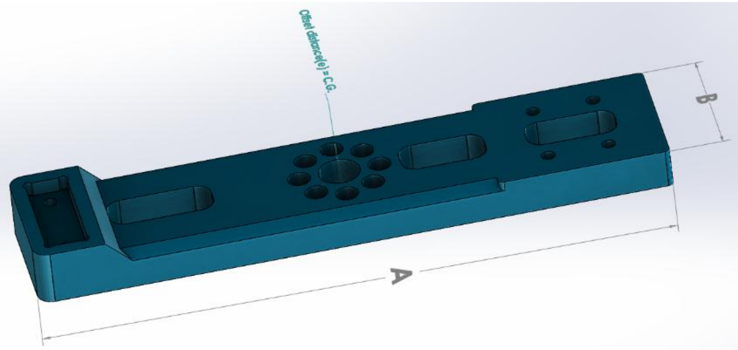

Fig.18. *Yaw motion provider*

▹ Mechanism Specification:

$A = 220mm$

$B = 50mm$

$C = na$

$e = 0mm$

Arm Mass $= m = 6.5kg$

Other Moment of Inertia: $J_e = 275.708 \times 10^{-4} [kg \cdot m^2]$

Transfer Mechanism Primary Side Diameter :

(*We haven't used any transfer mechanism)

Secondary Side Diameter $= D_{g1} = na$

Primary Side Mass $= D_{g2} = na$

Secondary Side Mass $= m_{g1} = na$

Belt Mass $= m_{gb} = na$

Gear Ratio $= i_g = na$

Efficiency $= \eta_g = na$

Moment of Inertia $= J_g = na$

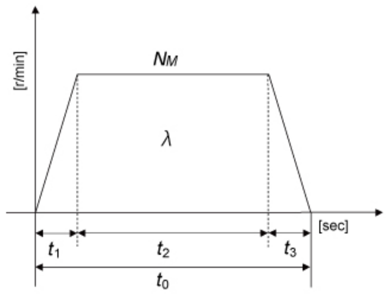

Fig.19. *Operation Pattern*

▷ Operation Pattern:
Travel Amount = λ = 1.8 [mm (deg)]
Rotation Speed = NM = 0.6 [r/min]
Acceleration Time = t_1 = 0.001 [sec]
Constant Speed Operation Time $= t_2 = 0.498$ [sec]
Deceleration Time $= t_3 = 0.001$ [sec]
Positioning Time $= t_0 = 0.5$ [sec]

• Calculation of Inertia
→ Moment of load inertia of the arm / frame

$$J_a = \frac{1}{12}\rho ABC\left(A^2 + B^2 + 12e^2\right) = \frac{1}{12}m\left(A^2 + B^2 + 12e^2\right) = 275.708\times10^{-4}[kg\cdot m^2]$$

→ Moment of inertia of the transfer mechanism

$$J_g = \frac{1}{8}m_{g1}D_{g1}{}^2 + \frac{1}{8}m_{g2}\frac{D_{g2}{}^2}{i_{g2}{}^2} + \frac{1}{4}m_{gb}D_{g1}{}^2 = 0[kg\cdot m^2]$$

→ Total Load Inertia

$$J_L = \frac{J_T + J_m n}{i_g{}^2} + J_e + J_g = 551.416\times10^{-4}[kg\cdot m^2]$$

• Calculation of Required Torque
→ Load Torque(External Torque)

$$T_e = 0[N\cdot m]$$

→ Number of Operating Pulses

$$A = \frac{\lambda}{\theta s}\times i_g = 90[\text{ Pulse }]$$

∗If it is not an integer, an error will occur in the actual traveling amount
→ Operating Pulse Speed

$$f = \frac{A}{t_0 - t\text{i}} \text{ or } \frac{A}{t_0} = 180[Hz]$$

→ Acceleration Torque T_a Rotor inertia J_o $n = (3.6^\circ / \theta s)\cdot i$

$$T_a = \left(J_0\cdot \text{i}^2 + J_L\right)\frac{\pi\cdot\theta s\cdot f}{180^0\cdot t_1} \text{ or } T_a = \left(J_0\cdot\text{i}^2 + J_L\right)\frac{\pi\cdot\theta s\cdot f^2}{180^0\cdot n} = 4.726[N\cdot m]$$

→ Required Torque

$$T = T_a + T_e = 4.726[N\cdot m]$$

•Calculation of the selected motor judgment item

(Safety Factor $S_f = 1$)

$\rightarrow$ Safety factor S Motor torque of the rotation speed Tr = 12$[N \cdot m]$

$$S = \frac{Tr}{T} = 2.54$$

$\rightarrow$ Inertia ratio β

$$\beta = \frac{J_L}{J_0 \cdot i^2} = 4.6$$

$\rightarrow$ Acceleration/Deceleration Rate T_R

$$T_R = \frac{t_i}{f} = 5.54$$

VI. COMPONENT INSTALLATION WITH PROCESSS FLOW AND FEEDBACK CHART

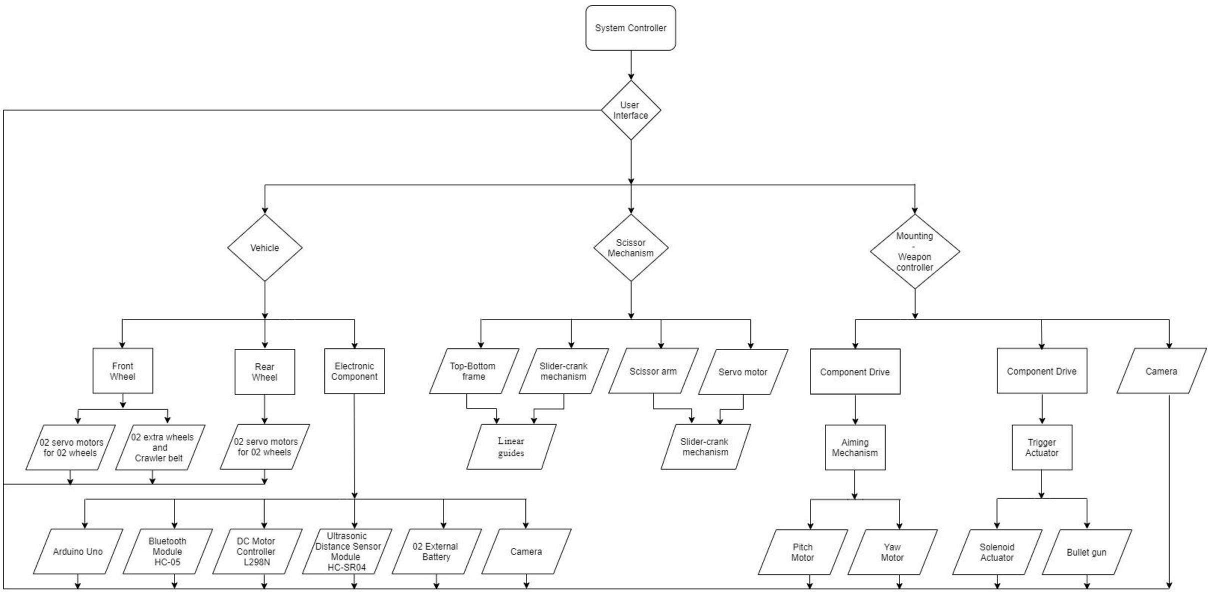

Fig.20. *Chart*

VII. CONCLUSION

The "Remotely operated weaponized robot control system and vehicle" is the plan and built to carry out dangerous and fragile operations to save human existence. This system is designed by considering requiring load-bearing capacity, stability, compatibility, and various weather conditions. The whole system architecture is developed in such a way that a user-friendly interface can be readily adaptable. The system is built to facilitate simple processes, easy mobility, and robust attacking and monitoring easier. One person can comfortably manage it. This also serves to track places of concern. It also helps to surveillance the suspicious areas. All the remotely operated mechanical parts are easy to connect and unmoved from the system, making it simple to carry from one end to the other. Compact and lightweight that adversary cannot spot easily. Every semi-automatic weapon can be used and controlled by the system because no specific weapon is necessary. The project's most significant and active feature is that it protects the country's son/daughter's precious life.

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