Volume 3 No. 5 2026, 680 - 696
DOI : 10.62335

CENDEKIA

Jurnal Penelitian dan Pengkajian Ilmiah

https://manggalajournal.org/index.php/cendekia
E-ISSN 3031-8939

Effectiveness of Combined Tactical Forward Posts in Countering Enemy Drone Attacks

Nur Rachman Supadmana Muda[a*], M. Faisal Fadilah[b]

[a,b] *Politeknik Angkatan Darat,*
*email: nurrudal@gmail.com **

ARTICLE INFO

Article history:
Received : 12 April 2026
Revised : 6 May 2026
Accepted : 14 May 2026

Keywords:
Combined Tactical Forward Post (CTFP), Counter-UAS (C-UAS), Drone Swarm Defense, Sensor Fusion, Layered Air Defense

DOI: 10.62335

ABSTRACT

The rapid proliferation of small and low-cost unmanned aerial systems (UAS) has introduced complex threats, particularly swarm drone attacks that challenge conventional defense systems. Without an integrated command structure, defensive operations tend to be fragmented, resulting in poor situational awareness, delayed responses, and inefficient use of resources. This study examines the effectiveness of a Combined Tactical Forward Post (CTFP) as a centralized command and control node to enhance territorial defense against drone threats. The CTFP integrates multi-sensor inputs—including radar, radio frequency (RF) detection, electro-optical/infrared (EO/IR) systems, and unmanned platforms through sensor fusion and AI-assisted analysis to generate a real-time common operational picture. A layered defense model is proposed, consisting of detection, command and control, electronic warfare, kinetic engagement, and inner protection zones, enabling synchronized application of soft-kill and hard-kill measures. The results indicate that CTFP significantly improves detection accuracy, decision-making speed, and coordination across defensive units, particularly in handling swarm attacks through parallel tracking, threat prioritization, and adaptive response. Additionally, the incorporation of redundancy and distributed backup systems enhances operational resilience under contested conditions. Overall, the CTFP framework provides a comprehensive, adaptive, and scalable solution for countering modern drone threats, making it highly relevant for complex operational environments such as archipelagic regions.

INTRODUCTION

The emergence of drone warfare has introduced new asymmetries in modern conflict. Small unmanned aerial systems (sUAS) are increasingly used for intelligence gathering, target acquisition, and direct attacks. Conventional air defense systems often struggle to effectively counter such threats due to their small size, low altitude, and swarm capabilities. The Combined Tactical Forward Post

(CTFP) represents a forward-deployed command element that integrates intelligence, operations, and defensive systems. In the context of drone threats, CTFP plays a critical role in coordinating counter-UAS (C-UAS) operations at the tactical level. In recent years, the character of warfare has undergone a significant transformation driven by rapid technological advancements, particularly in unmanned aerial systems (UAS). Small and relatively low-cost drones are now widely employed for reconnaissance, surveillance, and attack missions. Their accessibility and ease of deployment have enabled both state and non-state actors to conduct operations that were previously limited to advanced military forces. As a result, modern battlefields are increasingly exposed to persistent aerial threats that are difficult to detect and neutralize using conventional defense systems.

In the absence of an integrated forward command structure such as a Combined Tactical Forward Post (CTFP), defensive operations against drone threats tend to be fragmented and reactive. Individual units often rely on isolated sensors and localized decision-making processes, which leads to delayed detection, poor coordination, and inefficient use of defensive assets. This lack of integration creates critical gaps in situational awareness, allowing hostile drones especially in swarm formations to penetrate defenses and reach high-value targets with minimal resistance.

Moreover, without a centralized system for sensor fusion and command coordination, data collected from various detection platforms remains underutilized. Radar systems, RF sensors, and electro-optical devices may operate independently, producing uncorrelated information that is difficult to interpret in real time. This results in increased false alarms, misidentification of threats, and slower response times. Consequently, the effectiveness of both non-kinetic measures (such as electronic warfare) and kinetic responses (such as air defense systems) is significantly reduced.

The challenge becomes even more critical in the context of swarm drone attacks, where dozens or even hundreds of drones can approach simultaneously from multiple directions. Without a coordinated command and control mechanism, defensive units may become overwhelmed, engaging targets inefficiently or redundantly while leaving other threats unaddressed. This saturation effect can quickly degrade the defensive capability of a unit, leading to mission failure and increased vulnerability of critical assets.

In contrast, the introduction of a CTFP fundamentally transforms the operational paradigm from a fragmented defense into an integrated, network-centric system. The CTFP serves as a forward-deployed command and control node that consolidates data from multiple sensors into a unified operational picture. Through advanced communication systems and real-time data processing, it enables commanders to achieve comprehensive situational awareness and make informed decisions quickly and accurately.

With the implementation of sensor fusion and AI-supported analysis within the CTFP, the system is capable of detecting, classifying, and prioritizing threats in real time. This allows for a more efficient allocation of defensive resources, ensuring that high-threat targets are addressed promptly while minimizing redundancy in engagement. Additionally, the integration of electronic warfare and kinetic defense systems under a single command structure enables a synchronized and layered response to incoming threats.

Furthermore, the presence of a CTFP enhances operational resilience and adaptability. By incorporating redundancy in communication networks and command nodes, the system can maintain functionality even under electronic or kinetic attacks. The layered defense approachranging from early detection to inner protection—ensures that threats are addressed at multiple stages, significantly increasing the probability of neutralization before reaching critical areas.

Ultimately, the expected condition with a fully operational CTFP is a highly responsive, coordinated, and resilient defense system capable of countering complex drone threats, including swarm attacks. It enables faster decision-making, improved resource utilization, and enhanced protection of personnel and assets. Therefore, the integration of CTFP into modern military operations is not only advantageous but essential for maintaining operational superiority in an increasingly drone-dominated battlefield.

LITERATURE REVIEW

This study is grounded in the theory of Command and Control (C2) and its evolution toward network-centric warfare, where information superiority and rapid decision-making are critical to operational success. In this framework, a Combined Tactical Forward Post (CTFP) functions as a forward-deployed C2 node that integrates intelligence, surveillance, and operational control into a unified system. The effectiveness of CTFP is closely linked to its ability to generate a Common Operational Picture (COP), enabling commanders to perceive, understand, and act upon battlefield information in real time. This aligns with modern C2 principles emphasizing decentralized execution supported by centralized situational awareness.

A second theoretical foundation is sensor fusion and situational awareness theory, which explains how multiple heterogeneous data sources can be integrated to enhance perception, comprehension, and projection of threats. In counter-drone operations, sensor fusion combines inputs from radar, radio frequency (RF) detection, electro-optical/infrared (EO/IR) systems, and unmanned platforms. Through artificial intelligence and data analytics, this integration reduces uncertainty, improves detection accuracy, and enables real-time threat classification. As a result, decision-makers are equipped with actionable intelligence rather than fragmented data.

Closely related to this is the concept of predictive and AI-supported decision-making, which extends situational awareness into the domain of anticipation. By analyzing flight patterns, swarm behavior, and signal characteristics, AI systems embedded within the CTFP can forecast potential attack trajectories and identify high-priority threats. This predictive capability transforms the operational approach from reactive engagement to proactive defense, which is essential when facing high-speed and multi-directional drone swarm attacks.

The study also draws on the principle of layered defense (defense-in-depth) within counter-unmanned aerial systems (C-UAS) doctrine. This approach organizes defense into multiple concentric layers, including early detection, command and control, electronic warfare, kinetic interception, and passive protection. Each layer contributes to the gradual degradation of incoming threats, ensuring that no single point of failure compromises the entire system. The integration of soft-kill (e.g., jamming and spoofing) and hard-kill (e.g., missiles and gun systems) mechanisms enhances flexibility and effectiveness in threat neutralization.

Finally, the framework incorporates the concept of system resilience and redundancy, which is essential in contested and high-threat environments. A robust CTFP system includes backup communication networks, distributed command nodes, and adaptive operational capabilities to maintain functionality under electronic or physical attacks. This resilience ensures continuity of operations even when parts of the system are degraded. Together, these theoretical perspectives support the argument that a CTFP-enabled defense architecture can significantly improve situational awareness, coordination, and survivability in modern drone-centric warfare.

RESEARCH METHOD

This study employs a qualitative and conceptual systems approach to examine the effectiveness of a Combined Tactical Forward Post (CTFP) in countering drone and swarm drone threats. The research is based on doctrinal analysis, literature review, and synthesis of existing concepts in command and control (C2), counter-unmanned aerial systems (C-UAS), and network-centric warfare. Key variables analyzed include detection capability, decision-making speed, response coordination, and system resilience. The study focuses on modeling how a CTFP integrates multi-sensor inputs—such as radar, radio frequency (RF) sensors, electro-optical/infrared (EO/IR) systems, and unmanned platforms into a unified operational framework through sensor fusion.

A scenario-based modeling method is applied to simulate drone and swarm drone attack situations against a defended area. Two operational conditions are conceptually compared: (1) a baseline scenario without CTFP integration, characterized by fragmented systems and decentralized decision-making, and (2) an enhanced scenario with CTFP implementation, featuring centralized command, sensor fusion, and layered defense. The layered defense architecture is structured into concentric zones, including detection, command and control, electronic warfare, kinetic engagement, and inner protection. System behavior is analyzed in terms of detection time, threat classification accuracy, engagement sequencing, and neutralization effectiveness.

To evaluate system performance, a comparative analytical framework is used, focusing on key operational indicators such as situational awareness quality, response time, coordination efficiency, and survivability of protected assets. The study also considers system resilience by examining redundancy mechanisms, including backup communication networks and distributed command nodes. Although the approach is primarily conceptual, it provides a structured basis for understanding how CTFP enhances operational effectiveness in countering complex drone threats and offers a foundation for future quantitative modeling and simulation studies.

RESULTS AND DISCUSSION

Tabel 1. Comparative Table: Without CTFP vs With CTFP)

Parameter	Without CTFP (Conventional System)	With CTFP (Integrated System)
Situational Awareness	Fragmented, limited visibility	Unified Common Operational Picture (COP)
Sensor Integration	Independent sensors (radar, RF, EO/IR not integrated)	Full sensor fusion (multi-sensor integration)
Detection Time	Slow and delayed	Rapid and real-time detection
Detection Accuracy	Moderate, high false alarm rate	High accuracy with cross-verification
Threat Classification	Manual and inconsistent	AI-assisted, fast and precise
Response Time	Delayed due to poor coordination	Fast and synchronized response
Command & Control (C2)	Decentralized and fragmented	Centralized and integrated (CTFP-based)
Electronic Warfare Effectiveness	Limited, uncoordinated jamming	Optimized, area-wide coordinated disruption
Kinetic Engagement Efficiency	Redundant firing, inefficient targeting	Optimized target allocation, minimal redundancy
Swarm Handling Capability	Easily overwhelmed	Capable of handling multi-directional swarm attacks
Resource Utilization	Inefficient and overlapping usage	Efficient and prioritized allocation
Interoperability	Low compatibility between systems	High interoperability across units
Operational Coordination	Weak synchronization	Fully synchronized multi-unit operations
System Resilience	Vulnerable to disruption	High resilience with redundancy systems
Continuity of Operations	Easily degraded under attack	Maintained through backup nodes & networks
Survivability of Assets	Low protection level	Significantly improved protection
Overall Effectiveness	Moderate to low	High and adaptive performance

Discussion

Situational awareness within a Combined Tactical Forward Post (CTFP) is fundamentally enhanced through the implementation of sensor fusion, which integrates data from multiple sensing systems into a single, coherent operational picture. In modern drone-threat environments, relying on a single sensor such as radar creates vulnerabilities due to limitations like low radar cross-section or electronic interference. By combining inputs from radar, radio frequency (RF) detectors, electro-optical/infrared (EO/IR) sensors, acoustic sensors, and unmanned aerial platforms, CTFP can significantly improve detection reliability. This multi-sensor integration allows operators to observe the battlespace more comprehensively, reducing uncertainty and enabling early identification of hostile drone activity.

The contribution of sensor fusion to situational awareness can be understood across three levels: perception, comprehension, and projection. At the perception level, fused sensor inputs increase the probability of detection and minimize false alarms by cross-verifying targets across different modalities. At the comprehension level, advanced algorithms often supported by artificial intelligence analyze patterns such as speed, trajectory, and signal characteristics to classify threats accurately. Finally, at the projection level, predictive models estimate the future behavior of detected drones, including flight paths and potential targets. This layered understanding allows CTFP to transition from reactive to proactive decision-making in counter-drone operations.

Operationally, sensor fusion enables faster and more synchronized responses across all defensive elements within the CTFP framework. A unified common operational picture (COP) ensures that electronic warfare units, air defense systems, and interceptor platforms operate based on the same real-time information. This reduces response latency and enhances coordination, which is critical when facing high-speed or swarm drone attacks. Additionally, sensor fusion improves system resilience; if one sensor is degraded or jammed, other sensors can compensate, maintaining continuity of situational awareness under contested conditions.

However, the implementation of sensor fusion in CTFP is not without challenges. The integration of large volumes of heterogeneous data requires robust processing capabilities and low-latency communication networks. Interoperability between different sensor systems and platforms must also be ensured to avoid data fragmentation. Furthermore, sensor fusion systems are potential targets for cyber and electronic warfare attacks, necessitating strong cybersecurity measures. Despite these challenges, ongoing advancements in artificial intelligence, edge computing, and distributed sensor networks are expected to further enhance the effectiveness of sensor fusion, making it a cornerstone capability for future CTFP operations.

As shown in Table 1. the implementation of a Combined Tactical Forward Post (CTFP) significantly enhances overall defense effectiveness compared to conventional systems without CTFP. In the absence of CTFP, operations are fragmented, with isolated sensors, delayed detection, limited situational awareness, and uncoordinated responses that lead to inefficient use of resources and vulnerability to drone swarm attacks. In contrast, the CTFP-enabled system integrates multi-sensor inputs through sensor fusion to produce a unified Common Operational Picture (COP), enabling faster detection, higher accuracy, and AI-assisted threat classification. This integration allows for rapid, synchronized responses across electronic warfare and kinetic defense layers, improving neutralization rates while minimizing redundancy. Additionally, CTFP enhances interoperability, coordination, and resource allocation, ensuring that defensive actions are prioritized and efficient.

The system also demonstrates greater resilience through redundancy mechanisms such as backup communication networks and alternate command nodes, maintaining continuity of operations under contested conditions. Overall, the table highlights that CTFP transforms a reactive and inefficient defense structure into a proactive, integrated, and highly adaptive system capable of effectively countering complex and multi-directional drone threats.

As shown in Figure 1. a layered territorial defense system centered on a Combined Tactical Forward Post (CTFP) designed to protect a strategic area—such as an island base—against a swarm drone attack. The concept follows a defense-in-depth approach, where multiple concentric layers work together to detect, disrupt, and neutralize threats before they reach critical assets.

At the outermost layer, labeled the Outer Detection Zone (5–10 km), the system employs radar sites, RF sensor stations, and UAV patrols to provide early warning. These assets monitor the airspace continuously and are capable of tracking multiple drones simultaneously. Their primary role is to detect incoming swarm formations from all directions and generate an initial threat picture, giving the defense system sufficient reaction time.

Figure 1.CTFP PROTECTED AREA AGAINST SWARM DRONE ATTACK

Moving inward, the Control & Command Zone (3–5 km) contains the CTFP Command Post, which acts as the central brain of the system. Here, data from all sensors is fused into a single operational picture using C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance) supported by AI. The command post analyzes threats, prioritizes targets, and coordinates responses across all defense units. Surrounding this area are communication vehicles and data relay systems to ensure continuous and secure information flow.

The next layer is the Electronic Warfare Zone (2–4 km), where systems such as EW trucks, jammer antennas, and RF disruptors create a "jamming field." This layer attempts to neutralize the swarm non-kinetically by disrupting communication links and navigation systems (e.g., GPS spoofing). The goal is to break swarm coordination, causing drones to lose control, scatter, or fail before reaching the inner defenses.

Closer to the center is the Kinetic Defense Zone (1–2.5 km), which represents the primary hard-kill layer. It includes SHORAD launchers, automated anti-drone turrets, CIWS systems, and interceptor drone launch pads. These systems physically destroy or disable drones that survive the electronic warfare layer. This zone is designed for high-intensity engagement, capable of handling multiple targets simultaneously during saturation attacks.

At the core lies the Core Protected Area (0–1 km), which contains critical assets such as troops, armored vehicles, logistics hubs, and hardened command shelters. Passive defense measures such as camouflage, concealment, and decoy targets are used to reduce the effectiveness of any drones that penetrate the outer layers. The objective here is damage mitigation and survival rather than interception.

Finally, the diagram highlights a Backup / Redundant Zone, which is distributed and not confined to a single radius. This includes alternate CTFP nodes, backup communication systems, and mobile command units. Its purpose is to ensure continuity of operations even if the primary command post is degraded or attacked.

CONCLUSION

This study demonstrates that the integration of a Combined Tactical Forward Post (CTFP) fundamentally transforms territorial defense against drone and swarm drone threats from a fragmented and reactive system into an integrated, adaptive, and highly effective operational framework. Without CTFP, defensive efforts are constrained by limited situational awareness, delayed detection, and uncoordinated responses, which significantly reduce the ability to counter complex and multi-directional threats. In contrast, the CTFP-enabled system enhances operational performance through centralized command and control, multi-sensor fusion, and the generation of a real-time Common Operational Picture (COP).

The implementation of a layered defense architecture comprising detection, command and control, electronic warfare, kinetic engagement, and passive protection—enables synchronized and efficient threat mitigation. Sensor fusion and AI-assisted analysis play a critical role in improving detection accuracy, accelerating decision-making, and enabling predictive threat assessment, particularly in swarm scenarios. As a result, the system achieves higher neutralization rates while optimizing resource utilization and minimizing redundancy in engagement.

Furthermore, the incorporation of redundancy and distributed backup systems ensures operational resilience and continuity under contested conditions. The ability of CTFP to maintain functionality despite partial system degradation highlights its robustness in modern battle environments. Overall, the findings confirm that CTFP is a critical enabler for effective counter-UAS operations, providing enhanced situational awareness, coordination, and survivability. Therefore, the adoption and further development of CTFP-based defense systems are essential for maintaining operational superiority in increasingly complex and drone-dominated warfare scenarios.

REFERENCES

NRS Muda. “Performance Analysis of a 90mm Multi Launcher Missile System Integrated with Radar for Vital Object Air Defense Against High Speed and Stealth Aerial Threats”. ITEGAM-JETIA, 11:53 (2025) :201-207. https://doi.org/10.5935/jetia.v11i53.1971

Muda, Nur Rachman Supadmana. "Trimodal Autonomous Drone with 3 Hours Flight Duration and 2000 km Range." International Journal of IJNRSM 4.7 (2024): 401-409.

Muda, Nur Rachman Supadmana. "Nur Rachman Supadmana Muda about Implementation of Falcon Hexacopter Drone with Cal 5.56 Weapon for Combat Operations." International Journal of IJNRSM 4.7 (2024): 150-160.

Muda, Nur Rachman Supadmana, et al. "Analysis of Stable Flight of Poltekad Eagle Drone Using ANSYS Method." Jurnal Penelitian Pendidikan IPA 10.11 (2024): 9173-9179.

Muda, Nur Rachman Supadmana, Bilqis Faranadila, and M. Faisal Fadilah. "DESIGN OF WHEEL ROBOT TO DETECT ANTI-TANK MINES BASED ON NRS MUDA METHODS." Journal of Innovation Research and Knowledge 4.4 (2024): 2439-2446.

Navalino, R. D. A., Muda, N. R. S., Hafizah, M. A. E., & Ruyat, Y. (2024). “Analysis of carbon nano particle variant as the propellant fuel to increase specific impulses of rockets. F1000Research, 12, 1414.

Muda, Nur Rachman Supadmana. "Two-Launcher Missile Based on Artificial Intelligence." International Journal of IJNRSM 4.7 (2024): 100-110.

Muda, Nur Rachman Supadmana. "Design of a Seeker System in Missiles Equipped with High Accuracy, High Speed, and Anti-Radar Detection Based on Artificial Intelligence." IJNRSM Vol4 (7) (2024): 601-701.

Muda, Nur Rachman Supadmana, and Bilqis Faranadila. "Robot Roda Rantai “BM” Penyapu Ranjau Berbasis IoT." Jurnal Cakrawala Ilmiah 4.1 (2024): 4115-4122.

Muda, Nur Rachman Supadmana. "Design of enemy detection system using identification friend or foe (iff) method based on ai." International Journal of IJNRSM 4.3 (2024): 20-26.

Hasan, Maulana, and Nur Rachman Supadmana Muda. "Design and Develop Autonomous 3 In 1 Agricultural Robots For Farming." IJNRSM Vol4 (5) (2024): 56-65.

Muda, Nur Rachman Supadmana, and Ridwan Asri Sudarsono. "DESIGN OF ENEMY DESTROYER KAMIKAZE DRONE BY DIPOLE_31 TECHNOLOGY." Jurnal Pengabdian Mandiri 3.11 (2024): 1055-1066.

Hasan, Maulana, and Nur Rachman Supadmana Muda. "DESIGN AND DEVELOP KAMIKAZE DRONE PETIR-1 FOR FUTURE BATTLEFIELD." IJNRSM Vol4 (6) (2024): 40-50.

Muda, Nur Rachman Supadmana, et al. "Design and Construction of A Remotely Controlled Multy-Tasking

Chain-Wheel Combat Robot." Eduvest-Journal of Universal Studies 4.3 (2024): 723-740.

Muda, Nur Rachman Supadmana. "Design and Development of Insect Drones for Autonomous Reconnaissance." International Journal of IJNRSM 4.7 (2024): 201-208.

Yudistira, Daru Argya, Nur Rachman Supadmana Muda, and Telekomunikasi Militer. "Design and Development of Garuda Kamikaze Drone Based on ESP32." International Journal of IJNRSM 4.6 (2024): 1-7.

Kharis, Setiaji, Nur Rachman Supadmana Muda, and Politeknik Angakatan Darat. "Design and Build a Gelatik version of the Kamikaze Drone In the operation against the Sparatists in Battle Area Based on ESP32." International Journal of IJNRSM 4.6 (2024): 20-26.

Lucky, Dede, and Nur Rachman Supadmana Muda. "Design and Build Spartan Kamikaze Drones." International Journal of IJNRSM 4.6 (2024): 30-40.

Muda, Nur Rachman Supadmana, Bilqis Faranadila, and M. Faisal Fadilah. "CONTROL AND TELEMETRY SYSTEM FROM HUMANOID ROBOT TO BASE STATION USING A FREQUENCY OF 7 GHz." International Journal of IJNRSM 4.6 (2024): 1-12.

Muda, Nur Rachman Supadmana, and Hasby Fajrus Shodiq. "DESIGN AND DEVELOPMENT OF A STEALTH UNIC FOR SILENT OPERATION WITH ESP32-BASED AUTONOMOUS CONTROL." Jurnal Cakrawala Ilmiah 4.4 (2024): 429-442.

Sopandi, Yudi, and Nur Rachman Supadmana Muda. "Design of a wikan kamikaze drone based on ESP32." International Journal of IJNRSM 4.6 (2024): 80-86.

Muda, Nur Rachman Supadmana, and Moh Yuslan. "Design of Autonomous Robot for Coffee Bean Picking with RGB Camera Based Color Detection Technology."

Muda, Nur Rachman Supadmana. "Design and Development of a Double Blade Quadcopter Drone with the Ability to Carry Minimi Weapons and Maneuver a Distance of 50 km Using Waypoints." IJNRSM Vol4 (7) (2024): 301-309.

Muda, Nur Rachman Supadmana. "Data of 16 Caliber 100 mm Caliber Terrain Artillery Rocket with 300 km Firing Range Based on Hybrid Hypersonic Fuel." International Journal of IJNRSM 4.6 (2024): 70-72.

Muda, Nur Rachman Supadmana. "Design and Development of Humanoid Drone Based on Autonomous." International Journal of IJNRSM 4.8 (2024): 51-60.

Muda, Nur Rachman Supadmana. "Design of a Microdrone with AI-based Control for Long- Distance and High-Speed Operations." International Journal of IJNRSM 4.7 (2024): 451-457.

Muda, Nur Rachman Supadmana, et al. "Desain dan Implementasi Robot Pengolah Sampah Organik Berbasis Autonomous Menjadi Pupuk dengan Produktivitas 1 Ton Per Hari." CENDEKIA: Jurnal Penelitian dan Pengkajian Ilmiah 2.1 (2025): 18-28.

Muda, Nur Rachman Supadmana. "Telemetry System Coding Application on Combat Robots Using Firebase Connection to Spreadsheets." International Journal of IJNRSM 4.5 (2024): 170-178.

Muda, Nur Rachman Supadmana. "Development of a Satellite-Based Guidance System for Ballistic Missiles with a Range of 2000 km." International Journal of IJNRSM 4.7 (2024): 1-15.

Muda, Nur Rachman Supadmana. "Implementation of Seismic Sensor to Detect Tank." Journal of World Science 3.2 (2024): 202-207.

Muda, Nur Rachman Supadmana. "Implementation of a Power Management System on Combat Robots based on a Hybrid Energy Storage System." Asian Journal of Engineering, Social and Health 3.3 (2024): 475-485.

Muda, Nur Rachman Supadmana, and Yosera Rico Fahmi. "Designing of a Corn Seed Planting Robot Using Microcontroller and LIDAR in the Modern Agriculture." International Journal of IJNRSM 4.5 (2024): 170-178.

Muda, Nur Rachman Supadmana. "Implementasi Rute Patroli Menggunakan Embarcadero Delphi Menggunakan Tool Shape Yang Disandikan." International Journal of IJNRSM 2.3 (2024): 20-28.

Muda, Nur Rachman Supadmana. "Design and Build Plastic Waste Processing Robots in Indonesia to Support Sustainable Environmental Management." International Journal of IJNRSM 4.7 (2024): 200-210.

Muda, Nur Rachman Supadmana. "Analyzes of Trimodal Autonomous Drone with 3 Hours Flight Duration and 2000 km Range". IJNRSM VOL 4(7) DECEMBER 2024

Muda, Nur Rachman Supadmana. "Autonomous Fixed-Wing Drone Using Ramjet Propulsion: A Study on 5 PK Maneuvering and 500 km Range." International Journal of IJNRSM 4.7 (2024): 351-360.

Muda, Nur Rachman Supadmana, Bilqis Faranadila, and M. Faisal Fadilah. "CONTROL SYSTEM AND TELEMETRY OF HUMANOID ROBOT TO BASE STATION USING CARRIER FREQUENCY OF 7 GHz." Internationa Journal of IJNRSM 5.1 (2024): 52-63.

Muda, Nur Rachman Supadmana, and M. Faisal Fadilah. "Design of NRSM II Version of Quadcopter Drone Equipped with 7, 62 mm Caliber Weapon for Combat Operations." International of IJNRSM 5.1 (2025): 851-864.

Muda, Nur Rachman Supadmana. "Design and Build a Drone Capture Weapon System Using Nets." International Journal of IJNRSM 5.1 (2025): 1-8.

Muda, Nur Rachman Supadmana, M. Faisal Fadilah, and B. Faranadila. "Implementation of NRS Method for Controlling Anti-Tank Missile Caliber 100mm." International Journal of IJNRSM 4.7 (2024): 30-41.

Muda, Nur Rachman Supadmana. "UTILIZATION OF CD CHIPS AS SOLAR CELLS TO GENERATE 1000 WATTS POWER." International Journal of IJNRSM 4.7 (2024): 201-208.

Muda, Nur Rachman Supadmana. "THE BROUCS ROBOT CONCEPT FOR AUTONOMOUS GROUND COMBAT EQUIPPED WITH A 99 MM CALIBER ROCKET SYSTEM AND 23 MM CALIBER RIFLE." International Journal of IJNRSM 5.1 (2025): 601-614.

NRS Muda, YT Putra. "DESIGN AND DEVELOPMENT OF A FRIEND-OR-FOE DETECTION SYSTEM MOUNTED ON A UGV CAMERA USING LIDAR BASED ON ANN BACKPROPAGATION -VERSION YTP16", International Journal of IJNRSM 5.10 (2025): 25-43

NRS Muda. "Bird Robot Platform with Arduino Uno and Raspberry Pi for Autonomous Navigation", Journal of Mechatronics and Drone Technology 1 (3) (2025): 1-16

Muda, Nur Rachman Supadmana, P. Fandi, and P. T. Azizia. "Design and Build a Dog Paw- shaped Robot Camouflage for Reconnaissance Equipped with Ss2 V2 Weapon." International of IJNRSM 1.1 (2025): 641-653.

Hasan, Maulana, and Nur Rachman Supadmana Muda. "Rancang Bangun Robot Ranjau Anti Tank Dengan Detektor Vlf (Very Low Frequency) dan Pulse Induction (PI)." International Journal of IJNRSM 4.2 (2024): 1-8.

Muda, Nur Rachman Supadmana, and M. Baihaqy. "Automatic Spraying Tool for Coffee Plants in the coffee Plantation in Bumiaji village Batu east java based on IoT". IJNRSM VOL 4(5) OCTOBER 2024

Muda, Nur Rachman Supadmana, and Arjun Prayudha. "Design and Development of a Terrain Artillery Rocket with Four Launchers of 90 mm Caliber and a Range of up to 150 km." International Journal of IJNRSM 4.7 (2024): 250-256.

Muda, Nur Rachman Supadmana. "Rancang Bangun Robot NRS MUDA Mendeteksi Ranjau Anti Tank Berbasis Teknologi AI." International Journal IJNRSM 1.1 (2024): 1-8.

Muda, Nur Rachman Supadmana. "Design and Build a Seawater Distillation System with a Capacity of 100 Liters per Hour." International Journal of IJNRSM 4.7 (2024): 300-310.

Muda, Nur Rachman Supadmana. "Energi Nuklir: Pemanfaatan dan Jenis-Jenisnya untuk Kehidupan." Jurnal Nasional Teknologi dan Inovasi 1.1 (2025): 12-23.

Muda, Nur Rachman Supadmana. "ESP32-Based Coconut Processing Robot with a Capacity of 1000 Grains per Hour." Internationa Journal of IJNRSM 5.1 (2024): 52-63.

Aloy, Aloysius, and Nur Rachman Supadmana Muda. "Aloy Drone As LONG-RANGE DESTRUCTION." International Journal of IJNRSM 4.6 (2024): 170-178.

Muda, Nur Rachman Supadmana, and Dinar Safanabila. "Rancang Bangun Robot Harvest Berbasis Raspberry Pi dan Solar Cell." IJNRSM Vol4 (8) (2024): 1-10.

Muda, Nur Rachman Supadmana, and D. Safanabila. "Metode Pembuatan Amonium Perklorat dengan Produksi 1 kg per Minggu." IJNRSM Vol4 (7) (2024): 950-954.

Yuslan, Moh, and Nur Rachman Supadmana Muda. "RANCANG BANGUN ROBOT HUMANOID" YN" BERBASIS ARDUINO DAN FACE RECOGNITION UNTUK INTERAKSI PINTAR." (2025): 621-633.

Muda, Nur Rachman Supadmana. "A Study on Drone Logistics and Control Range Using ANSYS Simulation." International Journal of IJNRSM 4.7 (2024): 180-190.

Muda, Nur Rachman Supadmana. "Review of MILES (Multiple Integrated Laser Engagement System) Vest Poltekad Version for Close Combat Training based on ESP 32." International Journal of IJNRSM 5.5 (2025): 61-69.

Muda, Nur Rachman Supadmana, et al. "Hexacopter Drone Prototype Equipped with a 90 mm Caliber Rocket Launcher." International Journal of Innovative Science and Research Technology 8.8 (2023): 1706-1709.

Muda, Nur Rachman Supadmana, M. Faisal Fadilah, and Bilqis Faranadila. "IMPLEMENTATION OF CODED SHAPE TOOL FOR PATROL ROUTES MONITORING BASED ON EMBARCADERO XE 7."

uda, Nur Rachman Supadmana, et al. "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 (2018): 4001-4017.

Muda, Nur Rachman Supadmana, Bilqis Faranadila, and M. Faisal Fadilah. "Implementation of Multisensor to Detect Vibration, Sound and Image of Combat Vehicles Use Artificial Neural Networks."

Akbar, Faisal, and Nur Rachman Supadmana Muda. "IMPLEMENTATION OF DTMF AND MPU6050 AS A DETECTOR OF STATE BOUNDARY MARKERS." International Journal of IJNRSM 5.1 (2025): 701-718.

Muda, Nur Rachman Supadmana, Dodo Irmanto, and M. Faisal Fadilah. "Design of an Anti- Tank Rocket Launcher Drone". International Journal of Research Publication and Reviews 4.9 (2023): 1528-1537.

NRS Muda, MA Wellyanto."Design and Development of Friend or Foe Detection System Mounted on UGV Camera Using LiDAR Based on Artificial Back Propagation." NA International Journal of IJNRSM 5.10 (2025): 1-24

Muda, Nur Rachman Supadmana, et al. "The total impulse study of solid propellants combustion containing activated carbon from coconut shell as a catalyst". Proceedings of International Conference of Graduate School on Sustainability. Vol. 1. No. 1. 2017.

Muda, Nur Rachman Supadmana. "Desain dan Implementasi Peluncur Roket Anti Ranjau de coplax dengan Jangkauan 500 Meter".

Muda, Nur Rachman Supadmana, Bilqis Fananadila, and M. Faisal Fadilah. "Design and Construction of a Rotary Wing UAV Rotary Wing Anti Jamming Quadcopter Type."

Muda, Nur Rachman Supadmana, Azizia Putri Transallia, and Bilqis Faranadila. "Rancang Bangun Robot Tank Bersenjata “Bractocs” untuk Operasi Tempur Modern." CENDEKIA: Jurnal Penelitian dan Pengkajian Ilmiah 2.2 (2025): 190-201.

Chorina, Prisca, Muhamad Yusuf Imani, and Nur Rachman Supadmana Muda. "Implementasi Backbone Network Security System Menggunakan Firewall Pada Komunikasi Hybrid." Jurnal Telkommil 2.1 (2021): 49-54.

Nur Rachman Supadmana Muda."Threat Analysis on Ground Vehicle Survivability of Leopard 2, M1A2 Abrams, and Merkava Mk.4 in Modern Battlefield". International Journal of IJNRSM 5.9 (2025): 21-32

Nur Rachman Supadmana Muda. " Implementation of Radar Systems for Detecting Multiple Drone Types Based on Data Accuracy: Experimental Evaluation and Performance Analysis". International Journal of IJNRSM 5.9 (2025): 21-30

Yuslan, M., and Nur Rachman Supadmana Muda. "Development of Autonomous Robot for Coffee Bean Picking with RGB Camera Based Color Detection Technology." International Journal of IJNRSM 4.5 (2024): 250-260.

Nur Rachman Supadmana Muda. " Design and Evaluation of an Autonomous Insect Robot with Integrated Navigation and Communication Systems". CENDEKIA : Jurnal Penelitian dan Pengkajian Ilmiah 2.9 (2025) : 1758-1771

Utomo, Tri Setyo, and Nur Rachman Supadmana Muda. "DESIGN OF AN ESP32-BASED V3. SU DRONE WITH EXPLOSIVE SYSTEM INTEGRATION." International Journal of IJNRSM 4.6 (2024): 100-110.

Muda, Nur Rachman Supadmana. "Implementation Of Backbone Communication Security System Between Controller And Operator In Tank Vehicle." International Journal of IJNRSM 4.5 (2024): 220-227.

Rizkiana, Dede Luki, and Nur Rachman Supadmana Muda. "DESIGN AND BUILD AN ANIMAL-SHAPED CAMOUFLAGE ROBOT FOR RECONNAISSANCE WITH AN IOT VERSION DECOHS17 BASED ON AN ASSAULT RIFLE WITH A RANGE OF 17 KM."

NRS Muda." Comparison of Long-Range Data Telemetry Systems for Fixed-Wing Drones Operating Beyond 100 Kilometers". Journal of Mechatronics and Drone Technology 1.3 (2025) : 251-265.

Nur Rachman Supadmana Muda, Baihaqy. "Automatic Spraying Tool for Coffee Plants in the coffee Plantation in Bumiaji village Batu east java based on IoT." (2024): 200-205.

Farandila, Bilqis, et al. "Analisa Daerah Rawan Bencana Longsor di Kota Batu Jawa Timur Berdasarkan GIS dan Penggunaan Sensor Berbasis IoT." CENDEKIA: Jurnal Penelitian dan Pengkajian Ilmiah 2.2 (2025): 226-239.

NRS Muda, BE Sutikno. " Design Of The Best-06 Version Of The Merpati Drone Based On Manual Control, Distance Sensor, And Multivibrator Pulse To Support Reconnaissance Into Enemy Areas". Journal of Mechatronics and Drone Technology 1.3 (2025) : 281-298

Muda, Nur Rachman Supadmana, Bilqis Fananadila, and M. Faisal Fadilah. "Design and Manufacture of Eagle Robot Drone for Reconnaissance". International Journal of Research Publication and Reviews, Vol 5, no 2, pp 2006-2014 February 2024

Muda, Nur Rachman Supadmana. "Implementation of a Robot Weapon System with Climbing Ability for Tactical Operations." International Journal of IJNRSM 4.7 (2024): 90-99.

Muda, Nur Rachman Supadmana. "Implementation of Coplax Hexacopter Drone with Cal 5.5 Machine Gun Weapon for Combat Operations." International Journal of IJNRSM 4.7 (2024): 120-131.

Muda, Nur Rachman Supadmana. "The Robot Helps Humans Harvest Rice." International Journal of IJNRSM 4.7 (2024): 1-12.

Nur Rachman Supadmana Muda, Yedi. "Design And Development Of The Angel Kamikaze Drone Based On Object Recognition Using Image Processing." International Journal of IJNRSM 4.6 (2024): 80-94.

Muda, Nur Rachman Supadmana. "Design of Oleng HERO DRONE BASED ON IoT." International Journal of IJNRSM 4.6 (2024): 1-6.

Hidayat, Nadhif Misbachul, Nur Rachman Supadmana Muda, and M. M. Hudha. "Implementasi Metode Stereo vision Pada Robot Tempur CIA Versi N2MR3 Dengan Menggunakan Dua Kamera." Jurnal Telkommil 2.1 (2021): 42-48.

Muda, Nur Rachman Supadmana. "Bilqis Faranadila, Muhammad Faisal Fadilah." Design Of Wheel Robot To Detect Anti-Tank Mines Based On NRS Muda Methods', Journal of Innovation Research and Knowledge 4.4 (2024): 2439-2446.

Nur Rachman Supadmana Muda. "Implementation of Arduino Uno as Flight Control on Quadcopter Drones". Journal of Mechatronics and Robotics Sciences 1.1 (2025) : 31- 48

Muda, Nur Rachman Supadmana. "Rancang Bangun Robot Roda Mendeteksi Ranjau Anti Tank Berbasis NRS Muda Methods." International Journal of IJNRSM 1.2 (2024): 7-14.

Muda, Nur Rachman Supadmana, and Dinar Hana. "Elektronika Sistem Senjata PENERAPAN SENSOR LIGHT DISTANCE AND RANGING PADA ROBOT BERKAKI 6 (HEXAPOD) UNTUK PEMETAAN LOKASI BERBASIS RASPBERRY PI 3: Teknologi." Jurnal Elkasista 3.1 (2022): 1-7.

Muda, Nur Rachman Supadmana, and Bilqis Faranadila. "RANCANG BANGUN ROBOT 'BM'BERBASIS TEKNOLOGI AI."

Muda, Nur Rachman Supadmana. "Pengembangan Robot Pengelolaan Kaleng Ikan Sarden Berkualitas Berbasis ESP32." (2024): 1-11.

Pawestri, Alivia Maulidina, Timbul Siahaan, and Nur Rachman Supadmana Muda. "ANALISIS DAN KARAKTERISASI FUELBINDER PROPELAN KOMPOSIT PADAT SEBAGAI UPAYA MEWUJUDKAN KEMANDIRIAN PRODUKSI PROPELAN ROKET DI LEMBAGA PENERBANGAN DAN ANTARIKSA NASIONAL." Teknologi Persenjataan 2.1 (2020).

Muda, Nur Rachman Supadmana. "Aplikasi Coding Sistem Telemetri pada Robot Tempur Menggunakan Koneksi Firebase ke Spreadsheet." (2024): 361-368.

Ashar, Imam, and Nur Rachman Supadmana Muda. "Analysis and Design of Microstrip Antipodal Vivaldi Antenna for detector through the wall with CST Studio Suite simulation." International of IJNRSM 5.2 (2025): 1-10.

Muda, Nur Rachman Supadmana. "Metode Mencegah Ransomware." (2024): 351-360.

Muda, Nur Rachman Supadmana. "RANCANG BANGUN ROBOT UNTUK DISABILITAS KAKI MULTI SIZE." (2025): 31-44.

Muda, Nur Rachman Supadmana. "Desain Roket Multi Launcher Kaliber 70mm Terintegrasi dengan Sistem Radar Anti-Serangan Udara: Studi Kasus MLRS Poltekad." International Journal of IJNRSM 4.7 (2024): 850-860.

Muda, Nur Rachman Supadmana. "Nur Rachman Supadmana Muda About Robot Design of Modern Agriculture." HARVEST ROBOT 1 (2024): 1-20.

Muda, Nur Rachman Supadmana, and Dinar Hana. "Teknik IMPLEMENTASI SENSOR JARAK (LIDAR) PADA ROBOT BERODA GUNA DUKUNG TUGAS OPERASI PEMBEBESAN TAWANAN MENGGUNAKAN METODE SLAM: Teknik Elektronika Sistem Senjata." Jurnal Elkasista 4.1 (2023): 1-9.

N.R.S Muda. "Conceptual Design of an Ambulance Hexadrone System for Disaster Victim Evacuation". International Journal of IJNRSM 5.12 (2025), 120-133

Muda, Nur Rachman Supadmana. "'Rancang Bangun Robot BM Berbasis AI'(2024)." International Journal of IJNRSM 2.2: 1-8.

Yuslan, Moh, and N. R. S. Muda. "DESIGN AND DEVELOPMENT OF KAMIKAZE" SUPERDEDE" BASED DRONE ESP 32 MICROCONTROLLER." International Journal of IJNRSM 4.6 (2024): 70-72.

N. R. S. Muda. " Implementation of an Artificial Neural Network on an Eagle-Inspired Drone for Precision Surveillance". ROBOTICS INTERNATIONAL DEC 2025 1.1 (2025): 1390-1399

Muda, N. R. S., MF Fadilah, B Faranadila. "Prototype of Communication System from HT with HP Using Tone Encoder Decoder Based on Interface Method". International Journal of Research Publication and Reviews (IJRPR) Vol 5(9) (2024): 2760-2763

N. R. S. Muda; M.F.Fadilah; B.Faranadila. "Autonomous Robot Concept to Convert Plastic Waste into Diesel Fuel with 98% Efficiency". International Journal of IJNRSM 5 .12 (2025): 100-115

N. R. S. Muda; B.Faranadila. "ACOUSTIC METAMATERIAL IMPLEMENTATION FOR NOISE ATTENUATION AND WAVE REDIRECTION IN QUADCOPTER DRONE PROPELLERS". Journal of Innovation Research and Knowledge 5.7 (2025), 8707-8714

Nur Rachman Supadmana Muda. "PROTOTYPE OF SHEPAT DRONE BASED ON BOMB FIXEDWING", IJSS (2025)

Nur Rachman Supadmana Muda, W.Pranata. "ANALYSIS OF AERODYNAMICS AND PERFORMANCE OF WAHYU PRANATA VERSION OF AEROMODELLING DRONE WITH MANUAL FLIGHT/STABILIZER AT A

CONTROL DISTANCE OF 18.8 - 19.5 KM”, International Journal of IJNRSM(2025): 91-109

Nur Rachman Supadmana Muda, Ardiansyah D Saputra. " DESIGN AND BUILD ADS VERSION OF FIXED WING RECONNAISSANCE MANUAL DRONES TO SUPPORT OPERATIONAL TASKS”, International Journal of IJNRSM(2025): 71-89

Nur Rachman Supadmana Muda, Ardiansyah D Saputra. " ANALYSIS OF YTP FIXED WING DRONES TO SUPPORT COMBAT TASKS”, International Journal of IJNRSM(2025): 51-68

Nur Rachman Supadmana Muda, Adithyan Putra Prathama." DESIGN AND BUILD AN AUTONOMOUS FIXED-WING DRONE WITH AN APP VERSION (ADVANCED PRECISION PILOTING) AND 17 MAP WAY POINTS TO SUPPORT UNIT OPERATIONS”, International Journal of IJNRSM(2025): 151-175

Nur Rachman Supadmana Muda, Egiadus Tefa." THE "EGT" MANUAL FIXED WING DRONE WITH A CONTROL DISTANCE OF 5 KM”, International Journal of IJNRSM(2025): 141-159

Nur Rachman Supadmana Muda, Septian Dwi Maulana." Design and Build a Drone Unmanned Aerial Vehicle (UAV) Based on Mission Planner and Flight Controller System Pixhawk at the West Papua Governor's Office”, International Journal of IJNRSM(2025): 111-129

Nur Rachman Supadmana Muda. "Weaponering for Specific Targets: Analysis of Air Blast Effects on Buildings, Bridges, and Non-Homogeneous Targets”, International Journal of IJNRSM(2025): 85-104

Nur Rachman Supadmana Muda. "CHAMELEON SKIN MIMICRY TECHNOLOGY AS A CAMOUFLAGE MATERIAL FOR VISUAL PROTECTION”, International Journal of IJNRSM 5.12 (2025): 65-80

Nur Rachman Supadmana Muda. "Comparison of Various Signal Amplifiers for Video Senders in Small-Sized Drones”, JDMP1000(2025): 41-52

Nur Rachman Supadmana Muda. " Implementation of Robust Control Methods for Stable Hovering of a Bird-Shaped Drone”, International Journal of IJNRSM(2026): 1-17