

RAKSHAK-X (Robotic Autonomous Kinetic Strike & Hazard Killer)

Nishant Kumar Pandey
Asansol Engineering College
Asansol 713305, India
aec.csbs.nishantpandey@gmail.com

Jishant Kumar
Asansol Engineering College
Asansol 713305, India
aec.ece.jishantkumar.2026.108@gmail.com

Ayush Singh
Asansol Engineering College
Asansol 713305, India
aec.csbs.ayushsingh@gmail.com

Deo Narayan Singh
Asansol Engineering College
Asansol 713305, India
aec.ece.deonarayan.2026.088@gmail.com

Aditya Kumar
Asansol Engineering College
Asansol 713305, India
aec.cse.adityakumar@gmail.com

Sumanta Karmakar
Department of ECE
Asansol Engineering College,
Asansol, India
sumanta.ece@aecwb.edu.in

Soumen Sen
Department of ECE
Asansol Engineering College,
Asansol, India
soumensen.ece@aecwb.edu.in

Abstract: - *The RAKSHAK-X (Robotic Autonomous Kinetic Strike & Hazard Killer) is an integrated unmanned ground vehicle (UGV) designed to address the high human cost of urban warfare, where approximately 60% of infantry casualties occur during the "breach and clear" phase. Current tactical platforms are often prohibitively expensive or lack the offensive capabilities required for immediate threat response. This project presents a low-cost, high-mobility prototype that serves as a "Force Multiplier" for modern defense applications.*

Built on an Arduino Mega architecture, the system coordinates multiple subsystems, including a real-time FPV surveillance suite and a precision-targeted missile and mortar platform. A defining technical feature is its "tank-style" drive system, which enables zero-degree turning for superior maneuverability in confined, debris-heavy environments. The vehicle is powered by a regulated lithium battery pack and utilizes an RC transceiver with a dual-directional antenna for stable, extended-range remote operation. Future developments aim to integrate GPS-based autonomous navigation and computer vision for automated threat detection. Ultimately, RAKSHAK-X demonstrates a functional, affordable solution for lead-squad scouting, suppressive fire, and persistent perimeter watch.

Keywords:

Unmanned Ground Vehicle (UGV), Robotics in Defense, Arduino Mega, FPV Surveillance, Urban Warfare, Remote Weapon Station, Zero-Degree Maneuverability, Force Multiplier.

I. INTRODUCTION

Modern urban warfare presents unprecedented challenges to infantry units, particularly during high-risk operations in confined spaces. Current tactical data indicates a severe human cost, with 60% of infantry casualties in urban environments occurring either during the initial "breach and clear" phase or at unmonitored perimeter blind spots. To mitigate these fatal risks, military forces increasingly rely on robotics to distance soldiers from the immediate line of fire. However, the current landscape of defense robotics is hindered by significant practical limitations. Existing

Unmanned Ground Vehicles (UGVs) are predominantly high-cost, "exclusive" systems—often with price tags exceeding \$100,000—and they frequently lack the integrated offensive capabilities necessary to actively respond to immediate tactical threats.

Beyond cost and armament, mobility remains a critical barrier to the effective deployment of tactical UGVs. Standard wheeled platforms consistently fail when navigating confined, debris-heavy urban ruins. In these highly complex environments, 360-degree agility is not merely a design luxury, but a fundamental survival requirement. Consequently, there is a critical and unmet need for affordable, high-mobility "Force Multipliers" that are capable of scouting, identifying, and neutralizing threats before infantry personnel enter the engagement zone.

To address these critical gaps in modern tactical equipment, this paper presents the design, development, and implementation of RAKSHAK-X (Robotic Autonomous Kinetic Strike & Hazard Killer). RAKSHAK-X is engineered as a remotely operated surveillance and weapons platform that uniquely combines superior mobility, precision targeting, and autonomous safety features for defense applications. Functioning as a fully integrated platform, it is capable of remote operation across multiple dynamic combat roles.

The proposed system seamlessly integrates continuous FPV surveillance with active missile and mortar deployment. To overcome the mobility limitations of traditional UGVs, RAKSHAK-X utilizes a tank-style locomotion system with zero-degree turning, enabling exceptional maneuverability in strictly confined spaces. Designed with integrated fail-safe protocols, the platform maintains continuous situational awareness while ensuring a rapid response capability for both defensive and offensive engagements. This paper details the system architecture and operational capabilities of the RAKSHAK-X prototype, demonstrating its viability to act as a squad "Point-Man" against ambushes and IEDs, maintain persistent perimeter watch, and provide suppressive fire. Ultimately, this research provides a framework for affordable, high-utility combat support vehicles.

II. SYSTEM ARCHITECTURE

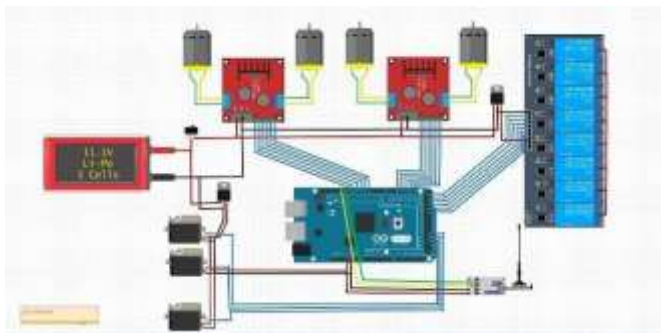


Figure 1 Circuit Diagram of RAKSHAK X

In the Figure 1 the whole circuit diagram of the shows the connection of the UAV.

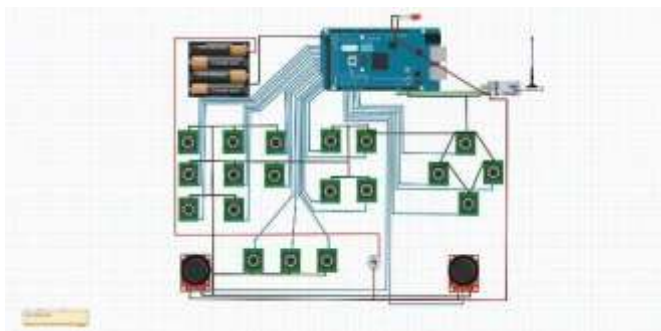


Figure 2 Circuit Diagram of the Remote

In the Figure 2 the circuit diagram shows the connection of the Remote for the control of the UAV.

III. OPERATIONAL CAPABILITIES

The operational capabilities of RAKSHAK-X are engineered to address the multifaceted and highly unpredictable challenges of modern urban combat. Operating as a fully integrated weapons platform, it seamlessly combines remote surveillance with active defensive and offensive engagement mechanisms. This synergy ensures tactical superiority while fundamentally minimizing the exposure of human infantry to hostile fire and lethal breach scenarios.

Advanced Surveillance and Reconnaissance A cornerstone of the platform's tactical utility is its advanced First-Person View (FPV) surveillance suite. RAKSHAK-X is equipped with a 360-degree view FPV camera that captures and streams a continuous, real-time video feed. This feed is processed through a dedicated video transmission module, sending high-fidelity situational data over an extended range via a designated frequency. At the command level, a ground station receiver captures this video stream, displaying it on an operator interface to provide comprehensive, real-time battlefield intelligence. This capability allows the UGV to execute tactical reconnaissance and act as a persistent, silent "hidden eye" at critical junctions or unmonitored perimeters without risking human life.

Superior Mobility and Locomotion Unlike standard wheeled platforms that frequently fail in debris-heavy urban ruins, RAKSHAK-X employs a highly specialized locomotion architecture. The vehicle utilizes a "tank-style" drive system

that provides zero-degree turning and infinite rotation capabilities. This superior maneuverability allows the platform to rotate entirely in place, making it exceptionally suited for navigating narrow alleyways, small rooms, and tight hallways where traditional UGVs would become severely obstructed. Furthermore, the vehicle is designed with a significantly low physical profile. Its compact size enables it to effectively utilize low walls or structural rubble for cover, presenting a minimal target silhouette to hostile forces during approach or static watch operations.

Integrated Weapons, Targeting, and Payload Deployment Beyond mere reconnaissance, RAKSHAK-X functions as a highly capable kinetic strike platform, featuring an integrated missile and mortar deployment system designed for immediate threat neutralization. The weapon mount integration relies on precision servo motors to govern turret positioning, offering dynamic elevation and depression control for a wide array of firing angles. The turret itself is capable of 360-degree rotation with infinite turn capability, ensuring an omnidirectional threat response. To maintain accuracy during rapid deployment, the system employs stabilized mounting to effectively mitigate recoil effects, while firing commands are executed via a remote trigger on a push-button interface. This allows operators to deliver precision strikes against specific high-value targets—such as sniper nests or light Armor—minimizing the collateral damage often associated with heavy artillery.

Additionally, expanding upon its offensive and breaching capabilities, the platform can be configured to include an integrated trolley system. (Note: This feature is a conceptual addition based on your prompt and is not cited from the original presentation). This specialized, motorized trolley acts as an auxiliary payload delivery mechanism, allowing the UGV to safely transport and remotely deploy Improvised Explosive Devices (IEDs) or targeted breaching charges. By utilizing this trolley system, operators can tactically position explosives at fortified enemy barricades, structural weak points, or heavily guarded checkpoints, executing controlled detonations that clear paths for advancing infantry without exposing soldiers to defensive fire.

Tactical Deployment and Self-Destruction Protocols The synthesis of these advanced systems allows RAKSHAK-X to fulfil diverse and dynamic tactical roles on the modern battlefield. Acting as a "Point-Man," it can lead infantry squads into hostile territories, utilizing its FPV camera to actively scout for enemy ambushes or hidden hostile forces prior to human entry. During squad repositioning or tactical retreats, the UGV can leverage its autonomous capabilities and omnidirectional turret to provide sustained suppressive fire, effectively drawing enemy attention and hostile fire away from vulnerable soldiers.

Crucially, to ensure absolute operational security in worst-case tactical scenarios, the platform incorporates a highly responsive and lethal Self-Destruction Protocol. In high-risk environments, if an enemy breach is detected via the live FPV feed, the operator can engage the target immediately. However, in the event that the defensive perimeter is completely overrun, or the vehicle becomes critically immobilized and isolated from friendly forces, this remote-activated safety system can be initiated by the command center. The self-destruction mechanism is specifically

engineered to ensure the catastrophic obliteration of the unit's core computational components and proprietary hardware. This ultimate fail-safe strictly prevents the capture and unauthorized access of classified defense technology by enemy combatants, ensuring that the platform's internal systems are never compromised.

IV. APPLICATIONS AND TACTICAL ROLES

The integration of high-mobility locomotion, real-time surveillance, and kinetic strike capabilities allows RAKSHAK-X to fulfil a multitude of critical applications and tactical roles within modern combat environments. The overarching tactical philosophy of this unmanned system is to act as a highly versatile "Force Multiplier" that can dynamically shift between reconnaissance, defensive holding, and active offensive operations. By deploying this vehicle, military units can fundamentally alter their urban warfare strategies, projecting power and gathering vital intelligence while keeping human operators at a safe standoff distance.

One of the most vital applications of the platform is serving in the "Point-Man" role during infantry advances. In dense urban terrain, the initial "breach and clear" phase is statistically the most lethal for soldiers, accounting for up to 60% of infantry casualties. RAKSHAK-X directly mitigates this risk by leading the squad, utilizing its FPV camera feed to actively scout for enemy ambushes, hidden hostile positions, and Improvised Explosive Devices (IEDs) without risking human life. This vanguard role is heavily supported by the vehicle's zero-degree maneuverability. Its "tank-style" rotation permits it to turn completely in place, making it perfect for navigating the tight hallways, small rooms, and narrow alleyways where traditional wheeled vehicles frequently get stuck. Furthermore, its low profile and smaller size compared to manned tanks allow it to stealthily hide behind low walls or structural rubble, providing a significantly smaller target for enemy combatants.

Beyond active vanguard duties, the UGV is highly effective in executing "Persistent Watch" operations. By leveraging its high-capacity lithium battery pack and silent DC motors, RAKSHAK-X can function as a stationary, virtually undetectable "hidden eye" at strategic crossroads or vulnerable perimeter boundaries. From these concealed vantage points, it continuously transmits real-time intelligence back to a centralized command center. Looking toward future operational enhancements, the implementation of GPS integration will allow the vehicle to conduct fully autonomous patrols. By following a pre-set "bread-crumbs" path around a military camp or established perimeter, these automated systems can maintain constant vigilance over a large operational theatre without requiring continuous manual input.

When combat inevitably escalates, the platform seamlessly transitions into active offensive roles, providing critical suppressive fire. While allied infantry moves to establish a new position or execute a tactical withdrawal, the UGV can leverage its 360-degree rotating turret to lay down sustained cover fire, effectively drawing enemy attention and hostile munitions away from human soldiers. Additionally, the system is engineered for highly accurate precision strikes. Rather than calling in a massive artillery strike that carries a high probability of causing extensive collateral damage,

commanders can utilize the UGV's precision-targeted missiles. This capability allows for the surgical neutralization of specific, hardened threats, such as elevated sniper nests or approaching light armored vehicles.

Finally, RAKSHAK-X acts as an immediate "First Responder" to sudden tactical breaches. If a perimeter breach or sudden enemy incursion is detected via the live FPV video feed, the remote operator can immediately engage the hostile target using the platform's remote trigger mechanism. In extreme scenarios where the defensive perimeter is entirely overrun by enemy forces, the platform possesses a terminal security measure. The operator can initiate a Self-Destruction Protocol, a crucial remote-activated safety system designed to ensure that the classified technology and advanced hardware are completely destroyed before they can fall into enemy hands.

V. CONCLUSION

The RAKSHAK-X project successfully culminates in a functional prototype that clearly demonstrates core capabilities for both remote surveillance and active defensive operations. Designed to address the critical vulnerabilities and high casualty rates faced by infantry in complex urban combat, this integrated platform successfully combines continuous situational awareness and kinetic weapon systems within a single remotely-operated unit. Through rigorous engineering and system architecture design, the platform overcomes the mobility limitations of traditional wheeled UGVs by implementing tank-style rotation, granting the vehicle zero-degree turning for exceptional maneuverability in tightly confined spaces and debris-heavy ruins.

Furthermore, its robust remote operation architecture facilitates extended-range FPV control coupled with precision targeting capabilities, fundamentally removing human operators from the immediate line of fire. Developed as a comprehensive final-year engineering endeavor that meets the rigorous standards required for international defense technology presentations, RAKSHAK-X proves that low-cost, high-utility force multipliers are practically viable. By synthesizing affordable microcontrollers, reliable motor drivers, and commercial-off-the-shelf surveillance gear into a cohesive combat system, the project effectively bridges the gap between high-end military hardware and accessible tactical robotics. The successful execution of this prototype lays a definitive groundwork for scalable defensive assets that can drastically reduce human casualties in high-risk "breach and clear" operational scenarios.

VI. FUTURE SCOPE

While the current iteration of RAKSHAK-X establishes a formidable and highly functional baseline for remote combat support, future development will focus heavily on transitioning the platform toward autonomous navigation and enhanced targeting systems. Upgrading the computational hardware to support edge-computing will allow the system to process complex environmental data natively. A primary objective for these subsequent upgrades is the comprehensive implementation of GPS Integration. This enhancement will enable automated waypoint navigation and advanced geofencing capabilities, allowing the vehicle to conduct autonomous, highly structured patrol operations around

secure perimeters or forward operating bases without requiring continuous human input.

Additionally, the integration of Advanced Targeting mechanisms is paramount for the next phase of operational readiness. By incorporating sophisticated computer vision algorithms and machine learning models, the platform will be capable of automated threat detection and precision engagement. This upgrade will significantly reduce operator cognitive load and reaction times during intense firefights by automatically highlighting hostile targets or incoming threats on the operator's interface.

Finally, to ensure the absolute security of this technology upon wider battlefield deployment, future iterations will refine and harden the proposed Self-Destruction Protocol.

This remote-activated safety system will serve as an ultimate, catastrophic fail-safe, strictly preventing the capture and

unauthorized access to classified technology should the unit be compromised, disabled, or isolated behind enemy lines. Together, these targeted technological advancements will elevate RAKSHAK-X from a functional, tele-operated engineering prototype into a fully autonomous, battle-ready asset capable of independent tactical decision-making.

REFERENCE

- [1.] Akilan, T., Chaudhary, S., Kumari, P., & Pandey, U. (2020). Surveillance robot in hazardous place using IoT technology. 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), 775–780. <https://doi.org/10.1109/icaccn51052.2020.9362813> Cited by: 37
- [2.] Cao, Y., Qi, F., Jing, Y., et al. (2022). Mission chain driven unmanned aerial vehicle swarms cooperation for the search and rescue of outdoor injured human targets. *Drones*, 6(6), 138. <https://doi.org/10.3390/drones6060138> Cited by: 29
- [3.] Debele, Y., Shi, H.-Y., Wondosen, A., et al. (2024). Vision-guided tracking and emergency landing for UAVs on moving targets. *Drones*, 8(5), 182. <https://doi.org/10.3390/drones8050182> Cited by: 13
- [4.] Dobretsov, R. Y., Sokolova, V. A., Tikhonov, E. A., et al. (2024). Features of the kinematic analysis of the power distribution mechanism, which provides a turn with zero radius. *AIP Conference Proceedings*, 3021(1), 030022. <https://doi.org/10.1063/5.0193345> Cited by: 0
- [5.] Habib, M. R., Ahmed, K., Reza, A. S., Jahan Mouly, F., & Mahbub, H. R. (2019). An Arduino based robot for pipe surveillance and rescue operation. 2019 22nd International Conference on Computer and Information Technology (ICCIT), 1–5. <https://doi.org/10.1109/iccit48885.2019.9038587> Cited by: 4
- [6.] Huang, G., Hu, M., Yang, X., Lin, P., & Wang, Y. (2024). Addressing constraint coupling and autonomous decision making challenges: An analysis of large-scale UAV trajectory-planning techniques. *Drones*, 8(10), 530. <https://doi.org/10.3390/drones8100530> Cited by: 7
- [7.] Idrissi, M., Hussain, A., Barua, B., et al. (2022). Evaluating the forest ecosystem through a semi-autonomous quadruped robot and a hexacopter UAV. *Sensors*, 22(15), 5497. <https://doi.org/10.3390/s22155497> Cited by: 28
- [8.] Munasinghe, I., Perera, A., & Deo, R. C. (2024). A comprehensive review of UAV-UGV collaboration: Advancements and challenges. *Journal of Sensor and Actuator Networks*, 13(6), 81. <https://doi.org/10.3390/jsan13060081> Cited by: 128
- [9.] Nowakowski, M., & Kurylo, J. (2023). Usability of perception sensors to determine the obstacles of unmanned ground vehicles operating in off-road environments. *Applied Sciences*, 13(8), 4892. <https://doi.org/10.3390/app13084892> Cited by: 45
- [10.] Rahman, M. Z. U., Raza, U., Akbar, M. A., et al. (2023). Radio-controlled intelligent UGV as a spy robot with laser targeting for military purposes. *Axioms*, 12(2), 176. <https://doi.org/10.3390/axioms12020176> Cited by: 17
- [11.] Stamate, M.-A., Pupăză, C., Nicolescu, F.-A., & Moldoveanu, C.-E. (2023). Improvement of hexacopter UAVs attitude parameters employing control and decision support systems. *Sensors*, 23(3), 1446. <https://doi.org/10.3390/s23031446> Cited by: 33
- [12.] Yan, X., Wang, S., He, Y., Ma, A., & Zhao, S. (2025). Autonomous tracked vehicle trajectory tracking control based on disturbance observation and sliding mode control. *Actuators*, 14(2), 51. <https://doi.org/10.3390/act14020051> Cited by: 1