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Comparative Analysis of Smart Munition & FPV Drones

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Abstract

This article presents the comparative analysis between two revolutionary technologies viz. smart munition and FPV drones, focusing mainly on certain key aspects such as cost-effectiveness, freedom of manoeuvrabilty, manufacturing, and frontline repairability. Though both technologies seem to be similar at a glance, but they differ in many contexts— smart munition can deliver a high-precision strike deep inside the enemy territory and involves numerous factors that need consideration, which have been highlighted in the article. In contrast, FPV lacks this capability but facilitates the operational efficiency in numerous other ways. This article brings out how one technology aids the strategic level while the other has the capability to revolutionise the ground or tactical/sub-tactical level.

Keywords: FPV, Smart munition, Frontline manufacturing, Precision-strike, Asymmetric warfare

Introduction

Modern warfare has evolved drastically over the last two decades. With the advent of new-generation equipment, traditional techniques of warfare are fading away. Latest conflicts in Ukraine, Israel, Nagorno-Karabakh and India-Pakistan have demonstrated the strategic importance of precision-guided munitions, autonomy in aerial weapon platforms, real-time surveillance and intelligence gathering. Where once the armoured vehicles had revolutionised the warfare strategies and operational doctrine, in today's battlefield the same has been accomplished by formidable autonomous weaponry that is capable of adapting as per real-time situation with minimal exposure of its operator to the enemy.

This transformation is driven in part by the rapid evolution of two key technologies: smart munitions and First-Person View (FPV) drones. Both these technologies provide the desired end results, but their fundamentals differ from each other in more than several substantial ways. Smart munition, mainly guided artillery shells and precision bombs, represents the highly autonomous technology capable of high strategic destruction. FPV drones, on the other hand, represents revolution at the lower level of warfare, providing sense of enhanced air-combat superiority to ground troops.

Technological Overview

Smart Munition

Smart munition refers to the weapon system with inherent navigational and control aids that enable the munition to follow a particular path or adapt as per the real-time situation. Unlike conventional bombs, smart munitions strike the target with utmost precision and accuracy, with an ability to adjust their trajectory in flight. Key components of smart munition are as follows:

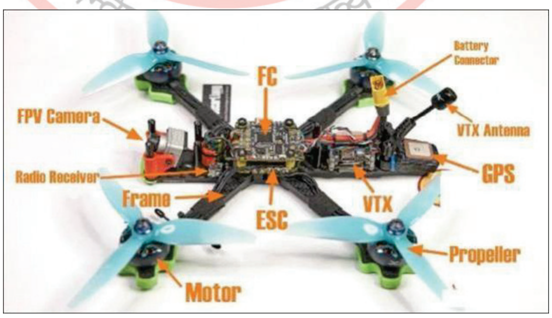
- Guidance mechanisms, which can either be GPS/inertial navigation systems (INS) or advanced features such as laser homing/terminal seeker heads (eg. Infrared or radar).
- Fins or canards placed over the surface for mid-course correction.
- Any Data-Link software to monitor the flight path.
- Fuze system that can be programmed as per the need of operation for airburst, impact, or delay detonation.

First-Person View (FPV)

First-Person View (FPV) drones are unmanned aerial systems controlled by the operator with help of real-time video being transmitted by a camera system, which can either be analog or digital. Key components of FPV are as follows:

- Lightweight carbon frames, brushless motors, and clockwise & anti-clockwise propellers.
- Camera, either analog or digital, with a video transmitter to send video feed.
- Radio transmitter and receiver, which can be ELRS or PPM or any other; for better encryption, OFC systems can also be used.
- Various payloads are also being used, such as explosives, biological agents, or electronic warfare modules.
- Lithium-polymer (LiPo) batteries that have a limited power supply but enable rapid deployment.

Figure 1: Parts of FPV drone



Source: Oscar Liang

Smart Munition v/s FPV

Cost Analysis

The main difference between smart munition and FPV drones lies in their production costs. Smart munition has specialised manufacturing processes, which is significantly more expensive as compared to FPV drones. For example, the Sudarshan laser-guided bomb kit developed by DRDO costs around 20 lakh rupees per kit, and SAAW developed by DRDO costs around 2 crore rupees per unit. In contrast, customised FPV drones using commercial off-the-shelf (COTS) components and 3D-printed parts costs around 35 thousand to 1.5 lakh rupees.

Figure 2: Smart Anti-Airfield Weapon developed by DRDO

Source: IDRW

Smart munition typically requires years of R&D investment, often in partnership with large defence contractors such as BEL. These R&D efforts are capital-intensive due to the testing requirements for accuracy, survivability, and integration with artillery and aircraft systems. FPV drones, however, can be built using the knowledge available on open source. The process of assembling and making an FPV drone is considerably fast and can be implemented at a lower level. Improvements can be done using online forums, and the same can be tested and implemented within weeks. R&D costs are significantly low in this case, compared to smart munition.

Deploying smart munition requires complex logistics such as artillery firebases, aircraft, or launch platforms, transport and storage infrastructure, specialist targeting systems and control nodes etc. Each launch involves coordination between spotters, fire control systems, and command units, which increase complexity as well as cost. In contrast, FPV drones can be launched from any concealed position with no need for specialised infrastructure. Operators can carry them in backpacks, and even they can be launched from bunkers. This makes deployment much cheaper and simpler.

Smart munitions are single-use but requires careful storage and handling. Maintenance as well as training artillery crews and forward observers to use these systems effectively can be resource-intensive. FPV drones require pilot training, battery management, and repair kits. Though the training and mastering the flying in acro mode takes time but maintenance involves readily available components which reduces cost burdens.

In terms of cost-per-kill or mission success rate, the efficiency of each technology depends heavily on the target and tactical environment. Smart munitions are highly effective against high-value targets at the strategic level— a single accurate round can destroy a 100 crore rupees project, thus justifying its high cost. However, FPV drones excel in attack in wave tactics and precision strikes against mobile or soft targets. When employed at the sub-tactical level, it can give high dividends.

Summary Table: Cost Comparison

Parameter	Smart Munition	FPV Drones
Unit cost (in Rupees)	20 lakhs – 2 crores	35 thousand- 1.5 lakhs
R&D cost	High, centralised	Low, open-source
Deployment cost	High	Low
Maintenance & Training	Moderate to high	Low
Cost efficiency in combat	High for strategic targets	High for Sub-tactical targets

Source: Made by the Author

Freedom of Manoeuvre and Deployment

Smart munition needs to be integrated into other weapon systems such as artillery guns, multiple launch rocket systems (MLRS) or aircraft. Hence, launching the smart munition depends on the movement of the larger systems. This presents several limitations on their usage, such as:

- Artillery shells and rockets require huge logistics vehicles, which in turn creates a transportation burden.
- Smart munitions cannot be fired without compatible platforms, howitzers, MLRS, or aircraft, each of which comes with logistical and personnel overhead. These launchers are also high-value assets and are thus susceptible to counter-arty or air attack.

In contrast, FPV drones offer extremely lightweight, flexible deployment— they can be carried in backpacks or drone boxes. A single infantry soldier can carry multiple drones. No specialised launcher is needed. Drones can be launched from bunkers, dead ground, or vehicles. Their deployment is silent and quick. FPV drones can be launched within 5 minutes, making them ideal for operations requiring stealth and speed or highly mobile operations.

Smart munitions offer limited in-flight manoeuvrability, as the pre-programmed sensors are designed to follow a particular path, and only minor adjustments can be made as per the real-time scenario with help of fins or canards placed over the surface. Most smart munitions require target coordinates to be fixed prior to launch, although some mid-course updates can be done, but the scope for change is limited. However, FPV drones provide complete manual control throughout the mission, enabling real-time flexibility. Operators can change targets mid-flight, react to changing battlefield conditions, or abort missions entirely. Pilots can steer around terrain features, obstacles, or enemy defences, increasing survivability and mission success. The real-time video feed provides allowance for major corrections during the mission, something smart munitions cannot achieve.

Most smart munitions function on GPS signals or laser homing systems, can be jammed or spoofed, and the folds in mountainous terrain can defeat the laser guidance system. INS systems, which are used as backup for GPS, measure acceleration and rotation to estimate position, though the accuracy thus provided remains questionable. Some advanced systems, mainly laser, infrared, or radar seekers for final targeting, can enhance precision but increase cost and complexity. However, FPV drones are typically steered manually by the operator using a live video feed. FPV video feed is the primary form of guidance; with analog or digital FPV systems, pilots react accordingly to navigate and strike the enemy targets. Some platforms integrate GPS for autonomous return-to-home or for pre-programmed waypoints, but GPS is not mandatory for flight or targeting

Manufacturing and Repair Capabilities

Smart munitions comprise of exclusive high end technology and military grade parts which severely limit its potential for in-house or battlefield manufacturing. Production of smart munitions requires precision based machinery, and access to sophisticated software such as nano-tech guidance systems, gyroscopes, and relay mechanisms. Components such as seekers, warheads, and fuzes are subjected to International Traffic in Arms Regulations (ITAR) or similar import restrictions which prevent unregulated sale by local vendors. Most systems are not available on open-source, thus damaged parts cannot be easily repaired or modified.

FPV drones, with substantial amount of research, offer high frontline manufacturing potential: militaries all over the world use 3D printers to produce drone frames, mounts, and casings, enabling production in mobile workshops, bunkers and even basements. FPV drones are often built from off-the-shelf components such as flight controllers (eg. Betaflight, Pixhawk), motors, cameras, batteries that can be assembled with basic soldering and programming skills

Figure 3: Frontline Manufacturing of FPV Drone

Source: Clicked by Author

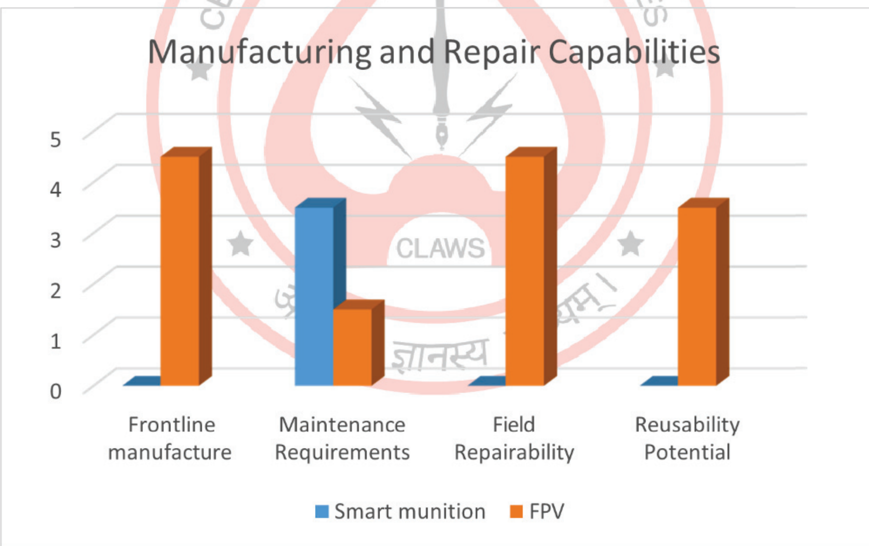
Being one-time use weapons, smart munitions do not require a maintenance cycle post-deployment. However, they require temperature-controlled storage, regular inspections, and handling by trained ordnance personnel in order to keep them in ready to use state. Advance electronics and explosive materials limit their useful life— some systems must be rotated out of inventory after 5–

10 years. Some systems may require software or firmware updates, but these are handled by the depot, not in the field. However, FPV drones require a maintenance cycle depending upon the usage and damages which typically can be summarised as:

- Damaged propellers, motors, or frames can be changed in two minutes using spare parts.
- Lithium-polymer (LiPo) batteries require special care such as avoiding over charging, avoiding complete discharge, etc.
- A well-supplied drone team can repair and re-launch damaged drones within hours, sustaining combat operations without external support.

There is virtually no field reusability of smart munitions. Once fired, they are expended. Damaged or misfired rounds must be disposed of with explosive by ordnance or engineers specialised teams. Complexity prevent repair or reprogramming in these munitions by field units. However, FPV drones are often field-repairable and modular. Using easily available parts such as motors, electronic speed controllers (ESCs), FCs and frames allows for quick repair of damaged drones. In many cases, drones that crash can be recovered, repaired, and re-deployed within hours.

Figure 4: Graphical Representation of Manufacturing and Repair Capabilities



Source: Made by Author

Strategic Roles and Comparative Case Studies

In conventional wars that involve neighbouring adversaries, smart munitions play a crucial role. Smart artillery and air-launched munitions allow long-range engagement of important enemy infrastructure and command nodes with great precision and minimum exposure of frontline forces. Systems like the Excalibur or GMLRS of the US Army can precisely suppress enemy artillery fire or can even destroy logistics hubs and fortified positions.

FPV drones are being used worldwide on a large scale, even in high-intensity warfare. Deployed in waves, they can destroy armoured vehicles, air defence radars, and concealed enemy positions. Their cost-effectiveness allows regular forces to sustain persistent attacks without any economic burden. With the advent of counter electromagnetic measures, drones face greater risks of jamming and interception.

Smart munitions are rarely used in asymmetric warfare. Their high cost and humongous requirements make them an impractical option for asymmetric warfare, as using such expensive munition against low-value targets is not at all justified. However, asymmetric warfare strongly favours FPV drones due to their cost-effectiveness, adaptability, and flexibility. Commercial FPV kits and open-source software allow the assembling of lethal drones at low cost. The continuous presence of drones creates a psychological fear and disrupts enemy morale. Drones enable the operator to react freely and provide space for improvisation for contingencies.

Smart munition acts as a double-edged sword in urban warfare. While guided weapons reduce collateral damage, GPS signals may falter in dense urban environments, which can lead to an undesired effect. Laser guidance also struggles with line-of-sight limitations. In contrast, FPV drones are suited for close terrain— they can navigate alleyways, windows, and building interiors. Small warheads and manual piloting make them ideal for clearing bunkers, buildings and vehicles. However, in rural/open battlefields, smart munitions perform effectively; clear GPS signals and large open spaces aid in maintaining the required precision, making them ideal for counter-artillery fire and command post targeting. FPV drones are effective but constrained by range and wind exposure.

Smart munitions are used for pre-emptive strikes and precision bombardment in an offensive role and are used for counter-arty fire, suppression of enemy artillery, and reinforcement denial through demolition in a defensive role. FPV drones are ideal for breaching defences, disabling vehicles, and supporting advancing infantry with fast reaction strikes in an offensive role and are being used effectively in perimeter denial, harassing attacks, and interception of enemy armour or vehicles in a defensive role. To understand the operational and strategic distinctions between smart munitions and FPV drones, it is essential to study real-world conflict scenarios wherein these technologies have been employed.

Russia-Ukraine War

Figure 5: A Ukrainian marine prepares to launch a first-person-view drone

Source: Army University Press

The Russian-Ukraine war has seen the first large-scale deployment of smaller drones, especially FPV drones, by both Russian and Ukrainian forces for direct combat purposes. Russian and Ukrainian forces have employed thousands of FPV drones to destroy tanks, fortifications, and troop concentrations. Units like Ukraine's "Aerorozvidka" have led drone innovation. Inexpensive FPV drones are launched en masse to overwhelm defences or to perform kamikaze-style strikes on moving targets. Civilian hobbyists and 3D printing networks have enabled Ukraine to rapidly produce and modify drones, creating a grassroot industrial base. FPV drones have neutralised high-value Russian assets (eg. T-90 tanks) at a fraction of the cost of guided missiles. Smart artillery like Excalibur and GMLRS rounds have been provided by NATO allies and used to target Russian command posts and logistics hubs. In coordinated offensives (e.g., the Kharkiv counter-offensive), munition provided to Ukraine has enabled deep strikes in Russia, but its higher cost and reliance on Western countries for its supply have limited its usage. FPV drones have redefined tactical warfare in Ukraine through cost-effective, scalable disruption, while smart munition has maintained relevance for precision deep-strike operations.

Israeli Drone Doctrine vs. Precision Munition

Israel is unique in its parallel mastery of both smart munition and drone warfare. Israel's air force uses a wide range of guided bombs (eg. Spike, JDAMs) to conduct pre-planned or precision strikes. Precision is emphasised not only for military effectiveness but also for legal and political legitimacy under international scrutiny. Systems like the Harop loitering munitions blur the line between drone and smart ammo. They loiter in airspace, autonomously detect targets, and strike with precision. In operations in Gaza, drones have been used for real-time reconnaissance, enemy tracking, and surgical strikes with minimal collateral damage. Battalion-level small tactical teams are often equipped with drone systems, allowing for fast, localised decisions.

Future Trends and Innovations

As smart munition and FPV drone technologies continue to evolve, they promise even more disruptive impacts at strategic and tactical levels. This section explores the futuristic trends and their expected impacts on warfare.

Artificial Intelligence (AI) will reshape the futuristic weapon system, including both smart munition and FPV drones. Future smart munitions will have AI-powered image recognition and target detection ability. They will be empowered to make decisions and amend trajectories automatically, which will reduce the human intervention significantly. Smart munitions will use AI to loiter around the area of interest, patrol combat zones, identify high-value targets, and strike on their own without being controlled by operators. Operating/flying FPV drones will also be easier with the advent of AI that will assist drone operators by providing enhanced stability and identifying potential targets within the video feed. Some drones will be fully autonomous, capable of targeting any human based on facial recognition with an ability to hover around and avoid any obstacles in the flight path.

Coordinated swarms of drones will be another revolutionary trend, which will easily overwhelm targets by sheer volume. Swarms will be operating in a shared network environment that will enable them to operate independently of their mother drone; in a nutshell, each drone can act as a mother drone for a specific time or situation. With AI interference, swarms will have the ability to adapt mid-mission to unexpected obstacles or enemy tactics.

The lines between drones and smart munition are increasingly blurred. Hybrid systems that combine elements of both are already being developed. Medium-sized drones are being fitted with modular weapon pods (eg. gliding smart bombs, laser-guided micro-missiles). Drones may carry both reconnaissance and strike payloads, dynamically selecting which to deploy based on real-time input. FPV drones may carry shaped charges or EFPs (explosively formed penetrators) with smart fuzing to detonate at optimal distance and angle. Sensors could enable strikes from above or around high-value targets, significantly boosting lethality. Munitions are effectively merging the characteristics of both systems—retaining drone flight control with smart terminal effects. These systems will be capable of surveillance, targeting, and final attack in one continuous operation.

The future of smart munitions and FPV drones lies in greater autonomy, tighter integration with data networks, and converging functionalities. As technology advances, militaries will need to adapt doctrines, logistics, and legal frameworks to fully exploit these capabilities while mitigating new risks—especially those surrounding uncontrolled escalation and accountability in autonomous warfare.

Recommendations

Smart munitions should be prioritised at the strategic and operational levels due to their precision, extended range and capability to neutralise high-value and deeply embedded targets with minimal collateral damage. Their advance guidance system makes them ideal for pre-planned strikes on critical infrastructure or command nodes. In contrast, FPV drones are best suited for tactical and sub-tactical level wherein their low-cost, agility, real- time adaptability and field repairability can enhance the unit level effectiveness many folds. As force multipliers, they provide precision strike options to company level surgical teams. This approach can optimise both effectiveness and resource allocation at the tactical level.

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Major Dikshant Kamboj is an alumnus of National Defence Academy, Khadakwasla. The Officer was commissioned into the Kumaon Regiment on 12 December 2020 and is a DGCA approved drone pilot. The officer has experience of serving in DCB as well as mountainous terrain. He is currently posted as company commander along the line of control in Western Ladakh.