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Invisible Sword Arm: Unmanned Vehicles in Land Border Security

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Abstract

India's vast border of over 15106 km and an equally daunting coastline of 7516 km is a logistical nightmare for an effective border control. The peculiarities of the border with Pakistan and an undemarcated border with China and a host of smaller nations like Bangladesh, Myanmar, Nepal and Bhutan all of which border India pose its own set of distinctive problems. To add to the difficulties in border management are four different guarding agencies each not answerable to the other. Apart from challenges in unified command and response mechanism, this also leads to one-upmanship. The absence of an integrated system has failed to provide a common operating picture to the guarding agencies. All the forces are manpower intensive and their inadequacy of technical resources renders India's borders porous and vulnerable to inimical ingressions. The country continues facing threats through cross border terrorism, shifting border goal posts, illegal migration, drug and arms smuggling and induction of counterfeit currency. To obviate these and to ensure a robust first strike capability, this paper examines whether use of unmanned vehicles in aerial, ground and sea frontiers will provide a holistic capability to address threats emanating from India's neighbourhood.

Keywords: Land Border, India, Coastline, Aerospace, Unmanned Systems, Integration, Terrorists, Technology, Central Forces, Command Structure, Security Threats.

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Introduction

Territorial disputes have been the most common issue over which states collide and go to war and are best avoided when a country enforces a strong border control and management. Border security has always remained a key issue in a country's core national interest. The central value of any nation state is to defend and protect its territory and sovereignty even under the most demanding circumstances. The issue assumes great significance for India as it has persisting border disputes with neighbouring countries and numerous of internal security problems due to the porous borders. India is one of the few countries globally which shares borders with multiple countries. It shares land borders with Pakistan, China, Nepal, Bhutan, Bangladesh and Myanmar and a maritime border with both Sri Lanka and Bangladesh.

India has 15,106 kilometres of land borders and a coastline of about 7,516 kilometres.[1] Only 5 out of 29 Indian states have no international border or coastal line. In Indian case borders are quite complex and almost all kinds of terrain, including mountains, hills, plains, valleys, forests, deserts and swamps have to be guarded at all times. India borders two belligerent countries China and Pakistan both overtly hostile and nursing inimical interests towards India. Myanmar and Bangladesh though not overtly hostile but are not favourably disposed of toward India thus undermining the overestimated depth of India's friendship with these two nations. A truculent country like Nepal of late is itching for a fight though it is only an irritant and only Bhutan currently is sharing warm relations with India. Sri Lanka which lies in the ocean on the southern tip of India also conceives India as unfriendly and hence does not maintain a cordial relationship. Indonesia and Maldives which share a water border with India are fairly disposed of and India does not envisage any animosity from these two countries in the near future. India's conception of national interest is based on the facts discussed above and there is a definite need to have a robust border security infrastructure to safeguard India's national interest.

The responsibility of guarding India's borders lies vested with the Ministry of Home affairs (MHA) which functions under the union Home minister. Border Management-I (BM-I) Division of MHA[2] deals with issues relating to strengthening of international land borders,

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their policing and guarding which encompasses management of land borders by creating and improving infrastructure works like border fencing, roads, flood lighting, out posts of border guarding forces along Indo-Pakistan, Indo-Bangladesh, Indo-China, Indo-Nepal, Indo-Bhutan and Indo-Myanmar borders. BM-I Division also deals with matters related to Empowered Committee on Border Infrastructure (ECBI).

To carry out the task in its enormity the Indian Government has deployed various border guarding agencies like the Border Security Force (BSF) to guard the Pakistan and Bangladesh borders, the Indo Tibetan Border Police (ITBP) to guard the Chinese borders, Sashastra Seema Bal (SSB) to guard the borders of Nepal and Bhutan, and the Assam Rifles to guard the Myanmar border.[3] Further the Border Roads Organization (BRO) have been given the responsibility of laying and maintenance of roads leading to the borders and along the borders. The number of agencies involved in the border guarding has all the ingredients of a bureaucratic design and is cumbersome in practice. Each agency continues to function under its own tactical wavelength, thereby hindering effective border governance.

Despite having faced open aggressions, wars and relentless terrorist incursions, India's border management strategy has till now relied essentially on manpower intensive measures that have apparently not yielded the two fundamental requirements in border management – deterrence and prevention. With the advent of technologies like unmanned systems, is there a fundamental change in India's border management strategy is the fundamental question this paper attempts to address.

The paper is divided in two parts dealing first examining the present border management philosophy and then, a theoretical scenario with unmanned systems integrated into the present framework.

The land borders alone have been taken into consideration for suggesting remedial measures and the coastal borders have been kept out of ambit in this essay.

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Part I: Existing Framework, Assumptions and Challenges

Defence without Deterrence

The border management has never been accorded due importance in India, and sadly has been characterised by an apathy, security ambivalence and lack of forward strategic thinking by successive governments in power. Ironically the bulk of Indian borders are man-made artificial boundaries inherited from the colonial masters and not based on natural features such as rivers and watersheds, they are very permeable and easy to cross. The presence of different forces on the same borders has unavoidably led to the lack of accountability as well as problems of command and control. Despite India having been a victim to a number of cross-border terrorism incidents, in which thousands of people lost their lives and extensive damage done to national wealth, the country keeps treating the border issue as yet another routine political matter without bothering to see whether the measures are adequate on ground. The border control currently in place has not reduced the following happenings.

1. There are regular attempts by the Chinese to redraw the border by frequent intrusions which never gets detected in time as was evident in Galwan of Ladakh in June 2020.
2. Trans-border terrorism and movement of insurgents continuing unhindered.
3. Penetration and exfiltration of armed militants
4. Strong links between arms smugglers and narcotics peddlers continues unabated
5. Illegal migration that has drastically changed the demography of the Eastern and north eastern parts of India does not see a green light in the end of the tunnel. Neither the BSF on the border nor the Border organisation in the interior, could prevent large scale illegal migration from Bangladesh. The border is very porous and the illegal migrants enjoyed political patronage. Efforts to prevent their ingress or to deport them were not very successful.
6. Local terror groups abetted by Pakistan is seen on an upward trajectory.
7. Externally funded madrasas established particularly in the border areas through hawala and smuggling of counterfeit currency, has become the recruiting place for the terrorist outfits.

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Structural Oddities

Despite decades of experience in being deployed in the borders and considerable numerical strength notwithstanding, the central police forces have failed to emerge as able security providers in border management. The border guarding forces have been equipped with an array of equipment's ranging from Laser fencing, Thermal Imagers, pressure pads, trip wires, Night Vision Devices, multi directional flood lights, perimeter surveillance Radar (PSR), and ground sensors.[4]

India's borders continue to be manned by a large number of military, paramilitary and police forces as shown in Table 1 below, each of which has its own ethos and each of which reports to a different central ministry at New Delhi, resulting in almost no real coordination in managing the borders.[5] The employment of multiple forces results in problems of command and control as well as the lack of accountability for encroachments, poor intelligence and inept handling of local sensitivities.

Table 1: Deployment of Forces

International Border	Guarded by	Number of Companies Deployed
Indo-Pakistan Border	Border Security Force (BSF)	411
Indo-Bangladesh Border	Border Security Force (BSF)	480
Indo-China Border	Indo-Tibetan Border Police (ITBP)	136
Indo-Nepal Border	Sashastra Seema Bal (SSB)	162
Indo-Bhutan Border	Sashastra Seema Bal (SSB)	97
Indo-Myanmar Border	Assam Rifles (AR)	60
Total Number of Companies Deployed		**1346**

Source: South Asian Terrorism Portal

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Leading Assumptions

1. The border guarding forces in addition to their primary duties are also assigned duties of counter terrorism which takes a huge toll on their operational efficiency due to the extreme rigours involved in execution.
2. The overuse of the Central Armed Police Force (CAPF) for rigorous internal security and election-related duties to the extent that even the reserved battalions are deployed not giving them enough time for rest and recuperation.[6]
3. To enhance security and improve the infrastructure at border checkpoints, India has developed Integrated Check-Posts (ICPs). This was set up as an ICP is intended to be a one-stop solution that houses all regulatory agencies, such as immigration, customs and border security. So far, 20 border checkpoints in India have been designated as ICPs, of which half are located along the India-Bangladesh border which witnesses the maximum cross border traffic. The ICPs unfortunately lack sufficient screening facilities. There are no technological tools available to scan the trucks crossing the border for loading and unloading of goods. The goods are being inspected manually, which is not a reliable method. Moreover, the BSF, which is in charge of border security and monitoring the ICPs, are only sanctioned to check the permits for the trucks entering/exiting, not the cargo. Such loopholes allow people to carry out unlawful activities across the border.[7]
4. The budgetary allocation vis-à-vis the threats involved would highlight the plight of the Indian border guarding agencies. An amount of Rupees 33,000 crore has been allocated to border security.[8] The sum involves the total amount allotted to the border guarding forces BSF, ITBP, SSB and for developing border infrastructure. Besides, a large portion of the funds allocated will also have to be utilised for upkeep of the existing infrastructure. It may be seen that only a very small portion of Rupees 2,000 crores will be available for acquisition of new systems or R&D. There exists no doctrinal concepts on border management.
5. As in many areas of our country's operations, in border management also we face problems relating to multiple agencies and lack of cooperation thereof, lack of financial resources and inadequacies, lack of technological mind-set, and a reluctance to adapt and induct new devices like the unmanned vehicles which would prove to be a force multiplier in border guarding operations. In the recent past, the optimum use of sophisticated technical equipment's has been weighed down by its incompatibility with terrain and existing border security infrastructure. A number of critical questions have been raised about provision of

three-phase power supply and border road along with fencing. The power back-up of generator sets is also a challenge which is yet to be addressed. Without plugging these loopholes, reaction capability of the QRT is going to be seriously compromised. Despite all efforts there is a lack of well-trained technical manpower which is a nagging issue. Due to a rotational policy of the border guarding forces, the expertise acquired by the border personnel risks being lost as soon as the private firms leave the project site, hampering the technical capability. Non transfer and permanent positioning has its own pitfalls.

6. Taking a cue from the existing trend across the world, the ideal solution is to integrate all the stakeholders in one single entity with a mandate to cover all aspects of border-management. There should be a well-trained and equipped central agency, having a presence along all stretches of the border, both land and coastal, with a clearly defined mandate of preventing and detecting any border violations.

Doctrine of Men over Weapons

The last two decades, has witnessed an exponential increase in the size of India's Central Armed Police Forces (CAPFs) which has almost doubled. It will not come as a surprise that the expenditures incurred on these forces have increased by almost an order of magnitude. Between 2006 and 2010, the staffing in MHA increased by 68,984, and between 2010 and 2014, by an additional 167,063. In 1998, CAPFs were less than 58 per cent of the size of the army, and by 2015, this had increased to 82 per cent – and the number is climbing.[9] The bulk of the increase in the central police forces was due to increase in the intake of BSF and ITBP. Organisationally, there are hard questions regarding the overall effectiveness of these forces, stemming from weaknesses in training, poor equipment, and ineffective leadership. Rapid expansion has meant that recent inductees have not gone through as much rigorous training as needed. There are potentially serious long-term implications of this very rapid expansion of CAPFs. For one, there are fiscal implications, not just of relative priorities of public spending, but even for the CAPFs themselves, as pension and healthcare bills will sharply rise in due course and cut into much-needed spending on better equipment and facilities.

The conventional border protection systems are based mainly on expensive ground facilities installed along the entire length of the border complemented by human patrols. Despite overwhelming strength and a plethora of gadgets available with the border guarding agencies the commensurate results have been far from satisfactory due to various reasons discussed above. Use of latest surveillance technology to guard India's porous IB needs to be appreciated

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as it is generally felt that the one who has better technology will dominate in the future. There is a need to introduce a system which would be cost effective, less manpower intensive and provide real time intelligence for a proactive offensive action. It is proposed that unmanned systems both land based and aerial may be introduced post haste to obviate the plaguing problems in border management.

Operational Philosophy

The unmanned vehicles have the unique wherewithal to offer a live-stream, real-time video and image capture, along with the additional ability to intercept including armed intervention. The unmanned vehicles are a favoured weapon system because of their productivity, information accumulation capacities and assurance of human life. These vehicles have the potential to perform intelligence, surveillance and reconnaissance (ISR) missions. Their application has extended to electronic assault, strike mission, concealment, suppression and demolition of enemy air defences (SEAD/DEAD), battle pursuit and salvage, and combat search and rescue (CSAR).[10]

The architectures designs for unmanned vehicles are generally mission and platform oriented and are commonly employed in patrolling, search and rescue and human hazardous missions. Irrespective of the differences in unmanned aerial and ground vehicles, the algorithms for obstacle detection and avoidance, path planning and path-tracking can be generalized for a seamless operation. These can be effectively used for terrain mapping and topographical surveys which would enhance the anti-border violation capabilities manifold. The vehicles are used to capture aerial data with downward-facing sensors, multispectral cameras, and Light Detection and Ranging (LIDAR) payloads. During a drone survey with an RGB camera, the ground is photographed several times from different angles, and each image is tagged with coordinates. The RGB (Red, Green, & Blue) sensor is the metering sensor that helps the camera analyse the scene being captured and determines the amount of light needed to produce a well-exposed image. Photogrammetry combines images that contain the same point on the ground from multiple vantage points to yield detailed 2D and 3D maps.[11]

From this data, a photogrammetry software can create geo-referenced orthomosaics, elevation models or 3D models of the project area. These maps can also be used to extract information such as highly-accurate distances or volumetric measurements. These data would be very

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useful in identifying terrorist camps across the border and can also identify vulnerable patches in our defences. Unlike manned aircraft or satellite imagery, UAVs can fly at a much lower altitude, making the generation of high-resolution, high-accuracy data, much faster, less expensive and independent of atmospheric conditions such as cloud cover.[12]

An aerial mapping UAV can take off and fly almost anywhere. The organization operating these vehicles are no longer limited by unreachable areas, unsafe steep slopes or harsh terrain unsuitable for traditional measuring tools.[13]

Double Trap Approach

India faces a peculiar boundary problem with each of its neighbours. To cite an example, the India-Pakistan border areas are spread across extreme climatic conditions given that the boundary runs from the marshy Rann of Kutch, to the unbearably hot Thar Desert in Rajasthan, traverses through the lush green fields of Punjab, to the unforgiving cold Himalayas in Jammu and Kashmir. Similarly, in the north, the India-China boundary runs along one of the imposing mountain ranges covered with snow all through the year in Ladakh region, to the daunting landscape of Uttrakhand which has been witnessing outward migration leaving the border areas with virtually no population, and the harsh terrain with intimidating passes of Sikkim, to the clement forests of Arunachal. The India Myanmar boundary is draped with lush tropical forests with its myriad undergrowth which is most favoured for insurgents to operate with impunity. The Indo-Bangladesh boundary has to come to terms with the ever-shifting riverbeds in the region. These diverse ecological and climatic conditions create immense hurdles for extending the security and administrative reach in these border areas. With these massive challenges it is absolutely essential to identify the variant of unmanned systems which would ideally function all along the borders. The unmanned systems coupled with a trained and an effective quick reaction forces can neutralize threat in quick time. India's long borders, extreme physical-geographical and climate conditions, future demographic restrictions and other factors that necessitate the development, creation and induction of remotely controlled and semi-autonomous systems that protect and defend the country on land, air, and sea.

Activities and Actions

In Gujarat, the BSF has a Water Wing to police the Creek area, a unique environment, where the border with Pakistan is a wide stretch of several creeks and narrow channels subjected to a

tidal difference of several feet, twice a day. There is also a whole expanse of three wide channels with several connecting narrow channels that are not navigable during low tide. The whole expanse of the creek area as it is loosely called is several hundred hectares with not a drop of fresh water, and adjacent to this is a stretch of desert that during the rainy season is flooded with salt water from the sea and during the dry summer is a salt encrusted desert where the temperatures touch 115 degrees Fahrenheit. During this period there is a continuous haze and visibility is just about ten to fifteen yards. Movement is along tracks with poles buried deep to act as markers. The Border posts at the International Border have to stock water for all purposes for five months as it is too shallow for a boat and too deep for movement on foot. To obviate this problem, the All-Terrain Vehicles (ATVs) are used by the BSF to traverse the marshy areas of the Rann, which get inundated by the nearby creeks and the Harami Nullah. Soldiers sit inside these ATVs and patrol the vast areas along the border and in these kind of ground conditions the utility of an unmanned ground vehicle would be negligible. It's a very difficult terrain to operate for several reasons. First, most of the creek areas go under water during the high tide. During the low tide, the marshy land emerges with snakes, scorpions and the like. Walking in that area is not easy. A floating border outpost (BOP) is armed with "well-trained" BSF personnel and weaponry which includes medium machine guns and grenade launchers. Each floating BOP is equipped with fast-patrol boats that patrol the creeks. An unmanned aerial vehicle (UAV) would be ideal in these conditions. The UAV is controlled from a ground control station (GCS), through a satellite connection, and from it is given missions by a human operator. Furnished with complex radar and sensing systems, it can supply responsive and persistent information from many places along the international border, day or night, with minimal concern for vagaries of weather.

In Rajasthan, in the Shahkargarh bulge, there are sand dunes thirty feet high for miles on end that can only be traversed on camels. In summer the temperature touches fifty degrees centigrade. Mercifully in the troughs between sand dunes, there are trees and water available in narrow wells.[14] Border Security Force (BSF) personnel, guarding the 270-km-long India-Pakistan border in western Rajasthan, are grappling with a drinking water crisis. Out of the 66 border outposts in Barmer, only two have piped drinking water; the rest depend on water supplied through tankers. This area is conducive for both a ground and an unmanned aerial vehicle and the command and control is less cumbersome as they are controlled by the same operator in the ground control station. These vehicles come with inbuilt algorithms sensor fusion to generate navigation and point cloud data, 3D implicit terrain representations of the

scene, receding horizon path planning with obstacle avoidance constraints and a waypoint controller to enable the vehicle to follow the planned path. The unmanned ground vehicles in addition to border surveillance, can also supply water to these remote outposts and supplement with medicines and other essentials.

The length of the international border in Punjab is 553 km, of which only 461 km is fenced. Riverine stretches along the courses of the Sutlej and Ravi in Punjab and nullahs in the Samba sector south of Jammu are difficult to guard because of the undulating terrain, waterlogging and thick growth of wild grass. The rivers criss-cross the international border at several places. The unmanned aerial vehicle will help our troops to monitor the border areas especially in unhelpful weather conditions where it is onerous for the troops to identify and neutralise the threats. This can effectively prevent a fog of confusion or miscommunication identifying and neutralising the targets.

India shares an interesting border with Pakistan in the Jammu and Kashmir sector. India and Pakistan share an Advanced Ground Position Line (AGPL)**:-**This is a 110 km long de facto demarcation line in the world's highest battlefield region of Siachen Glacier which separates Indian Military post from the Pakistani Military Post. It southernmost point is Point NJ 9842 and northernmost point is Indira Col where there is triangulation of Chinese, Indian and Pakistani territories. This area is manned by the Indian Army.

Line of Control (LOC):- It is primarily a ceasefire line which came into existence after 1947-48 India-Pakistani War (First Kashmir War) when United Nation Security Council (UNSC) passed resolution 1947, dividing the princely state of Jammu and Kashmir on basis of Indian or Pakistani held territories. This line was renamed during 1972 Shimla Agreement as Line of Control. Its starts from Kathua Sector in Jammu Region till Point NJ 9842. This border is guarded by the BSF in the Kathua, Samba and RS Pura sectors and all areas beyond by the Indian Army.

Part II:

The Invisible Sword Arm: Unmanned Vehicles in Border management

The discussion below is surmised on both aerial and ground unmanned vehicles being operated and supervised by a command and control centre. The ground platforms are both the watching stations and the first reaction patrols, which will inform the control and command centre on an attempted illegal entry, and undertake the proper measures to stop the illegal action almost autonomously with supervision of border guarding troops. It shall be emphasised that action including observing and detecting illegal entry attempts are to be taken by vehicles and if need so arises can engage the intruders, and this minimises the risk to own human health and life. Irregular forces adopt asymmetric tactics in order to reduce the technological disadvantage they have when facing superior forces and hence the vehicles would be an ideal platform to thwart those attempts.

Unmanned Aerial Systems

The Unmanned Aerial Vehicles **(**UAVs) are defined as a powered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry lethal or nonlethal payloads. UAVs come with several costs and benefits. One potential benefit of UAVs is that they could fill a gap in current border surveillance by improving coverage along remote sections of the Indian borders. These aerial assets would be a significant force multiplier and would allow the Indian Border guarding agencies to deploy fewer personnel in a specific area while maintaining the ability to detect and counter intrusions as a part of the day-to-day operations. Moreover, the range of UAVs is a significant asset when compared to border guards on patrol or stationary surveillance equipment. There is a necessity to focus on expanding the area of operations for the UAVs. It is primarily tasked with intelligence gathering over enemy territory and also for reconnaissance, training, surveillance, target designation, artillery fire correction, damage assessment, ELINT and SIGINT.

The Electro-Optical (EO) sensors (cameras) embedded in the UAVs can identify even small objects the size of a backpack preferred by terrorists from an altitude of 60,000 feet. These unmanned vehicles in addition can also provide precise and real-time imagery to a ground control operator, who would then disseminate that information so that informed decisions

regarding the deployment of quick reaction teams can be made quickly. Additionally, these can fly for more than 30 hours without having to refuel, compared with a helicopter's average flight time of just over 2 hours. The ability of UAVs to loiter for prolonged periods of time has important operational advantages over manned aircraft. The longer flight times of UAVs means that sustained coverage over a previously exposed area may improve border security.[15]

The function of a UAV is determined by its payload. The payload is directly related to the task. To undertake surveillance, there would be the necessity of carrying a Charged Couple Device (CCD) cameras with Multi Optronic Software payload. For tasks entails lasing, the bird would carry a Laser designator, to facilitate pinpoint attacks by aircraft or artillery. This would be extremely useful in neutralizing terrorist camps located across the border. The Indian defence forces have already been operating the Searcher variant of drones and the Heron variant which have proved their worth for the roles sought for. So it is only but natural the Border guarding agencies seek to acquire, operationalise and effectively use the drone technology for better border security. There are issues though still about the quality of pictures obtained while using the Synthetic Aperture Radar (SAR). Recent international improvements in SAR provide a clear image of the object, and that is where the effort is headed now. Many terrorists and militants in the north or north-east regions of India hide in areas of thick foliage. There is a need to obtain high quality SAR devices to generate good images. Further, in the Indian environment, there is an immediate need to weaponize these unmanned aerial platforms to destroy hostile targets with precision as on date India does not operate the armed drone variants.

The single attribute that unifies the UAVs or the drones is that they are all remotely piloted. Beyond those similarity, the differences are vast. They vary enormously in terms of size, the capabilities, and the range they can cover. Some are semiautonomous, meaning they rely on a human in some fashion, even if remotely. Others are autonomous, in which case the system is preprogramed and based on the artificial intelligence of the drone making the critical decisions. Some are armed; others are used for intelligence, surveillance, and reconnaissance. Some are hand-launched; others can take off and land by themselves from an airfield.

The Indian scenario would warrant a variety of the unmanned aerial vehicles as the role varies from an offensive action to deterring intruders. It is due to the differing yardsticks in treatment of intruders in different sectors. The Pakistani sector is generally considered extremely hostile

and hence an appropriate action in consonance with the risk is initiated. The same yardstick is not applied on the other borders including China.

There are also mini-drones that are designed for quick deployment and easy mobility, making them ideal for reconnaissance, surveillance, and target acquisition. These systems are launched by hand and powered by an electric motor, and have the capability to be operated remotely or operated autonomously using global positioning system (GPS) navigation. Because they do not require intricate support systems, mini-drones are ideal for supporting forward-deployed units within the border guarding forces. It would be extremely useful in the Myanmar and the Bangladesh sectors.

The helicopter drones can be effectively used as a tactical vehicle for detection, identification and classification of both conventional and non-conventional targets, and would be able to perform multi-tasking easily.[16] Many concurrent and complementary missions can now be flown at the same time and by the same operator, from urgent medical delivery to surveillance and quarantine enforcement when there is a ceasefire violation and unprovoked firing is in progress. The idea is extremely attractive and cost beneficial in as much as it offers the attractive option of evacuating a casualty from life threatening environment including in zones of fire without the risk of endangering the pilot. It is a double advantage when one considers the possibility of the same machine delivering cargo to troops engaged in operations and, on the return leg, undertakes medical evacuation.[17]

Last but not the least it is very essential for equipping the border guarding agencies with Unmanned Combat Air Vehicle (UCAV). The technological advances will soon enable UCAVs to play a much more important role as coercive instruments. In battle, forces engage an adversary by either direct combat or indirect fires. Indirect fires, or standoff engagements, preserve forces and are preferred whenever available and effective. UCAVs promise to carry the concept of indirect fires to a new level. They will be more flexible than missiles in time-sensitive target selection and more readily expendable in high-risk environments than manned systems, and they will have a greater sustained battle presence than either missiles or manned systems. They can be used effectively for constraining purposes: long-term sustainability of operations, and credibility in delivering precision punishment strikes. The UCAVs in the hands of the border forces would definitely alleviate the need of quick reaction troops rushing in to neutralize the enemy and the armed drones can take out the targets immediately on identifying as hostile. The roles and missions for UCAVs must be determined and prioritized. Particular

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high-risk missions that UCAVs might take on are suppression of enemy border posts facilitation border violation by terrorists and deep strike against some stationary targets, especially targets that may be rapidly relocatable like a terrorist convoy.

Several factors have made UAVs appear to be the "cureall" for border violations and counterterrorism. UAVs in the Indian case have proved to be a technology enhancer and enabler for performing reconnaissance, air and maritime surveillance of borders, and intelligence collection. One potential benefit of UAVs is that they could effectively fill a gap in current border surveillance by improving coverage along remote sections of the borders. The range of UAVs is a significant asset when compared to border troops on patrol or stationary surveillance equipment installed. If an inimical entrant attempts to transit through dense woods or mountainous terrain to breach own borders, the UAVs would have a greater chance of tracking these anti-national elements with thermal detection sensors than the stationary video equipment which is often used on the borders. The unmanned aerial vehicles ensures that the terrorists do not have an opportunity to score a psychological victory over own forces by causing a presumably large number of casualties thus dampening own morale and losing the will to continue with the fight. It also facilitates in identifying emerging high value and time-sensitive targets which can be quickly monitored and neutralized. The UAVs are also primed to take over transportation and logistical roles by improving sustainment with autonomous aerial cargo delivery. To cite an example, UAVs could be used to regularly resupply ITBP Forward Posts all along the Chinese border which have difficult accessibility routes. It can also effectively reduce surveillance gaps faced by the Indian border forces due to the treacherous nature of the terrain and inclement weather conditions. The Sense-and-avoid technology inbuilt should allow UAVs to detect other airborne objects including drones and provide early warning. Finally UAVs would reduce war's negative psychological consequences for the troops and their families because both groups will be so distanced from war's horrors. Families will neither experience the constant fear of losing a loved-one nor will they experience the sadness of missing a loved-one who is fighting in the unforgiving borders.

Ground Vehicles

Unmanned and Autonomous Ground Vehicle (UAGV) is a smart vehicle that is capable of doing tasks without the need of human operator. These vehicles are specifically designed to be used in war like conditions for border security, and can participate in a variety of missions such as ground warfare, intelligence gathering and logistical supply by carrying cargos, search and

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rescue, and border defence, reducing the border guard's exposure to danger and freeing them to perform other duties. UAGV designed for RSTA (Reconnaissance, surveillance and Target Acquisition) missions, or more simply put, extending the eyes and ears of the small unit provides a much-needed capability for ground forces. Whether the mission is to clear and hold, or find and fix, RSTA-specific technology supports the IW (Information Warfare) force by improving the contact rate with the enemy. These vehicles provide a near-instantaneous responsiveness dramatically shrinking what targeting experts call the "find-fix-finish" loop that most other platforms lack. This would be a huge deterrence for those trying to cross the borders illegally.

This type of vehicle mainly uses sensors to observe the environment and automatically takes decisions on its own under unpredictable situations. It can engage the intruder depending upon the circumstances and can pass details on the action taken to the operator who controls the UAGV through modes of embedded communication when it requires augmented support. This UAGV can also send visual feedbacks to the operator at the ground station present at a faraway location who will suitably control the vehicle through tele-operation. An on board sensor gives the complete environment of the vehicle as signals to the operator. The supervisory control exercised by the operator is often given to the myriad of control schemes which combine inputs from both an external human operator and on-board sensors to determine the path. The UGV's are embedded with three mobility levels such as teleoperation, computer aided driving and autonomous control. The control station has the capability to simultaneously control the operation and manage UGV's. They are built to handle a variety missions ranging from border patrol, surveillance and during active combat can duplicate as both a standalone unit and a human soldier as well.[18] Fernandez, et.al., [Fernandez, S. George, K. Vijayakumar, R. Palanisamy, K. Selvakumar, D. Karthikeyan, D. Selvabharathi, S. Vidyasagar, & V. Kalyanasundhram (2019)][19] also point out that:

> An operator can control this system comfortably from a remote place wirelessly. This system comprises of two units. One is the control unit (to control mobility) and the other is the motion tracking unit. Both these units have two modes-Automatic and Manual. This vehicle would be armed with an automatic weapon mounted onto a turret and a remote operator would be getting a live video feed from the camera to help him manually control both the above mentioned units of the UAGV. The vehicle is also capable of automatically tracking movement of objects in its range of vision. In the

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automatic mode, the vehicle uses Image Processing techniques to track motion. The vehicle has GPS navigation and commands to navigate can be given wirelessly. Additionally, infrared sensors aid in obstacle detection and path mapping. There is one on board computer, which receives command from command centre control and issues commands to the on board microcontroller for controlling the stepper motors, servo motors, wireless data reception, GPS navigation, and obstacle detection.

These vehicles help in clearing mines, improvised explosive devices and other unexploded ordinance and would be extremely useful in bordering the hostile areas bordering Pakistan especially in the Kashmir valley sector. There are baseball sized vehicles which are in use to efficiently collect audio visual data in hard to reach or dangerous zones such as tunnels or collapsed structures. The number of tunnels being used by Pakistan to infiltrate weapons, drugs and terrorist can be identified and neutralized with relative ease. A number of these vehicles are being manufactured by Russia including the variants suggested above. It is pertinent that the close cooperation that India maintains with Russia on armament transfer technology may facilitate a joint production as this may prove invaluable for the overstretched border guards.[20]

The UGVs can also be used for conducting amphibious operations and logistics support. It would prove to be invaluable in the Bangladesh border. The 61-km border in western Assam's Dhubri sector where the expansive Brahmaputra river flows into Bangladesh is arguably the toughest to man. Vast sandbars or river islands and innumerable water channels make surveillance a challenge, especially during the rainy season. It is in this sector that Smuggling is usually done at night and through blind spots that are difficult to monitor.

The UGVs also have their unique set of advantages as it greatly lightens the guarding troop's physical and cognitive workloads by ensuring that there is no weary foot patrols in hostile and undulating terrains and it also sustains the force with improved distribution of logistics, throughput and efficiency. These vehicles increase situational awareness and assist the identification of the exact point of action thereby facilitating movement and manoeuvre. It can detonate IEDs and mines thereby totally obliterating the possibility of human casualties, and also prevent planned ambush by the enemy. There are certain variants of unmanned vehicles that are primarily used to ferry supplies to soldiers in combat. This concedes the soldiers to have a surplus of ammo to keep them in the fight and greater their chances from being harmed in combat. One example of a military vehicle capable of this job is the Lockheed Martin's

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SMSS (Squad Mission Support System. This vehicle "can cover all types of ground at speeds of up to 25 miles per hour, while carrying a 1,000 lb payload".[21] These vehicles have a unique all weather operational capability and will bolster the effectiveness of patrols near Pakistan and Bangladesh borders which are often subject to extreme vagaries of weather. Troops adapted to its usage say one of the biggest advantages to having this "is the ability for these vehicles to stop out enemy snipers in the area". Since snipers are among the deadliest weapon used in any form of warfare, giving the opportunity to spot these snipers out before anyone is harmed is a tremendous advantage. Finally it can be effectively used for casualty evacuation of injured troops and ferrying in medicines and other essentials for remote posts.

Advantages of Unmanned Systems

Considering the mammoth challenges in border management currently seen, use of unmanned systems to supplement it has various advantages. To briefly state a few: cost advantage, speed, accuracy, reliability, ease of deployment, and portability. Static posts have the advantage of round the clock monitoring their area of interest and, if need be, intervene with heavier armed drones to neutralize threats. Such a scenario has obvious advantages for minimising human cost. The Unmanned systems offers a bouquet of advantages to effectively govern the vast Indian borders.

Challenges in Unmanned systems

The constraints over the use of unmanned systems in the Border Management are as equally important as the requirements for their use. While unmanned systems may fulfil a variety of requirements in compelling ways, the constraints may also present similarly compelling reasons to limit the use of unmanned systems. The costs of operating a UAV is likely to be more than the costs of operating a manned aircraft on specific areas due to the UAVs requirement of a significant amount of logistical support and a specialized crew with maintenance infrastructure. Operating one UAV requires a crew of up to 20 support personnel as it includes the pilot, sensor operator, intelligence analyst and maintainer. UAVs are less expensive to procure than manned aircraft but may cost more to operate. There is a constant need for trained manpower who possess the requisite technical qualifications to operate these systems and the cost of training to operate the systems would also add to the financial factor governing the use of the unmanned systems. The training would be a continuously ongoing process as the forces will have to cater for personnel exiting from the organization or transfers for alternate duties.

If a variant of the fixed wing aircraft experiences a failure of control systems, a well-trained pilot is better positioned to find the source of the problem because of his/her physical proximity. On similar grounds if an UAV encountered a similar system failure, or as an extreme measure a UAV landing is attempted during inclement weather conditions, the ground control pilot would be at a disadvantage because he or she is removed from the event. In the event of a UAV crash, combat rescue teams may have to be deployed to recover components from the crash site. This can prove counterintuitive since this deployment of rescue teams places the humans at risk within a combat zone to recover parts from an uninhabited system.

The drones must undergo extensive testing to assess the corresponding threat level when they fall into the wrong hands after either a forced landing or a crash. It is therefore mandatory, that the applications that control the operational criteria of the drones must be tested to prevent any security flaw that could be exploited by attackers. An alternate is to design automated drone penetration tests which enhances the cost substantially.

In the absence of an armed drone where the sensor to shooter time is drastically reduced an input from unarmed drone passing real time intelligence may prove to be ineffective in the event of not taking immediate offensive action. Thus a vital intelligence gathered by the unmanned systems can be rendered useless if the reaction is muted. Further the cost factor is also likely to escalate steeply in the event of a twenty four hour surveillance even over very vulnerable areas as it adds to the wear and tear of the machine and also the necessity to put more than one machine into orbit or on the ground. The manpower requirement would also substantially increase as the operators in the command centres will have to work in shifts to ensure round the clock operations thereby obviating the theory of machine over manpower. The unmanned ground vehicles requires the best technology in vogue and that goes into commissioning of these vehicles. The weapon mounted on these system requires its own specific programming. This requires huge man hours by competent technical personnel on testing and designing these vehicles. A huge disadvantage envisaged is when the can be destroyed by enemy fire before it has accrued any benefit to own troops. The possibility though remote cannot be ruled out in totality.

UAV Design and Development- A comparison

The bulk of the UAVs including Herons and Searchers variants in service in India are all imported from Israel. Israel continues to remain the leading supplier of surveillance drones to

India. Indian does not have any unmanned ground vehicles on date. Despite efforts from the DRDO India has not been able to make the desired progress as far as the indigenous **Nishant** UAVs which was initiated as early as 1995 and with multiple problems the project stands shelved. This programme can be revived by calling for a public private partnership with modifications to its aero frame and can serve the requirements of the border guarding forces well. India has also accelerated the indigenous **Rustom-2** surveillance drone trials a significant upgrade from Rustom-1 first flown in 2010. In addition the Indian Army along with other central forces uses **Netra quadcopter** UAV also indigenously produced to provide surveillance and accurate identification, tracking localisation of targets on-ground and is primarily used by Security Forces in Kashmir. India appears to be satisfied with importing drones from the USA and Israel for all its security needs despite a number of Indian start-ups technically levered up to produce UAVs. India may have to invest in indigenous technology to prevent over dependence on simple systems.

To the contrary China has been able to make rapid strides in the development of unmanned vehicles and is one of the biggest manufacturer and exporter of drones. The People's Liberation Army (PLA) signature model UAV, **the GJ-2** is an 11-metre long with a payload of 480kg. It can carry up to 12 missiles or bombs, has a top speed of 380km/h, a cruising speed of 200km/h and a service ceiling of 9,000 metres and has recently sold 48 of them to Pakistan under the export brand name, Wing Loong II. There are reports that PLA has deployed another drone **CH-4** which underwent tests in the Tibetan plateau region in 2018, and the BZK-005C – specifically modified for use at high altitudes.

Turkey is yet another country which has been leaving increased footprints in the field of drone technology. Turkey is continuously developing and improving its existing drones and also is increasing the production of various lethal armed drones, ranging from hue, high altitude, bomb-laden ones to very small, low-flying ones that can form deadly swarms. The recently concluded Armenia-Azerbaijan conflicted decisively tipped in Azerbaijan's favour due to the presence of Turkish **Bayraktar TB-2** drones. The TB-2, as it has been proven, is known to completely blind all air defences,having even blindsided the coveted Russian Pantsir and S-300 air defence systems. The **Anka-S** drones have proven themselves decisively in combat during various operations in Syria, Iraq, and as far afield as Libya. Turkey's prototype Aksungur drone, indigenously built by Turkish Aerospace Industries (TAI), can carry as many as 12 Turkish-built MAM-L (Smart Micro Munition) guided missiles under its wings, a much bigger payload than what can be carried by the Bayraktar TB2 or Anka-S.[22]

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It is pertinent that both China and Turkey are countries who are not favourably disposed of towards India but are having strategic level relationships with Pakistan and their drone fleets supply to Pakistan can substantially tilt the drone game towards Pakistan. The drones can be effectively used by Pakistan against India to clandestinely aid various cross border transgressions and will pose a huge challenge to Indian unarmed vehicles guarding the Indian border. India post haste must take necessary actions to ratchet its indigenous production by giving all assistance to Indian start-ups to counter this oncoming menace in the near future.

Concluding thoughts

India's daunting border guarding takes a heavy toll on all the border guarding agencies. With the increased threat perception no amount of manpower seems to be enough as there are yet gaps to be filled. While it is an impossible task saturating the borders with manpower, the country needs to look into viable, economical and less risky options to provide a fool proof border security. The analysis brings out that the unmanned vehicles both the aerial and ground variants would be an ideal supplement to the existing troops and improving operational efficiency manifold. The advantages discussed certainly outweighs the cons in terms of loss of lives and the areas that are likely to be covered. Using this technology in border management would prove valuable in reducing costs, providing opportunities for taking higher risks with lower casualties, enhanced capacity and reducing time lags.

The unmanned technology will also render future operations increasingly risky on account of hybrid nature of military theatres along the border. Operations across difficult terrains will involve new concepts making warfare asymmetrical. The need for having a secure and uninterrupted line of communication (LOC) between frontline troops and support facilities at the rear would be critical. Apart from securing LOCs, presence of secure routes for carrying huge amounts of resources from the rear facilities will also be needed. In view of the above discussed facts the Indian government should embark upon introducing unmanned vehicles to the border guarding agencies, train the personnel manning in effective and seamless operation and utilise this asset to its fullest potential. If the Indian Government can amalgamate all the border forces into a single entity the possibilities for better coordination can be ensured.

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