19

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Unmanned & Autonomous Vehicles and Future Maritime Operations in Littoral Asia

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The US Defense Advanced Research Project Agency's New Fixed Wing Naval Combat Drone. Photo: Foxtrot Alpha-Jalopnik.com

ABSTRACT

As the strategic environment in Asia turns increasingly fraught, regional navies have been focusing on the development of autonomous and unmanned systems – not only to improve situational awareness, but also as a means to undertake intrusive missions in forward locations. A transformative and potentially disruptive capability, autonomous platforms with artificial intelligence (AI) systems are pushing the boundaries of maritime interdiction to produce a new

normal in the global commons. For India and the Indian navy, the new systems' defining feature is their capacity to overwhelm target systems and sensors, leading to a severe degradation of the enemy's defensive capability.

INTRODUCTION

With rising asymmetric challenges in the global maritime commons, an interesting area of academic inquiry is the use of unmanned and autonomous vehicles in maritime missions. The proliferation of weapon and sensors technology over the past few years has led to an examination of trends in naval operations, with the aim of determining the critical characteristics of the future nautical battle-space. Of primary importance in this endeavour has been the need to improve situational awareness by enhancing information content, deploying platforms and procedures that allow for a more efficient collection, processing, evaluation and exploitation of intelligence data. In part, this is attributable to a dawning realisation that the future operating environment will be defined not so much by the potency of maritime force, but by the quality of combat decisions taken – particularly those that would enable navies to more effectively coordinate actions in targeting and engaging enemy forces.

While studies of the future maritime environment highlight different aspects of evolving military capabilities, each acknowledges the increasing predisposition of maritime forces to employ precision-guided weaponry and networked systems in contested situations.[1] There are, apparently, valid grounds to believe that the use of long-range sensors and precision-strike capabilities in the future will rise exponentially, even as the maritime battle-space undergoes a veritable compression, imposing sharp restrictions on the freedom of manoeuvre of surface naval forces. But empirical research has also shown that maritime operations in the post-modern era are likely to involve operational concepts that would require remote sensing and stand-off capability.[2] Analysts reckon that in many of these areas, viz. scouting campaigns, network centric warfare, special operations, and littoral war-fighting, unmanned and autonomous systems will play an important role in influencing events – both during times of peace and conflict.

For many maritime watchers, autonomous systems represent the single most important feature of future maritime environment. A transformative and potentially disruptive capability, integrated decision-making and artificial intelligence (AI) systems can push the boundaries of intrusive maritime missions to produce a new normal in the maritime commons.[3] Their defining attribute is the ability to extend combat operations into the adversary's anti-access / area-denial zone without risking the integrity of onboard systems or putting own forces in harm's way. What is most likely to distinguish such systems from other platforms, however, is their capacity to overwhelm target systems and sensors by sheer numerical strength, leading to a dramatic decline in the adversary's combat efficiency.

UNMANNED AERIAL SYSTEMS (UAS) IN THE ASIA PACIFIC

Unsurprisingly, the discourse on unmanned systems in the Asia Pacific has been led by the US. For a few years now, the US Navy has been working on the latest version of the RQ-4 Global Hawk –an unmanned aircraft system (UAS) designed to provide military field commanders with comprehensive, near-real-time intelligence, surveillance and reconnaissance (ISR), and the ability to detect moving targets over large geographical areas. The new updated MQ-4C Triton is capable of providing a persistent, broad area maritime surveillance (BAMS) over wider radius. The MQ-4C Triton acts in concert with the P-8A Poseidon, providing broader Intelligence, Surveillance and Reconnaissance (ISR) strategy. The former's ability to provide a superior surface picture enables the Poseidon to focus on below surface activity. With an advanced radar and sensor suite, the Triton tracks surface ships, collecting intelligence, on contacts within its field of vision.[4]

Despite its enhanced ISR capabilities, however, the Triton is believed to be vulnerable to electronic and physical attacks. China, American analysts say, is capable of targeting the new BAMS systems with electronic jamming and could shoot these systems down if deemed threatening. For this reason, the US defence industry has been designing stealthy, high-altitude and long-endurance (HALE) systems, which would be more suitable in a conflict-prone environment. The RQ-170 Sentinel and the longer-range RQ-180 are next-generation stealthy unmanned ISR platforms that have the endurance and capabilities to the Global Hawk, and enable reliable and accurate situational awareness in conditions of 'violent-peace'.[5]

Global Hawk. *Photo: FoxtrotAlpha-Jalopnik.com*

RQ 170 Sentinel. *Photo: Defence Aviation.com*

The US navy's anxieties about Chinese capabilities are not entirely misplaced. China's investments in unmanned systems have rapidly surged with plans to procure over 41,000 UAVs between 2014 and 2023, at a cost of approximately $10.5 billion.[6] While the majority of these systems are likely to be low- to mid-end systems used for tactical ISR, China is also developing relatively sophisticated HALE systems, such as the Divine Eagle and the Soar Dragon, which could be used in support of Beijing's emerging reconnaissance strike complex.

In particular, US analysts say, the design characteristics of the Soar Dragon suggest a capability for over-the horizon targeting for anti-ship cruise and ballistic missiles, thus providing a critical enabler for long-range A2/AD weaponry. In a worst case scenario, China could even deploy a large number of its UAVs in a saturation strike against the US or allied surface assets – a mode of attack maritime analysts say could debilitate onboard defensive systems, neutralising not only individual ships, but an entire surface action group.

THE INDIAN NAVY AND UAS

For the Indian navy, unmanned aerial systems evoke interest primarily in the context of near-sea operations. Since high-performing drones can remain on station for extended periods and provide crucial data in real time, unmanned systems are perceived as a definite asset. Since 2009, the navy has established three UAV squadrons in Kochi (Kerala), Porbander (Gujarat) and Ramanathapuram (Tamil Nadu) that operate Heron and the Searcher MK II vehicles for coastal surveillance.[7]

Plans are also in place to induct at least two more squadrons of UAVs to be controlled from ships to increase the range of surveillance. In March 2015, the Indian Navy (IN) invited bids for 'Ship-Borne Unmanned Aerial Vehicles' (UAV) that can augment various patrolling and search-related tactics on its vessels. The Request for Information (RFI), issued by the Directorate of Naval Air Staff (DNAS) stated a need for 50 Shipborne UAS for Intelligence, Surveillance and Reconnaissance (ISR) and monitoring of Sea Lines of Communication (SLOC), as well as EEZ safety, anti-piracy and anti-terrorism patrols.[8] Ship-launched UAVs are useful because they enhance the ship's communication with other friendly vessels, aircraft and satellites by relaying signals—especially from the IN's dedicated naval satellite (Rukmani).

The more significant dimension of the wider road-map for UAV capability creation is the navy's plans to induct strategic unmanned systems. Its proposal in 2010 for the acquisition of a fleet of high-altitude long-endurance (HALE) maritime UAVs resulted in an offer from the US government for Northrop Grumman to conduct preliminary discussions with Indian officials for the sale of the modified Global Hawk developed under the US Navy's Broad Area Maritime Surveillance (BAMS) program.[9] The US considered it a reasonable proposition because the Indian navy was the first export customer of the Boeing P-8. Unfortunately, discussions did not proceed beyond the preliminary stage.

A year earlier, the Indian navy had proffered a case for the acquisition of rotary-wing tactical UAS. The requirement was floated following slow movement on an existing naval rotary UAV (NRUAV) program based on the Chetak/Alouette-III helicopter. The program had run into several hurdles with its autopilot and other systems, delaying it indefinitely and compelling the navy to unlink it from its immediate requirement. Again, three firms—the Northrop Grumman's (MQ-8 Firescout), the SAAB (Skeldar) and EADS (Cassidian Tanan 300)—placed bids, only to find the matter stalled at the bidding stage.

India's Military UAVs

UAV	Type	Utility	Endurance	Range (km)	Altitude (ft)	OEM
Searcher	Tactical UAV	S/R/Int	20 hrs	300	23,000	IAI
Heron 1	MALE	Intelligence	45-52 hrs	350	20,000	IAI
Nishant	Technical	Intelligence	5 hours	160	3,600	ADE/ DRDO
Harpy	Lethal UAV	Combat	6 hrs	500	--	IAI
Harop	Suicide Drone	Combat	6 hrs	1000	--	IAI
Rustom	MALE	Tactical/ Int	12-15 hrs	350	30,000	DRDO
Gagan	Rotary UAV	OTH	6 hrs	250	20,000	IAI & HAL
Rustom 2	MALE / UCAV	Combat/ Int	24 hrs	500	30,000	DRDO

IAI – Israel Aerospace Industries
DRDO – Defence Research and Development Organisation
HAL – Hindustan Aeronautical Ltd
ADE – Aeronautical Development Establishment
Source: Compiled by author from Defence Forum India.[10]

The failure to acquire high-end drones, however, has not dampened India's enthusiasm for autonomous and combat platforms. Rising tensions in the Asia-Pacific, followed by an increased deployment of surveillance platforms in the regional littorals, have spurred the Indian navy to acquire unmanned platforms. Beijing's positioning of the high-tech Harbin BZK-005 drone on Woody Island has reinforced an existing impression in New Delhi that China's maritime operations in Asia are meant to dominate the Asian littorals.[11] Fearing an expansion of China's naval presence in the Indian Ocean, New Delhi has sought to improve its surveillance capabilities in the IOR by inducting long-range maritime aircraft (P 8-Is) and seeking the transfer of the multi-mission 'Predator' platforms from the US.[12] The jet-powered Predator Avenger will not be the first foreign unmanned combat aerial vehicles (UCAVs) to be transferred to India. Israel is in the process of producing a batch of 10 Heron TP armed drones for the Indian Air Force, capable of carrying 2,000 kg of weapons payload and air-to-ground precision missiles.[13] As mentioned earlier, India already operates unarmed Heron-1 aircraft for surveillance and reconnaissance missions and a fleet of Harpy drones – a self-destruct aircraft carrying a high-explosive warhead and primarily used for taking out enemy radar stations. The Predator, however, is likely to have greater operational utility than the Heron armed drones. Based on the MQ-9 Reaper drone, the Predator's bigger fuselage enables larger payloads and more fuel, allowing for extended missions. With jet-powered engines and a 2,000-pound Joint Direct Attack Munition (JDAM), these UCAVs will be able to carry out high-speed and long-endurance surveillance, and undertake massive strike missions.[14]

Heron TP. *Photo: Defence Update.com*

Rustom II. *Photo: AERMECH.in*

Predator Avenger. *Photo: General Atomics-ASI.com*

Heron 1. *Photo: Ainonline.com*

Searcher Mk 2. *Photo: Ainonline.com*

Another driver of Indian efforts to weaponise its drone fleet is Pakistan's acquisition of armed unmanned aerial vehicles (UCAV). In May 2015, Pakistan test-fired a laser guided missile from its Burraq drone—developed with Chinese assistance – setting off alarm-bells in New Delhi, and an accelerated effort to develop a counter weapon.[15] The initial momentum resulted in the setting up of a high accuracy satellite-based augmentation system (SBAS) and a dedicated military communication satellite, but a fully operational UCAV continues to elude the Indian armed forces. The Defence Research and Development Organization (DRDO) has begun work on weaponising the indigenously developed Rustom-I Medium Altitude Long Endurance (MALE) UAV by integrating a locally developed anti-tank missile called the HELINA, but the project still seems many years away from completion.[16]

Despite the slow movement on UCAV projects, however, there is some cause for cheer. India has placed in orbit the GSAT-7, a dedicated military communication satellite, meeting a key requirement for operating armed drones.[17] The Indian Navy has also enabled a networked program for missile firing exercises from its ships and aircrafts, with the GSAT-7's Ku band transmissions enabling critical Indian UAV operations. At a policy level, New Delhi is said to be working on a blueprint to procure more than 5,000 UAVs over the next 10 years.[18] Reports suggest the Ministry of Defence has cleared Project Ghatak to build on the autonomous unmanned research aircraft (AURA) programme to develop a futuristic "Indian Unmanned Strike Air Vehicle".[19] Notwithstanding the inevitable delays and cost overruns, therefore, there is much enthusiasm for autonomous platforms.

UNMANNED UNDERWATER VEHICLES (UUVS)

While the more substantive developments in unmanned technology have involved aerial drones, the more interesting possibilities are in the field of underwater vehicles. Indeed, despite the institutional and policy attention enjoyed by aerial platforms, it is unmanned and autonomous undersea vehicles that have been the subject of strategic debate and discussion in Indian maritime circles.

Leading navies today use high-tech submersibles for mine countermeasure (MCM) operations, naval intelligence, surveillance, and reconnaissance (ISR) roles, and anti-submarine warfare (ASW) missions. Even though UUV technology is still in relative infancy, the use of UUVs is growing rapidly, notably in places like the Strait of Hormuz and the South China Sea, changing the way maritime forces perceive littoral operations.[20] The UUVs in contemporary use can be classified into two broad types: autonomous undersea vehicles (AUVs) and remotely operated undersea vehicles (ROVs). Although rapid advances in technology have blurred many distinctions between the two platforms, an AUV differentiates itself from an ROV by maintaining a degree of autonomy from human control. The AUV's chief attribute is that it can undertake ASW tasks typically carried out by nuclear-powered attack submarines (SSNs), freeing the latter to perform more critical functions. For this, these platforms are equipped with a passive sonar device to enable a constant tracking of submarines.

Remus 100

One reason why AUVs are a subject of such enduring fascination is because they possess onboard intelligence and an inherent ability to self-program and execute missions. Unlike ships and submarines that are commanded solely by humans, autonomous undersea vessels exercise their innate judgment in performing operational tasks.

AUV operations, however, are inherently risky. Despite avoiding subjective decisions based on incomplete information and tensions, unmanned vehicles sometimes find it hard to avoid risky manoeuvres, leading to untoward incidents or collateral damage in combat situations. They also pose many legal and moral dilemmas. For instance, consensus is yet to evolve on whether a AUVs prosecution of an enemy ship / submarine – without due authorisation from a human source—constitutes a legitimate act. Similarly, the deployment of an AUV in the territorial waters or EEZ of another state is widely considered as a violation of maritime law.[21]

INDIA'S UUVS

Notwithstanding the ethical predicaments involved in their usage, underwater unmanned vehicles have inherent advantages of which India is aware. For the past few years, the Defence Research and Development Organisation (DRDO) has been designing and developing multiple AUVs to meet broader operational requirements for futuristic scenarios. In April 2016, DRDO scientists successfully developed an autonomous underwater prototype for multiple maritime missions in India's waters. Manohar Parrikar, the defence minister, announced in the Parliament that a feasibility study undertaken for the development of different types of AUV platforms showed that the DRDO was capable of designing various kinds of UUVs—from hand-held slow-speed ones, to military-class platforms, with the capability to assist in the entire gamut of maritime security.[22]

The DRDO's prototype is a four-metre long, 1.4-metre wide, flat fish-shaped vehicle which can travel at a speed of about seven km per hour at depths of up to 300 metres below sea level. Fully pre-programmed in terms of algorithms and mission requirements, the robotic vehicle is piloted by an on-board computer that employs technologies developed by the Visakhapatnam-based Naval Science and Technology Laboratory (NSTL).[23] Reportedly, the design is being reworked to provide the prototype with passive sonar and electro-optical sensors for anti-mining missions.

Meanwhile, NSTL's ambitious program, 'Autonomous Sea Vehicle' (ASV), on the lines of the US Navy's 'Manta Unmanned Underwater Vehicle' program is making gradual progress. The Indian ASV will be a 'submadrones' – a submarine launched swimming spy plane, contained within an underwater drone with folded wings housed in a torpedo canister.[24] The drone is designed to be launched from submarine tubes and deploy in reconnaissance mode for a fixed time period. On completion of the task, it is programmed to drop into the water, to be then recovered by a small autonomous vehicle and returned to the submarine. For deep-sea exploration, India has the 'Samudra', a 'low cost' AUV that operates underwater with pre-programmed inputs. Fitted with an on-board image processing unit, it can undertake 'path detection, obstacle avoidance and target identification' under the sea.

A POTENTIAL REPLACEMENT FOR SUBMARINES

In the long term, India's development of unmanned and autonomous underwater vehicles could well depend on how effectively such platforms can carry out conventional submarine missions. There has, indeed, been some speculation in recent years over the autonomous vehicles' presumed capability to undertake full-spectrum submarine operations.[25] Indeed, still a hypothetical proposition, its conception nonetheless raises interesting possibilities. The need of modern submarines for secrecy requires considerable financial and technological investments, thereby limiting a commander's willingness to undertake forward missions in enemy waters. If underwater vehicles could replace submarines, then a navy's appetite for greater adventurism in enemy waters could rise significantly.

Still, maritime planners must come to terms with the complexity of ASW operations that are likely to place great demands on an autonomous platform's ISR sensors, and command and control systems that enable intrusive missions.

The bottomline objective for autonomous naval vessels is to extend operational awareness within the battle space without assistance from manned systems and human decision-makers. At the same time, such systems must be capable of accurately assessing the operational environment and undertaking calibrated action in the foreign waters without escalating an existing situation. The critical requirement is to ensure that the quality of command decisions closely match those taken by naval commanders.

The more important implication of U/AUV operations is the shift in anti-submarine warfare operations from defensive to offensive missions. Since their inception, ASW techniques have been used primarily to protect specific assets in critical littoral spaces. The thrust of the naval effort has involved protection of the core of the fleet from prowling submarines. U/AUVs challenge the existing paradigm, by targeting submarines on open patrol. In order to negate the advantages of modern submarines in terms of high endurance, speed and an inherent stealth, unmanned platforms are being designed to operate in packs, making it harder for submarines to escape detection in constrained spaces.

It is no surprise then that leading navies in the world – including those of US, Russia, Britain and China – are actively developing underwater vehicles for forward operations. In recent days, Moscow declared that it is developing a family of unmanned surface and underwater vehicles that can target US submarines in Russian waters.[26] The Russian navy is also said to be working on developing tethered UUVs to undertake complex operations at great depths. Meanwhile, the US Navy is said to be working on similar capabilities to combat Russian undersea forces in the Atlantic. In a report to the US Congress in January 2015, the Pentagon outlined plans to develop a web of fixed and mobile undersea platforms and sensors, as well as charging stations on the sea floor.[27]

As U/AUVs become more integrated with submarines as part of a family of systems, there will be a need for the Indian navy to focus on these vehicles and their missions. Specifically, for a maritime force with a growing security mandate in the Indian Ocean, the Indian navy might need to pursue the following types of undersea unmanned and autonomous platforms:

(a) **Micro UUVs:** Inexpensive, but limited in endurance and on-board power, these small sized units are easy to handle and can be deployed in large numbers or swarms as weapons. They could also be used to survey the ocean floor, and interfere with enemy ASW operations.

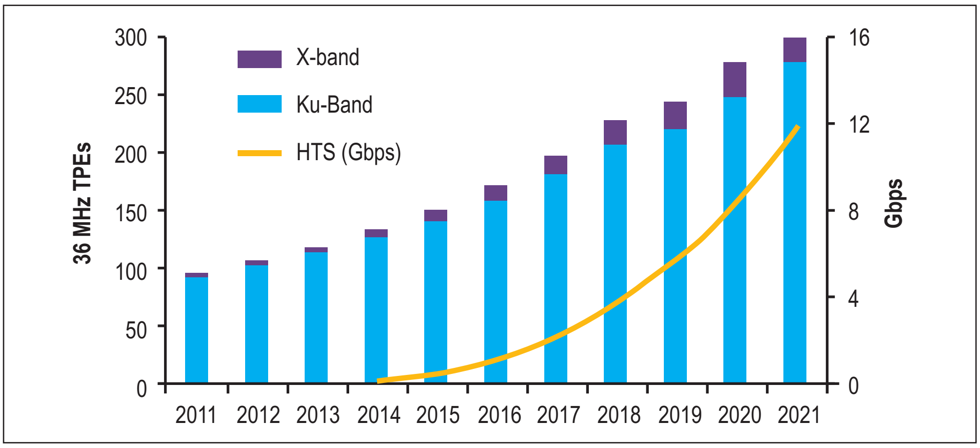
(b) **Survey and Mine-hunting UUVs:** The Indian Navy and Coast Guard are planning to acquire 50 ship-borne UAVs for ISR, monitoring sea lines of communications, search and rescue and anti-piracy roles, but the effort has not progressed beyond the stage of making preliminary inquiries.

(c) **Multi-purpose UUVs:** The size of a submarine-launched torpedo and configured to conduct a range of missions, from mining and long-range attack to electronic warfare. Such platforms are likely to play a key role in enhancing Maritime Domain Awareness (MDA) during future fleet operations.

(d) **Large Displacement Autonomous Vehicles:** These have extended sensor reach, payload capacity, and can be used in areas considered risky for submarine operations. In select cases, these could also be used for long-endurance surveillance missions or as trucks to deliver other payloads and UUVs.

CHALLENGES AHEAD

Without discounting India's many achievements in developing remote sensing technologies, the path to a comprehensive autonomous capability is likely to be a hard one. With unmanned aerial vehicles, New Delhi's biggest impediment is the lack of critical technologies that will help integrate multiple sensors with combat capability. The most rudimentary among absent expertise is a collision avoidance system (CAS) that has confined aerial unmanned operations to the military airspace.[28] Also, full-spectrum armed drone operations require a larger constellation of military communication satellites. Fewer satellites and insufficient communication bandwidth has meant that the armed forces have had to rely on short distance VHF links, limiting basing options for armed drones. In the future, there is likely to be a data surge from unmanned platforms to command centers that will drive higher bandwidth requirements. As in the United States, where UAVs are flying more often and for longer duration on primarily ISR missions (as the figure below depicts) India too must brace for a significant rise in UAV usage for intelligence gathering missions.



Source: Northern Sky Research

India's only long-range combat UAV, the Rustom-II, is still under development. While it is expected to assume the mantle of India's frontline armed drone, it has encountered challenges in the form of inefficient design, as well as the cancellation of export licenses by the US State Department of the American origin actuators. The indigenous replacements for those actuators have been lacking in quality. Now that India has joined the Missile Technology Control Regime (MTCR) it is expected that there would be better flow of dual-use items that go into UAV development.

In the domain of underwater vehicles, India will need to ensure that the technology developed advances artificial intelligence to a point where autonomous systems begin taking "decisions" that are consistent with safe navigation practices and the laws of armed conflict, and in sync with human decision-systems. Needless to say, developing, testing and employing intelligent control systems in unmanned ships and aircraft will be a major step forward in the acceptance of a fully-autonomous fleet of unmanned underwater vehicles.

In order to project decisive military force across all domains, unmanned and autonomous capability is likely to be a critical enabler. Integrated operations in the far littorals require the leveraging of cross-domain synergy to bring combat power to bear in the most effective manner, enhancing the effectiveness of ships, submarines and aircraft and also compensating for their vulnerabilities. In order to achieve superiority, maritime forces will need to create the freedom of action needed to complete the mission. Unmanned and autonomous platforms will allow this task to be performed efficiently, without unnecessary risks. Their trajectory of their evolution is likely to define the future of maritime warfare in littoral Asia.ORF

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