

ISSN: 2582-6433



# INTERNATIONAL JOURNAL FOR LEGAL RESEARCH AND ANALYSIS

Open Access, Refereed Journal Multi Disciplinary  
Peer Reviewed 6th Edition

VOLUME 2 ISSUE 7

[www.ijlra.com](http://www.ijlra.com)

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# **UNDERSTANDING AND ESTABLISHING** **LEGAL REGIMES FOR UNMANNED** **UNDERWATER VEHICLES (UUV)**

AUTHORED BY: - ADITYA BHUSHAN,  
ADITYA NARAYAN & KHUSHAL

## **Introduction**

Naval combat has always included dynamic means and techniques. For better or worse, it has changed and grown over time. We developed aircraft carriers from the wind-sailing ships that were once used to transport soldiers. During the second world war, we witnessed the advancement of submarines, torpedoes, and the usage of underwater mines. This entire development also resulted in modifications to the legal and regulatory framework controlling naval warfare. The autonomous underwater vehicles (AUVs), unmanned underwater vehicles (UUVs), and remotely operated underwater vehicles (ROUVs) are the most recent developments in the field. As their name implies, these are unmanned underwater vehicles that can be employed for a variety of tasks, including mapping, finding submerged wrecks, gathering intelligence, conducting scientific missions, and spying. As this technology advanced, there were many queries about the regulations that would govern its use. The definition of AUVs, UUVs, and ROUVs is one of the key issues. Whether it qualifies as a ship or vessel is up for debate. One of the main reasons for questioning this topic is because the United Nations Convention of the Law of the Sea (UNCLOS) is silent on its definition, which makes it difficult to determine who would be held liable for any harm that happen to these vehicles or these vehicles may do. This article examines the most recent developments made by India and other nations participating in Colombo Security Conclave, their implications for national security, and the legal frameworks that govern their usage.

# **Review of the Present state of Technological advancement on unmanned underwater vehicles (UUV) comprising autonomous underwater vehicles (AUV) and remotely operated underwater vehicles (ROUV)**

The 1960s saw the start of AUV development. Several testbeds were created in the 1970s. The development of AUVs was significantly impacted by a number of technology developments that occurred outside the AUV community in the 1980s. Complex guiding and control algorithms could potentially be implemented on autonomous platforms using small, low power CPUs and memory. The commercial market expanded between 2000 and 2010. As new solutions to technological issues emerged over time, the focus of technology development shifted. Development regarding

• Autonomy / Cooperation / Intelligent Systems and Technologies • Energy Systems / Energy management • Navigation • Sensor Systems and Processing • 3D Imaging • Communications<sup>1</sup>, took place.<sup>2</sup>

Apart from the abovementioned areas, progress is being done in the following areas:

Hydrodynamics and Control Systems, Autonomous Manipulation, Work Systems, User Interface, Development Tools, Emulation, Modelling, Distributed Control, Software System Architecture, Hardware System Architecture, Standardization, Platform Design, Cost, Reliability, and Robustness are all topics covered in the section on guidance and low level control.

## **UUVs Development in India**

India's UUV projects are still in their early stages, and according to industry observers, all parties involved must adopt an all-encompassing and inclusive strategy. Although it is still in its infancy, this new field of defensive technology has been introduced by the solutions and goods provided by Larson

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<sup>1</sup> J. W. Nicholson and A. J. Healey.(2008).The Present State of Autonomous Underwater Vehicle (AUV) Applications and Technologies. *Marine technology society journal*, 42, 44-51. [https://www.researchgate.net/profile/Steve-Cohan/publication/233659965\\_Trends\\_in\\_ROV\\_development/links/57d96f6608ae5f03b49a06ad/Trends-in-ROV-development.pdf#page=46](https://www.researchgate.net/profile/Steve-Cohan/publication/233659965_Trends_in_ROV_development/links/57d96f6608ae5f03b49a06ad/Trends-in-ROV-development.pdf#page=46).

<sup>2</sup> D. Richard Blidberg.(20021). The Development of Autonomous Underwater Vehicles (AUV); A Brief Summary. *Autonomous Undersea Systems Institute, Lee New Hampshire, USA*. [https://www.academia.edu/download/41963082/ICRA\\_01paper.pdf](https://www.academia.edu/download/41963082/ICRA_01paper.pdf).

and Toubro defensive, Mazagon Shipbuilders Ltd (MDL), and the Defence Research and Development Organisation (DRDO).

## **ADAMYA**

AdamyA is a UUV that can be deployed from submarines using torpedo tubes with a 533-mm dimension. It can run continuously for more than eight hours. It can be launched from a submarine torpedo tube despite being 5 meters long and rather hefty without the need for any further modifications to the submarine. Using the integrated launch and recovery mechanisms, it may also be launched from surface ships. According to L&T, the AdamyA can dive up to 500 meters underwater for more than eight hours at a speed of about four knots based on information that is in the public domain. Numerous systems allow for customization of the operational payload to the requirements of the user.<sup>3</sup>

## **AMOGH**

Amogh is a third-gen AUV that was created in partnership with Edgelab and Larsen & Toubro in Mumbai, India. The International Hydrographic Organization's criteria for hydrographic surveys and navigation safety are both adhered to in the design of Amogh. The integrated LARS-Launch & Recovery System and maintenance support system in the containerized design make it suited for quick implementation and installation. Amogh is a top-tier AUV for hydrographic and underwater monitoring and identification missions because of its cutting-edge sensors, payloads, propulsion, and energy system.

### **Main features<sup>4</sup>**

It can operate for 22 hours at the depth of 1000meters and attain a maximum speed of 5 knots

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<sup>3</sup> Huma Siddiqui.(2022,December 22). Indian Navy seeks indigenous underwater aerial vehicles to optimise unmanned tech: Know all about it. Financial Express. <https://www.financialexpress.com/defence/indian-navy-seeks-indigenous-underwater-aerial-vehicles-to-optimise-unmanned-tech-know-all-about-it/2907602/>

<sup>4</sup>Edge Lab. (n.d.). Amogh: the dependable underwater survey vehicle. [volantino compressed 2.pdf \(edgelab.eu\)](#).

### Application / Uses

Oceanographic in-situ data collection

### Salient Technical Features including Competing Features

Fully autonomous, pre-programmed missions, easy to operate through a user friendly GUI.  
Length 1.8m, diameter 0.23m, depth range 200m, nominal speed 1.5m/s, endurance ~ 6 hrs.  
Science payloads: CTD sensor, Chlorophyll sensor, Oxygen

### **DRDO**

In addition, flat-fished shaped UUVs with pre-programmed algorithms and mission criteria have been created by the Defence Research and Development Organisation (DRDO). The submersible, which can go at seven km/h, is managed by an on-board computer. The UUV has all of its algorithms and mission needs pre-programmed and is made to operate at depths of more than 300 meters. 10 of these ships are being considered for purchase by the Indian Navy. The vehicle can operate for a long time from land or a ship.<sup>6</sup>

### **MDL XLUUV**

The XLUUV design was created by Mazagon Dock (MDL), the top submarine constructor in India. Its functions include, payload placement, periodic communication, and execution of pre-planned missions and return to base. The Expression of Interest was also published by Mazagon Dock Shipbuilders Limited. A similar EOI for the creation of Mine Reconnaissance Autonomous Underwater Vehicles (MRAUV) has been issued.<sup>7</sup>

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<sup>5</sup> CSIR - NATIONAL INSTITUTE OF OCEANOGRAPHY. (n.d.). Technologies - Autonomous Underwater Vehicles (AUV) . <https://www.nio.org/research/technologies/autonomous-underwater-vehicles-auv>.

<sup>6</sup> Rohan Ramesh.(n.d.). Mean Machines India is now focusing on manufacturing underwater unmanned vehicles.. *FORCE* .<https://forceindia.net/feature-report/mean-machines/>.

<sup>7</sup> Mazagon Dock Shipbuilders Limited.(2022, December05). Expression Of Interest (Eoi) Invited From Global Firms Forcollaboration In Design, Development & Manufacturing Of Minereconnaissance Autonomous Underwater Vehicle(Mrauv)[Advertisement].[www.mazagondock.in](http://www.mazagondock.in).[https://mazagondock.in/images/pdf/EY\\_PLG\\_AP\\_GEN\\_313-H\\_2022\\_MRAUV\\_01\\_23122022.pdf](https://mazagondock.in/images/pdf/EY_PLG_AP_GEN_313-H_2022_MRAUV_01_23122022.pdf)

The Vishakhapatnam-based Naval Science and Technology Laboratory (NSTL) is also actively working to construct what it refers to as an indigenously designed AUV. India has the 'Samudra', a 'low cost' AUV that runs underwater with pre-programmed inputs, for deep-sea exploration. It can do "path detection, obstacle avoidance, and target identification" underwater since it has an on-board image processing unit.<sup>8</sup>

Regarding the nations taking part in the Colombo Security Conclave, institutions and organisations like Sri Lanka's "National Aquatic Resources Research and Development Agency (NARA)," "National Institute of Oceanography & Marine Sciences-Research," and "Centre for Defence Research and Development (CRD)" are working to develop and advance UUVs for both scientific and military uses. Bangladesh is home to "Bangladesh Oceanographic Research Institute, Bangladesh Institute of Maritime Research and Development." Maldives, Mauritius, and Seychelles are the other three nations that are not actively involved in the development of this technology.

## **Applications of AUVs and ROUVs and their implications on national security of nations**

UUVs can support or carry out a mission in the interest of national security in a variety of contexts and applications. Nine of those diverse contexts and applications have been identified<sup>9</sup>,

- (i) Intelligence Surveillance and Reconnaissance (ISR);
- (ii) Mine Countermeasures (MCM);
- (iii) Anti-Submarine Warfare (ASW);
- (iv) Inspection/Identification (ID);
- (v) Oceanography/Hydrography;
- (vi) Communication/Navigation Network Nodes (CN3);
- (vii) Payload Delivery;
- (viii) Influence Activities (IA);
- (ix) Time Critical Strike (TCS).

The next section discusses a few of the aforementioned types.

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<sup>8</sup> Supra note 6

<sup>9</sup> Robert W Button, John Kamp, Thomas B Curtin, and James Dryden. (2009). A survey of missions for unmanned undersea vehicles. RAND Corporation.(pp. xii-xiv). <https://apps.dtic.mil/sti/pdfs/ADA503362.pdf>.

## 1. Intelligence Surveillance and Reconnaissance (ISR):

The maritime domain has highlighted a need for persistent ISR. ISR is crucial for a variety of UUV missions and applications in addition to its usual use in intelligence gathering. The goal of carrying out ISR operations from a UUV is to gather intelligence data above and below the ocean surface (electromagnetic, optical, air sampling, weather, acoustic signals, water sampling, ocean bottom equipment monitoring, and object localisation) while avoiding enemy detection. Persistent littoral ISR, harbour or port monitoring, Chemical, Biological, Nuclear, Radiological, Explosive (CBRNE) detection and localization, surveillance sensor emplacement, battle damage assessment, active target designation, and more are just a few of the specific ISR UUV capabilities.<sup>10</sup>

The ISR mission area includes the gathering and delivery of a variety of data kinds, including target detection and localization, mapping (such as oceanography and intelligence preparation of the battlespace (IPB)), and all forms of intelligence collection (imagery, audio, and water profiling). Because they can operate at great standoff distances, in shallow water, independently, and with a level of covert capability not found in other systems, UUVs are ideally suited for information gathering.<sup>11</sup>

## 2. Mine Countermeasures (MCM):

The UUV's MCM mission may be the most challenging one. The MCM mission is one of the most difficult due to the abundance of mine types, their accessibility to prospective opponents, their simplicity of use across a wide range of water depths, and the nature of MCM operations, where there is no room for error. These parameters can be met by MCM mission types in operating contexts with a variety of mine hazards. They consist of<sup>12</sup>:

- ❖ Reconnaissance- Detection, Classification, Identification and Localization;
- ❖ Clearance- Neutralization and Breaching;
- ❖ Sweeping- Mechanical and Influence;
- ❖ Protection- Spoofing and Jamming.

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<sup>10</sup> Combined Joint Operations from the Sea Centre of Excellence. (2009, July 09) Guidance for developing maritime unmanned systems (MUS) capability. (pp. 8-9). <https://info.publicintelligence.net/CJOSCOE-MUS.pdf>.

<sup>11</sup> Department of the Navy united states of America. (2004, November 09). The navy unmanned undersea vehicle (UUV) master plan., Navy Research and Development, <https://apps.dtic.mil/sti/pdfs/ADA511748.pdf>.

<sup>12</sup> Ibid 12.

Mine detection and neutralisation are MCM tasks that are amenable to near-term UUV solutions. They can be divided into the phases of detect, classify, identify, and neutralise. The oceanographic and ISR missions are advantageous to MCM.<sup>13</sup>

### **3. Anti-Submarine Warfare (ASW):**

The goal of ASW is to use UUVs to patrol, find, track, and transfer enemy submarines. ASW is traditionally a labour-intensive discipline that relies on a range of highly developed sensors to collect vast amounts of data from devices like towed arrays and sonobuoys, from which it is possible to derive the pertinent data necessary to determine whether a target or no-target situation is present.<sup>14</sup> AUVs are considered another potential addition to the field of ASW because they might function as a component of a multistatic active sonar network. Additionally, they offer the advantages of stealth, reduced danger, reduced manpower requirements, potential persistence, and the capacity to optimise sensor position in 3D space in response to incoming sensor data.<sup>15</sup>

### **4. Influence Activities (IA):**

UUVs are ideal for two IA roles: the first is as a device to jam or introduce fake data into adversary computer networks or communications, and the second is as a submarine decoy. IA aims to trick, stop, and disrupt adversaries. UUVs are particularly suited for a number of IA tasks that cannot be carried out by other platforms due to their ability to operate surreptitiously in shallow waters and regions that are too dangerous for manned platforms. This makes it possible to move a transmitter and an antenna into close proximity to vulnerable communications nodes.<sup>16</sup>

“The advancements made in the field of UUVs may be seen as a technological revolution that will change people's lives, yet each breakthrough has advantages and disadvantages of its own. The use of unmanned underwater vehicles (UUVs) is a terrific way to save human lives, but it also has the potential to endanger national security.”

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<sup>13</sup> Supra note 13

<sup>14</sup> Ibid

<sup>15</sup> Ibid

<sup>16</sup> Ibid

## Legal and judicial issues related to UUV

### Military Application and the legal status of UUVs

Unmanned Underwater Vehicles (UUV) used for military purposes in foreign maritime zones is a new problem in maritime law that requires fast and thorough resolution. There is currently no legal framework in place that governs this technology.<sup>17</sup> Nonetheless, a number of States have employed UUV for a range of military functions, including observation, transportation, espionage, mine clearing, and assault weapons.<sup>18</sup>

UUV piloted by USNS Bowditch, an oceanographic survey ship, was taken over by the Chinese PLA Navy on December 15, 2016, 50 nautical miles inside the Philippine Economic Exclusive Zone (EEZ) in the South China Sea. China had not made it clear on what legal ground it had acted, despite statements attributed to the Chinese government linked the legitimacy of the drone's arrest to both the absence of clearly stated laws and the USA's repeated provocations in waters that China claims to control.<sup>19</sup> The US government responded by asking that China quickly return the UUV, claiming that both the USNS Bowditch and the UUV "were undertaking routine activities in line with international law" and that the UUV was "a sovereign immunity vessel of the United States."<sup>20</sup> After about a week, the incident was swiftly and amicably settled with the drone's return.<sup>21</sup>

The Bowditch incident demonstrates the ambiguity in international law about UUV eligibility for legal status.

### Is it possible to classify an unmanned underwater vehicle as a vessel?

The UN Convention on the Law of the Sea does not define a vessel, which is the main cause of contention. By interpreting Art. 29, it appears that ships are manned, yet there is no clear definition

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<sup>17</sup> Stephanie Showalter(2004), "The Legal Status of Autonomous Underwater Vehicles," The Marine Technology Society Journal, vol. 38.(pp.80-83). <http://nsglc.olemiss.edu/Commentary.pdf>.

<sup>18</sup> Eric Van Hooydonk(2014), "The Law of unmanned merchant shipping – an exploration", The Journal of International Maritime Law, vol. 20.(pp403-423). <https://mlaus.org/wp-content/uploads/bp-attachments/5193/Drone-Ships-JIML-2.pdf>.

<sup>19</sup> J. Borger(16 December 2016), 'Chinese warship seizes US underwater drone in international waters' The Guardian <[Chinese warship seizes US underwater drone in international waters | China | The Guardian](#)>

<sup>20</sup> Statement by Pentagon Press Secretary Peter Cook on Incident in South China Sea, 16 December 2016 <[Statement by Pentagon Press Secretary Peter Cook on Incident in South China Sea > U.S. Department of Defense > Release](#)>

<sup>21</sup> Statement by Pentagon Press Secretary Peter Cook on Return of U.S. Navy UUV, 19 December 2016<[Statement by Pentagon Press Secretary Peter Cook on Return of U.S. Navy UUV > U.S. Department of Defense > Release](#)>

in the Convention. Under international law, there is no commonly agreed definition of "vessel" or "ship," however several definitions can be found in numerous accords. Under Convention on the International Regulations for Preventing Collisions at sea (COLREGs), "vessel" is defined as including "every description of watercraft used or capable of being used as a means of transportation on water"<sup>22</sup>. COLREGs successfully fill the LOSC-created void in vessel concept or definition.<sup>23</sup> George K. Walker in his book went on to say that the International Law Commission's (ILC) decision not to provide vessels or ships a strict definition is perfectly correct. It represented the realization that there is no universal meaning or idea of those objects among states. But, in his opinion, the vessels definition from the American Branch International Law Association Law of the Sea (ABILA LOS) Committee can be used for national legislation. They described ships as "human-made technology, including a submersible vessel, capable of navigating the sea"<sup>24</sup>. According to this definition, UUVs can be categorized as vessels because they are man-made and capable of navigating the sea.

## **Incorporation of UUVs in existing legal regimes**

As for the remotely controlled UUVs, it seems easier to find a legal place for them. The ones that are deployed from a standard manned vessel are normally considered to be part of that vessel, as it would be for a mechanical part physically attached to the vessel (cables, cranes, robotic arms) or for torpedoes and capsules. So, an UUV of this kind would not be considered as an independent vessel, but simply as a part of the "mother ship" or part of its equipment. The eventual responsibilities would be of the operator and/or of the commander. Things become more problematic when it comes to autonomous UUVs, which operate without direct human control. It is obvious that any vessel operating in waters has the potential to cause harm to people, property, and the environment, either directly or indirectly. This implies that it must adhere to the existing rules. Rob McLaughlin underlines that USVs( Unmanned Surface Vehicle) and UUVs are clearly subject to the Convention on International Regulations for the Prevention of Collisions at Sea and must be capable of avoiding collisions to the extent that they may be called to maintain an "adequate and appropriate lookout."<sup>25</sup> Considering that all autonomous UUVs are covered by COLREGs, they will need to be built and

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<sup>22</sup> COLREGS - International Regulations for Preventing Collisions at Sea, 1972, Rule 3 - General definitions

<sup>23</sup> George K. Walker, 2012, *Definitions for the Law of the Sea: Terms Not Defined by the 1982 Convention* Martinus Nijhoff Publishers Leiden.( pp.21- 22). <https://brill.com/edcollbook/title/20556>.

<sup>24</sup> Manual.pp.34-35.

<sup>25</sup> McLaughlin, R. 2011, "Unmanned Naval Vehicles at Sea: USVs, UUVs, and the Adequacy of the Law", *Journal of Law, Information and Science*, Vol. 21, pp. 111. <https://search.informit.org/doi/10.3316/agispt.20124404>.

programmed to fulfil its specifications; they must follow the "rules of the road," operate safely, and be visible to other craft. COLREGs rule 5 states that "every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision". Rule 22 requires an inconspicuous, partly submerged vessel to display a white, all-round light visible for three miles. Under rule 33, vessels are also required to make various sound signals, depending on their size.<sup>26</sup>

The 1982 UN Convention on the Law of the Sea uses the terms "ship" and "vessel" interchangeably, without specifying a definition. Its Art. 91, which expressly outlines certain legal qualities of a "ship," emphasizes the need for a "genuine link" to exist between a State and its ship; this link is shown by the State providing the ship its nationality, registration in its territory, and the ability to fly its flag. If these were the elements that defined a vessel, a UUV may qualify as one because it has a nationality, can be registered in a State's registries, and may have a national flag.

UUVs are widely used around the world, and this trend is expected to continue. Nonetheless, there is still no definitive answer as to whether they are vessels or not. Depending on their size and application, UUVs appear to exist in a quasi-vessel condition. Autonomous UUVs of a certain size, technological sophistication, and use for specific applications could be termed vessels. Meanwhile, remotely operated vehicles may be thought of as extensions of the vessel from which they are operated. For the time being, it is evident that the only option is to follow existing rules. To avoid mishaps and legal problems, developers and operators should design and program UUVs to adhere to current legal frameworks, not necessarily all of them, but at least those pertaining to the vehicle's specific operation. UUVs would operate in a legal vacuum if they were not covered by existing legal frameworks. New regulations will be required, as will modifications to current ones. Furthermore, because state practice is the cornerstone of international law, it should be prioritized.

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<sup>26</sup> COLREGS - International Regulations for Preventing Collisions at Sea, 1972.  
<https://www.imo.org/en/About/Conventions/Pages/COLREG.aspx>.