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# Liability issues of Unmanned Surface Vehicles

Fausto Ferreira<sup>1</sup>, João Alves<sup>1</sup>, Andrea Bertolini<sup>2</sup>, Elena Bargelli<sup>3</sup>

**Abstract**—Unmanned Surface Vehicles (USVs) are a widespread technology nowadays. USVs of all kinds and shapes are used for a variety of applications from scientific research to transportation. However, safety and regulatory issues still prevent the exploitation of the full potential of USVs. In particular, without a well-defined safety standard and efficient risk allocation, it is hard to assign liability and define insurance or compensation schemes. In this article, we will discuss different types of liability regimes that could be applied to different types of USVs classified by length and autonomy level.

## I. INTRODUCTION

Unmanned Surface Vehicles (USVs) are a widespread technology nowadays. They can have very different shapes and sizes and can be applied in different areas ranging from small research purposes to Autonomous Ships. Currently, several initiatives are looking into adopting USVs for the shipping industry, passenger transportation or environmental monitoring. These projects have to deal with both technical and regulatory issues. On the one hand, the technological readiness level is high if one considers small-medium size vehicles. On the other hand, bigger Autonomous Ships are not yet on the market. In both cases though, the regulatory framework is lacking behind. Nonetheless, current work is being developed around the world on how to adapt current regulations to USVs (or create new ones).

In particular, the International Maritime Organization (IMO) started recently a regulatory scoping exercise to determine the need to amend current IMO instruments to enable safe operation of Maritime Autonomous Surface Ships (MASS)<sup>1</sup>. This is a landmark step as it would create legal binding regulations for USVs. However, this scoping exercise is still in a preliminary phase and the goal is not to draw new regulations in itself but only to analyse what needs to be done. The actual creation of new rules or adaptation of current ones is left for future work. Other international organizations such as the Comité Maritime International (CMI) that gathers national law associations in the maritime domain are performing a similar work. CMI created a Working Group on Maritime Law for Unmanned Crafts

that produced a position paper [1] and a questionnaire to its national members. CMI has currently looked at eight IMO conventions but there is still a substantial amount of work to do. However, this work does not create any regulations even if it informs the IMO Maritime Safety Committee. The fact that Autonomous Ships is a big market and that big players are investing on it<sup>2 3</sup> also contributes to the definition of a legal framework which will benefit all kinds of USVs.

There are many issues to deal with in order to frame the autonomous operation of USVs at sea from ethical [2], technical [3], [4] to legal issues [5], [6], [7]. In previous work [8], we have presented the most prominent current regulatory issues such as registration, classification, safety, liability and insurance. While there is still a considerable amount of work to do, considerable steps have been made in the direction of framing USVs operations. Namely, the first USV has been registered in the UK in 2017<sup>4</sup>. Several initiatives have proposed classification systems in their guidelines or recommended codes of practice [9], [10], [11] but these are only voluntary guidelines. In terms of safety, the Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREG) [12] could be applied to USVs according to some authors [13], [6] but the literature did not reach a consensus yet. Nonetheless, many research teams have been working for several years in COLREG-compliant USVs [3], [4], [14], [15]. Very recently, MAXCMAS (MACHINE eXecutable Collision regulations for Marine Autonomous Systems) project demonstrated COLREGs compliance with an outstanding performance<sup>5</sup>.

None of these issues is already fully solved and there is still the need to work on these topics. However, there start to be some practical solutions to each of these topics as the examples cited show. Instead, the liability issues are still far from being solved [16] as they depend on the previous aspects, e.g. without reliable safety testing of a USV, it is hard to assess the risk, assign liability and define insurance mechanisms. Within IMO, while the Maritime Safety Committee (MSC) started its scoping exercise for MASS in June 2017, the Legal Committee decided only in April 2018<sup>6</sup>

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<sup>1</sup><http://www.imo.org/en/MediaCentre/MeetingSummaries/MSC/Pages/MSC-98th-session.aspx>

<sup>2</sup><https://www.dnvgi.com/technology-innovation/revolt/>

<sup>3</sup><https://www.oneseaecosystem.net/dimecc-opens-first-globally-available-autonomous-maritime-test-area-west-coast-finland-one-sea-implementation-moves-forward/>

<sup>4</sup><https://www.ukshipregister.co.uk/news/uk-ship-register-signs-its-first-unnmanned-vessel/>

<sup>5</sup><https://www.rolls-royce.com/media/press-releases/yr-2018/21-03-2018-maxcmas-success-suggests-colregs-remain-relevant-for-autonomous-ships.aspx>

<sup>6</sup><http://www.imo.org/en/MediaCentre/MeetingSummaries/Legal/Pages/LEG-105th-session.aspx>

to perform also a scoping exercise and a gap analysis of liability and compensation treaties. This Committee will get as input the outcome of the MSC meetings in April and November 2018 as well as the abovementioned CMI work and has a target completion year of 2020. Thus, there is the need for studying deeper the liability issue which will be the next main issue in the development of USVs. The goal of this article is to look into the current proposals, critically analyse them and distinguish the different liability scenarios depending on the kind of USV studied. For example, a pre-programmed USV might imply a different liability assignment than an user-modified research purpose USV [1]. We will identify the different cases and present possible liability regimes applicable to each of them. In previous work [8] we have tested the feasibility of applying the regulatory guidelines contained in the European Parliament (EP) Resolution (2015/2103(INL))<sup>7</sup> to a specific use case of a research purpose USV. Here we will encompass different cases from small research USVs to large autonomous shipping vessels or ferryboats and focus only on the liability issues. The remainder of the paper is organised as follows: Section II introduces a simple categorisation of USVs that will be analysed, Section III describes different liability regimes that could be applied and then in Section IV we apply these liability approaches to different USV types. Section V concludes the article proposing future work.

## II. CLASSIFICATION OF USVS

There are many ways of classifying USVs based on different criteria such as size, speed, intended use, potential hazard, etc. Over the years, different categories have been proposed both for Autonomous Underwater Vehicles (AUVs) [9] and USVs [10], [11]. The Society for Underwater Technology published a Recommended Code of Practice [9] in 2009 applicable to AUVs. Later, the European Defence Agency (EDA) Safety and Regulations for European Unmanned Maritime Systems (SARUMS) group has published a document detailing best practices for Unmanned Maritime Systems handling, operations, design and regulations [10] in 2012, updated in 2015. In [10], three categories were defined based on length: small (up to 12 meters), medium (from 12 to 24 meters) and large (over 24 meters). Then, another categorisation was done based on the distance of operation: low end for less than 100 Nautical miles (Nm) and high end for more than 100 Nm. Finally, a category based on speed was defined: low end for less than 30 knots and high end for more than 30 knots.

Another way of classifying has been proposed by the UK Maritime Autonomous Systems Regulatory Working Group (MASRWG) in the Code of Practice [11] focussed on Unmanned Surface Vehicles (USVs), up to 24 meters in length, published in late 2017. Here, classes are defined both based on length and speed:

- Ultra-light: Length overall < 7 m and maximum speed < 4 knots

<sup>7</sup><http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P8-TA-2017-0051&language=EN&ring=A8-2017-0005#BKMD-12>

- Light: Length overall  $\geq 7$  m to < 12 m and maximum speed < 7 knots
- Small: Length overall  $\geq 12$  m to < 24 m
- Large: Length  $\geq 24$  m (and 100 Gross Tonnage)
- High-Speed: Operating speed  $V$  is not less than  $V = 7.19 \nabla^{1/6}$  knots, with  $\nabla$  the moulded displacement in  $m^3$

Categories or classes defined by length and/or speed are important but not enough to describe a kind of USV and what liability regime should apply to it. The mode of operation is very important as well. Both [10] and [11] defined five levels of control (level 0 would be human on-board):

- 1) Operated (or Remote Controlled): The operator makes all decisions, directs and controls all vehicle and mission functions.
- 2) Directed: The USV has a certain degree of on-board cognitive capability and can suggest actions but the authority to make decisions is with the operator.
- 3) Delegated: The USV can invoke functions but the operator has the option to object intentions declared by the USV during a certain time.
- 4) Monitored: The USV invokes functions without waiting for (or expecting) a reaction from the operator.
- 5) Autonomous: The USV will sense the environment, define actions, decide and act without informing the operator but reporting to him/her.

In this work, we will use the same levels of control proposed by [10] while considering a slightly different but similar to [11] categorisation of USVs. This is because very small USVs might have different purposes, risks and possible damages than larger USVs and the Ultra-light category of [11] does not distinguish between a 1 m USV or a 6 m one, which, as we will explain in the following section, it is worth to distinguish.

- Light: Length overall < 1.5 m, weight < 30kgs and maximum speed < 2 knots
- Small: Length overall < 12 m (and not respecting one of the above criteria for Light)
- Medium: Length overall  $\geq 12$  m to < 24 m
- Large: Length  $\geq 24$  m

Finally, there is another factor that needs to be considered: the intended use and connected to that who is the operator (owner, service provider, user, etc). We will distinguish among the following cases:

- a. Using a USV as a product where a user/owner defines a pre-planned mission and does not alter the behaviour of the USV;
- b. Same as before but the user is not the owner (e.g., charters/rents the USV);
- c. User modifying the USV for personal customization (hardware and/or software according to manufacturers authorised extra parts or software modules);
- d. User modifying the USV for research purposes (hardware and/or software). The USV must be registered in this case as a research platform in

an eventual Registry of USVs (maintained by the competent authority).

- e. Testing a prototype USV (non-commercial product);
- f. Service provider acting on behalf of a customer.

The full matrix of possibilities considering the categories of USVs (four), levels of control (five) and intended use (six) would give us 120 different cases. We will group these cases as possible and discuss the most representative ones in Section IV after presenting possible liability regimes in Section III.

### III. LIABILITY REGIMES

There are many types of liability regimes in tort law from absolute liability to liability with fault. Plus, liability can be joint and give origin to secondary liability. In certain cases, vicarious liability is applied in case a child or employee is involved. Product liability is used when it comes to defective products. To be clear, for the remaining of this work, we will look only at non-contractual civil liability (not criminal) deriving from damages to third-parties and describe the most common regimes that could apply to USVs. Their application to specific cases is detailed in Section IV. Liability rules are important to induce *ex ante* desirable behaviours by the manufacturer (such as safe products) by shifting costs of a harmful event to the responsible party while allowing for proper compensation of the harmed property/individual [17]. This is the case when the responsible party is the manufacturer which might not be always the case as it shall be described.

#### A. Liability with fault

Liability with fault (or guilt) is the common liability regime for criminal law. In this case, the mental element of the person is considered. Fault takes place when there is a breach of conduct rules (such as a negligent or reckless behaviour). Intention instead requires that the person is aiming to damage something/someone (*mens rea*). In civil law, this element is normally not needed to establish liability for tort but it can increase the scope of liability if the tort has been committed with fault or intention. This type of liability might be applicable for USVs that are remotely controlled by a human being but it would be very hard to assign intention to the USV itself in the case of truly autonomous USVs.

#### B. Strict liability (without fault) - non vicarious

Strict liability also called liability without fault drops the requirement of intention or fault to prove the liability of a party for the consequences of his/her acts. The liable person is the one causing the damage. In such a case, the claimant (damaged third-party) only needs to prove that the tort occurred and that the defendant was responsible. In some cases though, the defendant can prove due diligence and can raise a defence of absence of fault and argue that the consequences arose from the claimant actions (for instance, a defective product might not be the reason for the tort). This liability regime is mentioned by the EP resolution

(2015/2103(INL)) as possibly not sufficient (point AH). This is because Directive 85/374/EEC requires the injured person to prove not only the damage but also the defect in the robot and the causal relationship between damage and defect. The advantages of strict liability are that it promotes safe behaviours and it simplifies procedures (by not needing to prove fault). Nonetheless, at the same time, it might be seen as unfair and above all, it may have a chilling effect on the market as manufacturers would need to be overcautious. This means that they would need to take insurance policies that could become very expensive due to the lack of risk assessment. As [18] notes, without historical data and extensive testing (as in the car insurance market), it is hard to perform a realistic risk assessment and therefore to define appropriated insurance schemes. This means that the insurance prices will be high initially until technology is proven to be safe and the risk of accidents proven to be low.

#### C. Absolute liability

Absolute liability is similar to strict liability. The main difference is that in this case due diligence cannot be used as a defence. Looking at the EP resolution, this could perhaps suffice whereas strict liability is considered not enough. The Position paper produced by the euRobotics topics group on 'ethical, legal and socio-economic issues'[19] corroborates this position as it proposes to replace a fault-based rule with a risk-management approach based on absolute liability rules. In such a case, the party who is better placed to minimise the cost would be liable.

#### D. Product liability

Product liability is a special case of strict liability and is related to the defects in a product. Some authors consider robots as products [18] which makes the producer responsible for all damages caused by the functioning of the device. As it shall be seen in the next section, in certain cases, robots (USVs) cannot be considered simply products as their operation is complex and does not fit the paradigm of a robot consumer market.

#### E. Vicarious liability - Employers' and Principals' liability

Vicarious liability arises when there is a *respondeat superior* that is responsible for the conducts of a subordinate. In this case, the liable person is not the one causing the damage. This is a secondary liability case as the superior will be responsible for the acts of another party. A classic example is the employers' liability for negligent acts or omissions by their employees in the course of employment. This is an important approach as in the case of USVs, normally, more than one person from a given company is involved in the operation of the USV. Principals' liability applies when an owner lends a vehicle to another party and the owner is liable for acts committed by the person to whom the vehicle has been lent, if this person is acting on his behalf performing a task for the owner.



#### F. Things in custody liability

When damage arises from a thing that is in custody of a party, that party is responsible for the caused damage unless it proves a fortuitous case according for instance with Italian Civil Code (art. 2051). This could apply to USVs if one considers a USV a thing which is reasonable for the current levels of autonomy. If robots become electronic persons with a separate legal status as the EP resolution describes, then they would not be considered things but there is still a long way to get to that point. Bear in mind that proving a fortuitous case is many times cumbersome and therefore the party would be in most cases liable.

#### G. Abnormally dangerous activities liability

Another kind of liability that could be applied to USVs is the liability derived from abnormally dangerous activities. In this case, the party that is conducting these activities is liable unless it can prove due diligence.

#### H. Self-defence exemption and State of need

In many jurisdictions, self-defence for its own or others frees the party causing the damage from being liable. It is interesting to discuss if a USV has the right to self-defend itself or not. A similar case happens for the State of need. If a party was forced by the need of saving itself or others from the present danger of serious harm to personal injuries, and the danger was not voluntarily caused by that party or was otherwise preventable, then an indemnity is due to the injured person but it has to be measured equitable by the judge. Again, in this case, it is interesting to discuss if the USV has the right of saving itself or not.

### IV. LIABILITY FOR USVS

In order to choose the type of liability, one has to look at which incentives (e.g. increase safety) to give and to whom (producer, owner, user). Bearing in mind this we will present in this section some cases taking into account the classification and intention of use presented in Section II. All cases assume no intention from the USV or person driving/monitoring the USV to harm a third party. In such cases (e.g. a hacker taking control of a USV), the liable person should be the one controlling/monitoring the USV although the manufacturer could be held liable for not protecting the USV against cyberthreats. In the case of level 5 of control, it remains to be agreed if a USV could have an intention like human beings or could only be responsible by fault. We will assume the latter case in the following. We will also consider that the USVs are not operating within the limit of reserved beach areas for swimmers as to do so, special authorisations and precautions should be taken. Finally, we will consider that the USVs are used in their normal operating conditions, i.e. respecting the operating limits given by the manufacturer for what respects the sea state, wind, etc. If that is not the case, whoever takes the decision of launching the USV at sea should be the one liable (or in case of acting as an employee or principal and commanded to do so, the employer/owner should be the liable party as *respondeat superior*).

#### A. Light USVs

Light USVs can provoke only minimum damages in other vessels. This is a similar situation to lightweight Unmanned Aerial Vehicles (UAVs), popularly known as drones. In that situation, drones are assumed to represent no significant danger to people and their operation does not require any license or insurance. We could have an exemption of insurance (and liability) for light USVs while still requiring some kind of authorisation from the competent authorities to operate. The authorisation could be implicit for commercial products (e.g. if there are deemed safe to be sold no further authorisation is required) and explicit for prototypes and modified USVs. In any case, and as long as the damage is minimum, no person would be liable and a compensation fund as proposed by the EP Resolution (2015/2103(INL)) in Point 59.b would be used to compensate the damaged third party. This would simplify the operation of low-risk USVs, avoid litigation, and popularise the use of light USVs for recreational or scientific purposes.

#### B. All other kinds of USVs - Level 1 of Control

For all other kinds of USVs, in case of level 1 of control, where a human operator is remotely teleoperating the vehicle, the operator should be the person liable primarily, regardless of fault. The operator is the one commanding at all times the vehicle and therefore the responsibility to avoid damages is with the operator unless a fortuitous event is proven. If the operator controls the vehicle recklessly or with negligence, then liability with fault applies. Otherwise, this is the case of things in custody. In this situation, we are interested in compensating the damages occurred during the use of the thing. Secondary liability could apply in certain cases. For instance, if for some reason (i.e. defect) the USV does not respond to the operator's commands and the operator uses the emergency stop which also fails to work, then a regime such as product liability should be considered. In such a case, the operator could be held non-labile if he/she applied due diligence and the cause for the damage comes from a defect in the product. This is for the cases *a*, *b* and *f* of Section II when the USV is a product. For cases *c* and *d*, the operator should be held liable although the manufacturer of the extra hardware/software added to the original USV product could be held liable when the cause of the malfunction lied on that extra hardware/software. This can be hard to prove and only with well-defined logs (similar to airplanes black-boxes) it can be possible to investigate such a case. For case *e*, and when the operator is not the developer of the prototype, abnormally dangerous activities liability could apply to the developer of the prototype concurring with the liability of the operator. This to prevent the operator from being held liable for a design issue instead of an operation issue (e.g. operator commands USV to go left and USV goes right for a software design error).

#### C. Small and Medium USVs

For small and medium USVs, one possible solution is to follow the recommendation of the EP Resolution

(2015/2103(INL)) in Point 59.c of "allowing the manufacturer, the programmer, the owner or the user to benefit from limited liability if they contribute to a compensation fund, as well as if they jointly take out insurance to guarantee compensation where damage is caused by a robot". This might be complicated to implement and clear rules have to be established in order to define what are the limits of liability for each of the parties. This would most easily be defined in contractual liability instead of non-contractual liability. In any case, this limited liability would not be fault-based (strict liability type).

For instance, for levels 2 (Directed) and 3 (Delegated), in cases *a* and *b*, the producer might wish to limit their liability to specific operating conditions and with several constraints on what the user/owner can do with the vehicle and have this written down in a contract. If a damage occurs and these were not fully respected, the producer can claim not to be held liable or be liable for a limited scope. For case *c*, in a similar way, the producer might wish to define in a contract what is the level of customisation that the user is allowed to perform. The user would be held liable for torts deriving from non-authorized modifications. Eventually, if the fault is proven to rely on a faulty added sensor, the user could try to get compensated by the manufacturer of that sensor. For case *d*, a similar situation with case *c* occurs. However, not to hamper innovation, the user could be exempted of liability arising from its modifications and the general compensation fund of Point 59.b would cover damages resulting from those modifications. For the same reasons, in case *e*, a special exemption regime should be promoted but a certain minimum amount of liability should be covered by the developer to give incentives for careful behaviour. Finally, in case *f*, the service provider should be held liable only if it breaches the contract with the producer (similar to case *a* and *b*). The customer is the one in the worse position to compensate a third party.

For level 4 (Monitored) instead, limited liability might not be the best option as in this case, the USV acts autonomously and the human operator only monitors its actions. The risk can be higher in this case at least at the current state of technology and until extensive testing has been made to allow a precise risk assessment. This is one of the cases where strict liability might not be enough and an absolute liability for the producer/manufacturer should be applied for cases *a*, *b* and *f*. The operator could be liable for negligent or reckless behaviour for not monitoring properly the USV but the biggest share of liability should be assigned to the producer as this is the one putting a USV in the market that it is supposed to act by itself with no intervention. For cases *d* and *e*, strict liability should be assigned to the parties that modified/developed the USV as they are modifying a USV with full decision making capacities and their modifications can alter the behaviour as intended by the producer (case *d*) or manufacturers of parts (case *e*). The only reason not to use absolute liability here is that in cases *d* and *e*, users could argue due diligence in their modifications and operation and also to stimulate research.

#### D. Large USVs

Given the size of these USVs and thus the dimension of the damages they can produce, one possible solution is to use absolute liability which excludes due diligence as an excuse to not be held liable. This is a stronger alternative than strict liability but due to the possible damages, it should be preferable. One must bear in mind that it is not because the USV is larger that the risk is higher. What changes is the dimension of the damage due to a bigger size. Most probably, producers will invest even more in making these USVs safe for operation than smaller USVs and therefore using product liability to give incentives to producers to produce non-defective products will not make a big difference. The question here is who should be liable depending on levels of control and intended use.

For level 2 (Directed) where the operator still retains authority to make decisions, one should give incentives to operators to be careful and thus abnormally dangerous activities model could work. This model gives incentives to whoever carries on a dangerous activity to adopt the most appropriate measures to avoid risks. This applies to cases *a*, *b* and *f* where the operator is also the user (regardless of ownership). Vicarious liability should also cover the operator that is an employee or acts as a principal or else a huge load of responsibility would lie solely with the operator (as we are considering absolute liability). It should also apply to cases *d* and *e* with the difference that in cases of vicarious liability, the larger share of liability should be assigned to the party that modified/developed the USV and not the one operating it (unless this one was negligent or reckless). Even in these cases, if a programmer did follow its employer rules and was not negligent (or had intention), vicarious liability should be applied and the employer should act as *respondeat superior*. Case *c* would be rare as a large USV would not be typically customised after being bought. Mostly, users would require the manufacturer or other companies to add functionalities.

For level 3 (Delegated) where the operator can veto the decisions of the USV and decision-making is shared, strict liability (without fault) for the operator could be a better option than absolute liability. This is because in this case, the operator could easily argue that he took due diligence and it was a decision from the USV (to which he/she did not veto due to incomplete information) to cause the damage. As the operator still retains part of the decision-making process, the above model of abnormally dangerous activities should be kept. For level 4 (Monitored), the same as in the previous subsection should apply.

#### E. Self-defence and state of necessity applied to USVs

In many jurisdictions, self-defence for own or others can free the party causing the damage from being liable. Regarding USVs, it remains to be answered what happens if USVs reach the level 5 of control (Autonomous) and get the status of electronic person as suggested in point 59.f of the EP Resolution. This scenario is the farthest and needs a discussion that goes beyond the scope of this paper as it encompasses also ethical and philosophical questions.

Looking at more practical cases, self-defence for own (for the USV) regardless of which kind of party (user, owner, etc) and of the level of control, should not free the party from being liable of damages to people while it could be acceptable to be freed for damages to property if the self-defence is proportioned. For instance, if the USV would be intentionally destroyed by another vessel and has to hit a third one to avoid destruction, this could be a reason for exemption. Instead, thinking about self-defence for others, e.g., a USV transporting people such as an autonomous ferry, then self-defence is justified as the USV would save human lives.

For the state of need situation, as well, not considering the USV as an electronic person, a USV saving itself should not be a reason for decreasing the compensation given to an injured person. However, if the USV is saving people from a grave danger, then the compensation should be adjusted using the equitable criteria.

## V. CONCLUSION

In this article, we have categorised USVs based on their length, level of control and intended use. We have presented an overview of liability regimes that could be applied to USVs. We then applied possible liability approaches to different categories of USVs. While it is impossible to cover all possible cases one by one, we have grouped and introduced the most important categories and cases. The proposed liability regimes take into account current UAV regulations and some of the suggestions from the EP Resolution (2015/2103(INL)). They are also informed by the kind of incentives one wishes to give (either to producer, operator or owner). Summarising shortly, we propose a special regime for Light USVs (as it happens for lightweight UAVs) and a things in custody liability for all kinds of USVs that are fully teleoperated (level 1 of control). For Small and Medium USVs it becomes more complex. In this case, for low levels of autonomous behaviour (level 2 and 3 of control), limited liability could be used with some nuances regarding research purpose USVs. Instead, for level 4, an absolute liability could be more fit as the risk is higher. The same kind of absolute liability could be applicable to Large USVs which can provoke more considerable damages (not necessarily more damages).

We have also discussed exemptions due to self-defence and equitable compensation due to a state of need but these raise harder questions that go beyond the scope of the paper. In fact, we have excluded level 5 of control cases from our analysis due to the issues that it raises (ethical and philosophical) and to the technological challenges of implementing it. As future work, we would like to propose insurance schemes corresponding to these liability regimes in order to help producers and developers to get their USV safely and legally navigating in our oceans.

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<i>Title</i> Liability issues of Unmanned Surface Vehicles		
<i>Abstract</i> <p>Unmanned Surface Vehicles (USVs) are a widespread technology nowadays. USVs of all kinds and shapes are used for a variety of applications from scientific research to transportation. However, safety and regulatory issues still prevent the exploitation of the full potential of USVs. In particular, without a well-defined safety standard and efficient risk allocation, it is hard to assign liability and define insurance or compensation schemes. In this article, we will discuss different types of liability regimes that could be applied to different types of USVs classified by length and autonomy level.</p>		
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