

'Drone': technically correct, popularly accepted, socially acceptable

Different fields use different terms, but by changing its title, this journal is advocating for the discontinuation of 'unmanned' and recognition of 'drone' as an umbrella term for all robotic vehicles

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Introduction

The *Journal of Unmanned Vehicle Systems*—led by its founding editor, David Bird—published its first issue in December 2013. It was the first peer-reviewed scientific journal entirely dedicated to research relating to all types of remotely piloted or autonomous robotic vehicles, including those that operate in the air, on the ground, or on or below the water's surface. Although rare currently, it could also expand to include those that operate in outer space environments (Potter 2020). This is a uniquely eclectic field of research that encompasses multiple engineering and design aspects of the vehicles themselves in addition to a diverse and ever-growing array of practical applications of the technology.

Over the years, this diversity has been showcased across the content of this journal. Engineering-oriented papers have touched upon such topics as structural design, fabrication materials, propulsion, instrumentation, navigation and control, telecommunications, and human factors. Applications-oriented papers have spanned wildlife research and management, vegetation and habitat monitoring, forestry, various geosciences, agriculture, water resource sciences, archaeology, glaciology, meteorology and atmospheric sciences, emergency response, and civil engineering, among many other topics. Finally, the journal has also published many interesting and valuable works on societal aspects of the technology, including safety and incidents, regulations, public opinion and perceptions, economics, and collaborations with indigenous communities. Although content related to aerial vehicles has been dominant, the journal has also published occasional papers on ground vehicles, water-surface vehicles, and submersible vehicles.

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It has been fascinating to be part of this remarkably multidisciplinary community, where researchers from numerous fields intersect and evolve in harmony—except when it comes to one important thing: how we refer to our focal technology. Indeed, relentlessly inconsistent nomenclature has been an unfortunate hallmark of this discipline. At the time the journal was founded, the vast majority of researchers were using the term ‘unmanned’, but a debate was raging over whether they should be called ‘vehicles’ or ‘systems’; so the journal attempted to cover both bases by adopting the title *Journal of Unmanned Vehicle Systems*. But soon thereafter, a debate over changing the title was initiated by some who predicted the imminent demise of ‘unmanned’ and its universal replacement with ‘remotely piloted’ or ‘remotely operated’. This prediction of course did not come to pass, so the journal was wise at the time to abstain from transitioning to these alternative terms. An enlightening exploration of the nomenclature wars that have persisted in this discipline was presented by Granshaw (2018), who interestingly concluded that the prevailing term for the aerial variety of vehicles would be ‘unmanned aircraft system (UAS)’—to this day, ‘UAS’ appears unlikely to come anywhere close to challenging the longstanding dominance of ‘unmanned aerial vehicle (UAV)’ in the scientific literature (see below).

‘Unmanned’ is not socially acceptable

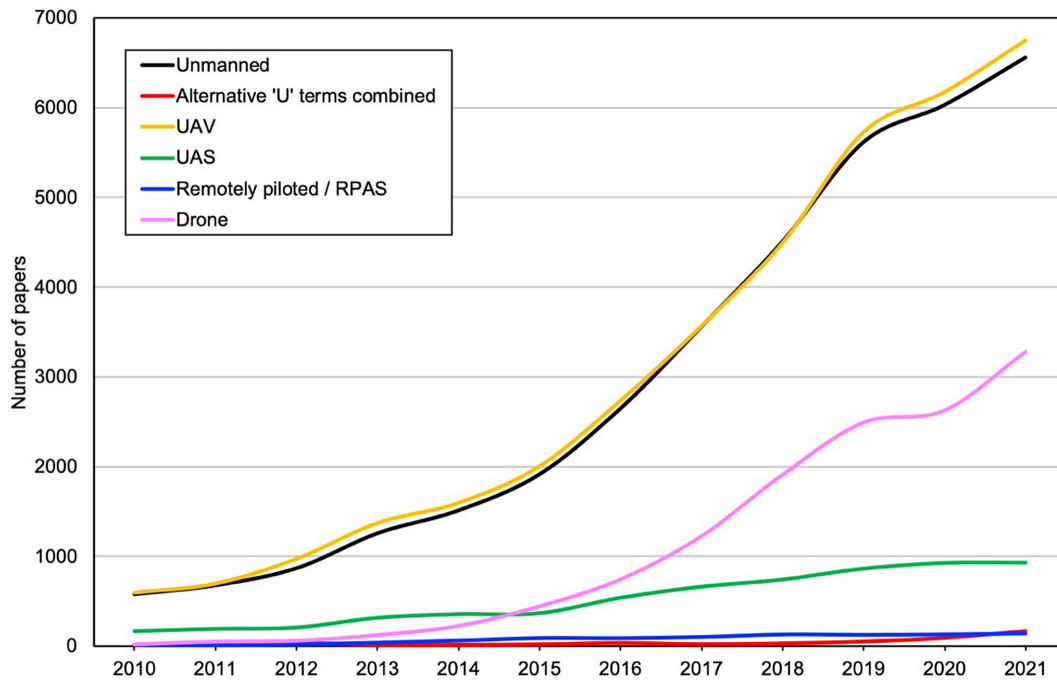
After holding fast for nine volumes as the *Journal of Unmanned Vehicle Systems*, the journal’s leadership decided it was finally time to adopt a new title. This decision was catalyzed by the work of Joyce et al. (2021), which provides a detailed synthesis of the importance of inclusive language as a foundation for diverse and inclusive societies and workplaces. Within that piece, a strong critical argument is made in favour of adopting gender-neutral terms within the scientific community, particularly recognizing current gender disparities in science and in citations. We do not wish to replicate the core arguments of that paper here—readers are referred to it should they wish to explore this more deeply. Instead, we are responding directly to Joyce et al.’s (2021) call for action that advances us towards a more open and inclusive scientific community.

Moreover, the publisher of this journal, Canadian Science Publishing (CSP), has put forth a policy that ensures equity, diversity, and inclusion (EDI) in all of its operations (<https://cdnsciencepub.com/about/diversity>). The policy pledges “to help build a more equitable, diverse and inclusive culture in science publishing” where everybody “can contribute to and benefit from scientific knowledge”. In discussion with CSP, the authors of this piece argued that it was necessary to revise the journal title as part of that EDI ambition, and the publisher agreed that changing the title would align firmly with its EDI goals.

‘Drone’ is the most prevalent alternative to ‘unmanned’ in the literature

To inform our selection of a new journal title, we performed a bibliometric analysis on the *Web of Science* of the relative frequency through time of several commonly or increasingly used terms and acronyms in the scientific literature: ‘unmanned’, ‘uninhabited’, ‘unoccupied’, ‘uncrewed’, ‘unpiloted’, ‘UAV’, ‘UAS’, ‘remotely piloted/RPAS’, and ‘drone’. We searched the *Science Citation Index Expanded*, the *Conference Proceedings Citation Index – Science*, and the *Emerging Sources Citation Index* for papers published from 2010 to 2021 containing these terms in their titles, abstracts, and (or) keywords. To avoid being overwhelmed with papers containing unrelated usages of the non-acronym terms, we searched this subset of terms (with the exception of ‘drone’) as follows: “— aerial” OR “— air*”. This consequently excluded non-aerial vehicles from the analysis, which go by a greater variety of names in the scientific literature. However, given that papers on aerial vehicles are far more numerous than those on their non-aerial counterparts, we deemed that this would provide an adequate overall idea of the relative prevalence of the terms.

Fig. 1. Frequency of various terms and acronyms used for aerial drones in the titles, abstracts, and (or) keywords of scientific papers published from 2010 to 2021 and indexed in the *Web of Science* (data last updated 5 October 2022). Precise search terms were as follows: “unmanned aerial” OR “unmanned air*”; “uninhabited aerial” OR “uninhabited air*”; “unoccupied aerial” OR “unoccupied air*”; “uncrewed aerial” OR “uncrewed air*”; “unpiloted aerial” OR “unpiloted air*”; “UAV” OR “UAVs” OR “sUAV” OR “sUAVs”; “UAS” OR “UASs” OR “sUAS” OR “sUASs”; “remotely piloted aerial” OR “remotely piloted air*” OR “RPAS” OR “RPASs”; (“drone” OR “drones”) NOT (“honeybee” OR “honey bee”).



For the term ‘drone’, to exclude papers on honeybees, we used the following search string: (“drone” OR “drones”) NOT (“honeybee” OR “honey bee”). Results would have included a small but relatively marginal number of papers on non-aerial ‘drone’ vehicles, again unlikely to significantly distort the overall picture.

The results of the analysis are shown in Fig. 1. Over the 12-year period, the terms ‘unmanned’ and ‘UAV’ have remained dominant over the others, showing an approximately elevenfold increase in frequency in virtual lockstep with one another, from just under 600 papers in 2010 to >6500 in 2021. ‘UAS’ has gained a significant and established following, but only appeared in 14% as many papers as ‘UAV’ in 2021 and has actually lost ground on this metric since 2010, when it appeared in 29% as many papers. ‘Remotely piloted/RPAS’ also has an established although much smaller following, appearing in only 2.2% as many papers as ‘unmanned’ in 2021 as its growth has stalled. Usage of the various alternative ‘U’ terms is virtually negligible relative to ‘unmanned’ but has increased over the last few years to 2.6% as many papers in 2021, led by ‘unoccupied’ (from 6 papers in 2018 to 76 in 2021) and ‘uncrewed’ (from 1 paper in 2018 to 59 in 2021), followed by ‘uninhabited’ (23 papers in 2021) and ‘unpiloted’ (11 papers in 2021). Interestingly, earlier on, ‘uninhabited’ was the dominant alternative ‘U’ term (e.g., 32 papers in 2012), but is now being overtaken by the others. Finally, ‘drone’ initially appeared less frequently than ‘UAS’, but overtook it in 2015 and has continued to pull away since. Notably, the frequency

of 'drone' relative to 'unmanned' has steadily increased from 3.8% in 2010 to a substantial 50% in 2021.

Based on these data, it is evident that 'drone' is by far the most prevalent alternative term to 'unmanned', and therefore in the strongest position to potentially catch up to and overtake it. Although use of the alternative 'U' terms has increased in frequency over the last few years, 'unmanned' is still very much dominant, and it is unclear at this time whether any of the alternatives are likely to break through. Moreover, there are multiple alternative 'U' terms gaining momentum, which means it is unlikely that we will gravitate to a consistent 'U' alternative in the near future.

'Drone' is technically correct

In addition to the issue of multiple competing 'U' alternatives, the currently leading term, 'unoccupied', is semantically problematic. Whereas 'unmanned' encompasses vehicles such as driverless cars and crewless ships that may carry passengers (research on which this journal welcomes) because to 'man' means to 'work at, run, or operate', 'unoccupied' explicitly implies no humans on board at all. For this reason, 'uncrewed' is a more accurate substitute, except that it is not yet a formally recognized word in the English language, merely a term specifically created as a replacement for 'unmanned'. Meanwhile, 'remotely piloted' is both clearly not a preferred alternative in the research literature and also semantically inadequate, as it excludes fully autonomous vehicles.

One term we did not include in the bibliometric analysis but that came up during deliberations over the journal's new title is 'robotic vehicle'. Semantically, it is an appealing potential substitute because it is not exclusive to a particular category of vehicle (i.e., air, ground or water), does not preclude passengers on board, and can encompass any mode of control (remote or autonomous). However, we decided against this term for the journal's title for the same reason we left it out of the bibliometric analysis: while it appears to have some recognition in the engineering community, it is scarcely used in the realm of applications, where the technology is overwhelmingly referred to as either 'unmanned' (or other 'U' terms), 'remotely piloted/operated' or 'drone'. Consequently, whereas the numerous applications-oriented contributors to the journal recognize *Journal of Unmanned Vehicle Systems* as an appropriate venue to publish their research, it is unclear they would feel the same about *Journal of Robotic Vehicle Systems*. Indeed, we were cognizant it could result in a sharp reset of the journal's perceived scope and focus, becoming a primarily engineering-oriented journal lumped in with the many other robotics journals. Furthermore, we were concerned about putting forward yet another alternative term that is ultimately unlikely to replace 'unmanned'.

'Drone', like 'robotic vehicle', does not specify the mode of control, does not preclude passengers on board, and can be used to refer to different types of vehicles beyond aerial. Indeed, the Oxford Dictionary includes the supplementary definition, "a remote-controlled or autonomous vehicle designed for use underwater or on land", and many examples of non-aerial vehicles referred to as 'drones' can be found in popular science articles: e.g., 'underwater drones' (Stanley 2016), 'drone ships' (Mizokami 2019a), and 'ground drones' (Mizokami 2019b). Thus, 'drone' emerged as the leading candidate for the journal's new inclusive title, based on its high prevalence in the research literature and its semantic accuracy.

'Drone' is popularly accepted in the wider community

Despite its overall popularity, there has long been resistance to adopting the term 'drone' in certain parts of the research community. Ironically, whereas a common argument against it during the first decade of this century was that it had ominous warfare

connotations, it is now commonly argued to be too colloquial and evocative of toys to be adopted as scientific lingo. Regardless of the terminology debate within the research community, the term ‘drone’ is, figuratively, the horse that has already bolted. It has been the most popularly accepted term within the wider community and the most globally recognized term for over a decade. Indeed, in many scientific papers, the more technical terms are often clarified with ‘drone’ in parentheses. In the popular science journal, *The Conversation*, a search for the term ‘unmanned aerial vehicles/systems’ produces articles that almost exclusively refer to ‘drones’ rather than that search term.

To those who contend that ‘drone’ is too colloquial for scientific writing, we counter that researchers *should* embrace a clear and widely understood term that is recognized by scientists, policy-makers, and the public alike. We are now working in an era where science is quite rightly required to speak to the public who fund it, and so there is a need for straightforward language to facilitate public communication of science. That can be done more easily if we adopt a simple inclusive term for our technology. In the words of [Chapman \(2014\)](#), the term ‘drone’ offers a clean, non-abbreviated, non-acronymic, “instant shortcut” through which communication with people outside of the industry or scientific community is enabled, meaning that we do not have to explain what we are doing because “they already get it”.

If researchers feel they must use a more technical term than ‘drone’ in certain situations, we suggest that ‘robotic vehicle’ is suitable due to its semantic correctness, but above all we call on researchers to desist from using ‘unmanned’.

‘Systems and applications’ reflects both the design and use of drones

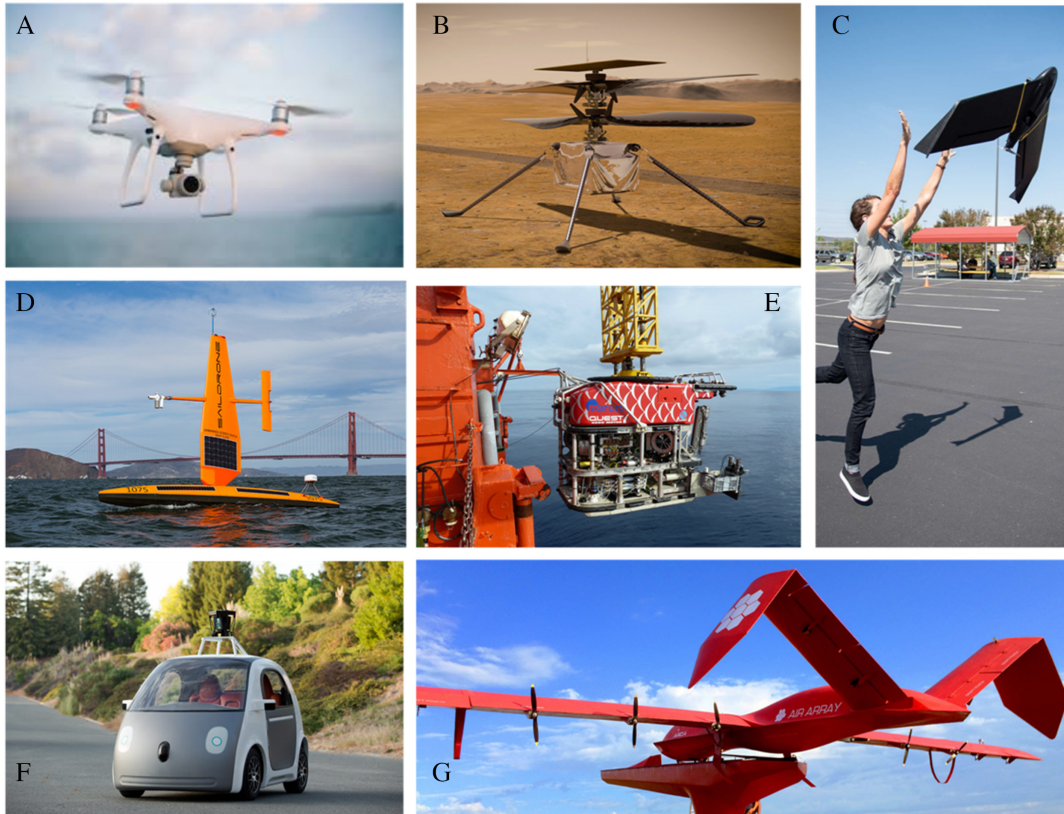
Beyond selecting a new term to replace ‘unmanned’, we used this opportunity to fully re-evaluate the journal’s title. While a major facet of the journal’s scope and roughly half of the content it publishes relates to applications of drones, the title *Journal of Unmanned Vehicle Systems* never adequately reflected this, coming across as more engineering-oriented. We therefore settled on the new title *Drone Systems and Applications*, with *Systems* preserving an element of the former title and representing the engineering and design facet of the journal, and *Applications* duly representing its other facet.

‘Drone’ as an umbrella term for all types of robotic vehicles

Through discussion with our editorial board about the shift to a new title, the greatest point of contention over using ‘drone’ was that researchers working with non-aerial vehicles may feel excluded; *Journal of Unmanned Vehicle Systems* was deemed to be more inclusive of all types of robotic vehicles. It seems that many researchers, perhaps especially in engineering-oriented fields, consider ‘drones’ to refer exclusively to aerial vehicles (common language dictionary definitions and popular science examples notwithstanding), have their own preferred terms for various non-aerial vehicles (e.g., rovers, gliders, ROVs/remotely operated vehicles, AUVs/autonomous underwater vehicles, etc.), and understandably do not want to feel forced to adopt new nomenclature.

We therefore propose the following compromise: researchers working with non-aerial vehicles continue to name them as they wish (preferably using ungendered, inclusive terminology) while at the same time the research community as a whole accepts ‘drone’ as a broad umbrella term/hyponym that encompasses all types of robotic vehicles. With this, we may finally arrive as close as can be hoped to a consensus (and gender-neutral) term for our collective technology.

Fig. 2. The diversity of drones: (A) lightweight commercial quadcopter (aerial drone) (B); NASA Ingenuity Mars helicopter (space drone); (C) hand-launched fixed-wing survey drone (aerial drone); (D) saildrone (water-surface drone); (E) underwater drone; (F) driverless car (ground drone); (G) large mechanically-launched fixed-wing reconnaissance drone (aerial drone).



For those who wish to fully embrace the term ‘drone’, we propose the following nomenclature:

- Aerial drones
- Ground drones
- Water-surface drones
- Underwater drones
- Space drones

These designations notably preserve the already-established terms ‘aerial’ (i.e., UAV/unoccupied aerial vehicle), ‘ground’ (i.e., UGV/unoccupied ground vehicle), ‘surface’ (i.e., USV/unoccupied surface vessel) and ‘underwater’ (i.e., UUV/unoccupied underwater vehicle), in addition to introducing a ‘space’ vehicle category.

Despite the title change and the views expressed in this editorial, *Drone Systems and Applications* will not be enforcing any particular terminology in submitted or accepted papers. Rather, it is our hope that the arguments presented in this piece and increasingly elsewhere will sooner than later persuade the full community to get on board with the use of inclusive language in this field of research.

We conclude by presenting Fig. 2 as a visual representation of the modern ‘drone’ in all its guises. We look forward to receiving papers from our broad community on any topic that engages critically with these varied drone technologies.

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