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Explaining 'Autonomous' Factor of UAVs

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As the name suggests, any unmanned aerial vehicle (UAV) can be flown without a pilot on board because they can be controlled remotely. Although the terms 'drone' and UAV are frequently used interchangeably. There is some debate about whether the 'cool' aerial tricks UAVs perform on their own qualify as autonomous flights or are simply self-flying or self-piloting actions. In the past, the terms 'autonomous' and 'self-flying' (or self-piloting) have been used synonymously, but with the industry moving forward a proper distinction between the two has become essential. If a UAV has obstacle avoidance sensors, it may have some autonomy over some of its routes when it takes off to fly in a circle, but it is simply self-piloting at that point. A drone will almost certainly never be completely autonomous, and it probably should not be.[1]

Hence there is a clear distinction between the two: while UAVs lack autonomous flight capabilities, 'Unmanned Autonomous System' (UAS), as autonomous UAVs are called, do have them. Although the term 'UAV' can be used to describe aerial vehicles used for commercial or non-commercial purposes, it is most frequently associated with military applications.

What is Autonomous System?

A system that is truly autonomous would be able to complete a specific set of tasks in a dynamic environment gather data about the surroundings, and operate for a considerable amount of time without human direction or intervention. Therefore, an autonomous system would be defined as a system that is capable of sensing, perceiving, planning, and acting without human assistance. Common examples are the use of autonomous mobile robots (AMRs) in warehouses and self-drive cars.[2] By putting safety measures in place, warning other drivers, and even assuming full control of

a vehicle, if necessary, autonomous systems lower the likelihood of collisions and accidents. For instance, self-driving cars are capable of detecting and responding to other vehicles, pedestrians, cyclists, construction zones, potholes, and traffic accidents. Most crucially, self-driving cars follow safety regulations that human drivers may neglect on purpose or accidentally.[3]

Advanced robotics and computing are combined with mechanical systems and sensors in unmanned autonomous systems. An autonomous vehicle is one that can sense its surroundings, navigate, and operate independently of human intervention. UAVs are the most popular autonomous vehicles that are already widely used.[4]

UAS are sophisticated, intelligent vehicles that can move through the air, land, or water without a human crew on board. UAS are adaptable machines with the ability to manoeuvre in a variety of, and occasionally hazardous, environments because of advanced computing, sensing, and electronic technologies, as well as mechanical design. To monitor threats to human lives and property, UAS can fly into the eye of a storm or into the path of a spreading wildfire, or other through remote areas to collect environmental data. Other uses for UAS include data collection and mapping, an inspection of hazardous waste, search and rescue, and entertainment. UAS cannot be remotely controlled by a person. UASs essentially carry out all of their operations on their own, including take-off, flight, and landing. UASs are flown using an on-board computer, sensor suite, and autopilot.

What is an autonomous UAV?

The term 'UAS' refers to both the UAV and the individual or group responsible for flight control on the ground, as well as the system that links the two (GPS, ground control, transmission systems, cameras, software, etc.). A UAS encompasses all of the components required for the UAV to function properly, as opposed to a UAV, which represents the specific vehicle. The development and functionality of UAVs are made possible by the complexity and numerous moving parts of a UAS. The technological level of unmanned systems has gradually increased with the growth of human knowledge.

An autonomous UAV is, by definition, a part of a UAS because it is operated by software rather than a person and is, by definition, a UAV that is piloted by software. UAVs are one type of UAS but not all UAVs fall under this definition. In the case of UASs, mission coordination and aircraft control are handled by communications management software as opposed to a person. An

'autonomous UAV' is a part of a UAS by definition because it is flown by software rather than a person and because it needs a full system to function.[5]

AI-powered software that controls the UAV and evaluates the collected visual data in order to navigate and drive. Autonomous vehicle technology combines AI-powered algorithms, specialised cameras, and sensors. These frequently consist of GPS, inertial navigation systems, lidar, radar, and sonar. In order to plot navigational paths and respond in real-time by stopping, accelerating, decelerating, and avoiding objects, self-driving vehicles analyse the data produced by these sensors.

The capacity to detect and recognise targets of interest in a non-dynamic and unknown environment is a necessary component for networks of autonomous vehicles. The success of these missions depends on the algorithms' capacity to handle the informational uncertainty of the dynamic environment and their capacity to deal with the potentially sizable amounts of communicated data that will need to be broadcast in order to synchronise data across networks of vehicles. A conflict-free task assignment across all vehicles has previously been created using centralised mission management algorithms, which have been developed because of their relative simplicity. To provide a consistent situational awareness from distributed sensors, these algorithms, however, frequently take a long time to respond to changes in the fleet and its surroundings and require high bandwidth connection.

Recently, decentralised decision-making algorithms have been presented that lower the amount of communication needed between agents and increase the system's robustness and reactivity to bandwidth constraints as well as fleet, mission, and environmental variables.[6] These technical improvements are anticipated to help proficient UAVs become even more competent.

Most current autonomous systems fall into the semi-autonomous category rather than the fully autonomous category. Semi-autonomous devices include robot vacuums, robotic surgery systems, and the majority of UAVs. Driver support systems in cars, such as 'lane-keep assist' and advanced braking systems, also fall under this category (UAVs and drones). However, most fully autonomous systems, including driverless cars, are still too expensive, data-intensive, power-intensive, or unsafe for widespread public use.[7]

SAE International, formerly known as the Society of Automotive Engineers, is an international professional association and standards body. By networking and training mobility specialists, it

primarily focuses on the aerospace, automotive, and commercial vehicle sectors, enabling safe, clean, and accessible mobility solutions. The U.S. Department of Transportation has since adopted SAE International's six levels of driving automation, which were developed in 2014.[8]

(a) Level 0: No driving automation
(b) Level 1: Driver assistance
(c) Level 2: Partial driving automation
(d) Level 3: Conditional driving automation
(e) Level 4: High-driving automation
(f) Level 5: Full driving automation

It would actually be considered level 5 autonomy for a UAV to be able to operate completely without any human intervention. However, the majority of commercial UAVs do not yet function entirely on their own. At this time, the level of autonomy is restricted to following a predetermined course or set of waypoints and returning to the home location once the flight is finished. Even in this case, the technology for commercial UAV use is still in its infancy, necessitating the use of a pilot to maintain the UAV. As a result, most UAVs have attained level 1 autonomy and are working their way up to level 2.

Autonomy of level 5 is assumed when dealing with UAS, but can human intervention be totally detached? According to Air Marshal Vinod Patney, former Vice Chief of Air Staff of the Indian Air Force, "UAVs have a wonderful future, expanding in popularity and utility, but no machine can match the human gift of discovery and situational awareness." The first known air-to-air conflict took place in December 2002 between an American Predator UCAV and an Iraqi MiG-25 equipped with a Stinger missile. They each launched a missile towards the other. The UAV was shot down, and the video downlink confirmed this. A fighter jet has a better chance of scoring an air-to-air kill due to its superior placement, speed, and manoeuvrability.[9]

In order to give autonomous technologies ever-higher levels of autonomy, advanced technologies like AI, memory, networking, and high-performance computing are collaborating. Vision systems and sensors interconnect, and memory and networking technologies are also becoming more sophisticated. Drones, robots, and driverless cars all immediately come to mind when discussing autonomous applications. The ability to gather information about their surroundings, process it, understand it, and take action on it is often what they all have in common. An autonomous machine's ability to think for itself independently is, of course, what distinguishes it

from a straightforward remote-controlled or programmable gadget. The level of autonomy of unmanned aerial vehicles is increasing as increasingly complicated mission scenarios are anticipated.[10]

When working with UAVs, safety comes first. In order to prevent mid-air collisions, UAVs must be programmed with 'detect and avoid' capabilities that are comparable to those of manned aircraft. Therefore, drones must be able to recognise probable collisions and steer clear of them.

Conclusion

UASs are very popular because they eliminate the risk of human error and the overhead of piloted UAV systems. But all UAVs are not autonomous. Intelligent unmanned autonomous systems are complex systems created by the fusion of various technologies related to mechanics, control, computers, communication, and materials. The way industrial and critical infrastructure sites perform routine maintenance, supervise safe and secure operations, ensure business continuity after severe weather and other incidents, and maintain compliance are all being changed by autonomous industrial UAVs.

There are many different kinds of intelligent UAS developing, and they will have a big impact on society and daily life. In recent years, issues with maintenance and safety, as well as the reliability of UAVs, have all taken on a significant amount of importance. This is due to improved avionics and more durable engines. Despite this, the attitude toward the dependability of drones remains overly fatalistic. Naturally, we believe that the lack of a pilot or other person on board does not permit us to build and realise the UAV with less strict requirements than those used for aeroplanes, based on dependability evaluations that are already available. From a different angle, highly developed UAV systems have a 25 percent overall failure rate. The difficulty is in extending a drone's dependability while optimising maintenance procedures.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])

Notes:

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[7] Blackberry, n. 2.

[8] Rambus, n.3

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