RAIN+
Fact or Fiction

DRONE SWARMS: FACT OR FICTION?

The video Slaughterbots depicts a dystopian near-future where swarms of inexpensive drones use artificial intelligence and facial recognition to kill innocent civilians *en masse*. Released in 2017, the video advocates for a ban on autonomous drone swarms. But are we really moving towards a world in which autonomous killer swarms are set loose on defenceless populations? Rain+ ETHICS dives into the world of swarming and separates fact from fiction.

Have militaries carried out swarm attacks?

Let's start by looking at whether there is any evidence of swarm attacks on record. That would at least determine whether we are talking about the current reality or a theoretical future possibility. On 6 January 2018, Russia's Khmeimim airbase in western Syria was attacked by 13 drones. The attack was thwarted by the Russian air defenses, but it marked the first drone attack popularly identified by close observers and the international media as having been carried out by a swarm.

A similar attack occurred in September 2019 when a group of 25 Iranian drones attacked the state-owned Saudi Aramco oil facilities at Abqaiq and Khurais. The attack was particularly noteworthy because the advanced Saudi air defense system failed to stop the drones. Half a year later Turkey launched the first deadly group drone attack. A coordinated mass of drones struck the Syrian army in March 2020, killing 19 people. Again it was reported as a drone swarm attack.

But did the drones actually swarm in these cases? Not really. The group drone attacks to date do not constitute true swarms because the drones did not demonstrate the distributed intelligence that would enable them to fly autonomously. These drones were unable to either coordinate amongst themselves or with their environment. Instead, the drones showed a basic level of collaborative autonomy that enables operators to use them for coordinated attacks. This can best be described as a basic swarm. Nevertheless, the attacks against the Saudi oil facilities and the Syrian Army demonstrate that basic swarms can do a lot of damage. Moreover, to people on the ground any group of small incoming drones will look like a drone swarm. This provides a psychological advantage that will likely be exploited by other countries in the near future.

What is a drone swarm?

A drone swarm is a collection of unmanned platforms capable of flying and coordinating autonomously to accomplish a shared objective. This capability is underpinned by artificial swarm intelligence that models the collaborative behaviour exhibited by insects, birds and fishes (also referred to as biomimicry). Within a swarm, drones may have different roles and functions. For example, drones equipped with high-tech sensors and machine vision algorithms can identify potential targets. Other weaponised drones can then rely on this information to strike the target.

There is a difference between centrally controlled and decentralised swarms. In centrally controlled swarms, one or multiple operators coordinate a group of drones by giving it central commands. Drones can be controlled separately, but it is also possible that a single operator controls multiple drones. These can be referred to as basic swarms because there is no or limited interaction between individual drones in the swarm. In contrast, **decentralised** swarms have no single leader to coordinate tasks. Instead, individual drones decide collectively how to coordinate and execute missions. Each drone can essentially fly itself using on board artificial intelligence to maintain formation and coordinate with other drones. This is also called *distributed intelligence*. Decentralised swarms are most controversial because they can be operated without the need for human control.

Why do militaries want drone swarms?

The point of swarming is that swarms are greater than the sum of their parts. More specifically, swarms offer militaries three key strategic advantages. First, swarms are **scalable**. It is easy to change the swarm's size depending on the mission. If a counter drone system can withstand 200 units, the swarm can be increased to 300 and so forth. The individual drones can also quite easily be replaced. Especially when the swarm consists of small and relatively cheap platforms. Second, swarms are adaptable, which means they can be used for many types of missions. Third, swarms are resilient. If a single node in the swarm is shot down, others can take over. This capability is particularly relevant when drone swarms are used in contested areas. With their speed, numbers and intelligence, swarms can be used for indoor mapping, overwhelming enemy (air) defences, aerial combat (dog-fights), and for intelligence, surveillance and reconnaissance missions.

Which countries are leading the development of drone swarms?

Eight countries are currently developing military drone swarming technology: China, US, UK, Turkey, India, Russia, Spain and Israel. The US leads the development of swarming technology, with China probably as its closest competitor. Military swarms are not yet operational, but testing is underway. The US Defense Advanced Research Projects Agency (DARPA) is developing the **X-61A Gremlin Air Vehicle**, which is equipped with distributed intelligence. The Gremlin UAV can be launched and recovered in-flight by its carrier aircraft, but **tests** with aerial docking have so far been unsuccessful. Another high-profile US swarming project is conducted by the US Air Force Research Lab, which is developing the **Golden Horde** swarming munitions. In this case the swarming technology is applied to bombs instead of UAVs, but the idea is the same. A test in November 2020 demonstrated how the swarming bombs could coordinate with each other after launch and respond to changes in the battlefield.

In the meantime, China is also experimenting with swarming technology. The China Academy of Electronics and Information Technology (CAEIT) tested a swarm of 48 weaponised CH-901 UAVs. In a **test video** we see how a truck launches the drones. Subsequently, an operator directs the drones to strike a target. It is unclear, however, whether the swarm is underpinned by distributed intelligence. More recently, the Indian army **demonstrated** a heterogeneous swarm of 75 small to medium-size drones at the Army Day 2021 parade. The drones simulated a range of offensive missions, including kamikaze strikes and cargo drops, without the need for a human operator intervening. These are just a few examples of the projects currently being explored. For a complete overview of military swarming projects, please visit RAIN+ Industry.

Are drone swarms a threat?

While swarming is often mentioned as a key future capability for armed forces, it is most often discussed as a looming threat for civilians. Armed, fully autonomous drone swarms, capable of locating, identifying and attacking without human intervention raise obvious ethical and legal questions. How can we trust anyone with this technology? A more pressing fear is that rogue actors and terrorists will exploit less advanced and **relatively cheap** swarming technology to commit large scale and highly effective attacks against civilians. Whether this is a realistic possibility or some science fiction B movie scenario, the fear of terror drone swarms has sparked a mini-boom in the sale of anti drone systems as well as the development of anti-AI.

Concluding analysis

Drone swarms are no fiction. However, fully autonomous decentralised swarms do not yet exist. The recent drone attacks carried out by Turkey and Iran demonstrate the proliferation of collaborative drone technology, but we have not yet seen true swarming intelligence in military operations. Yet, several countries are busy testing increasingly advanced decentralised swarms. The question is not if but when we see the first use of these swarms in combat.

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