DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Use of Water for Counter Unmanned Aerial Systems (C-UAS)

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The Defense Systems Information Analysis Center was asked to identify if there have been any studies on using water for a counter-unmanned aerial system (C-UAS). C-UASs are divided into two primary areas—detection and tracking systems and interdiction. One example of interdiction being used for a C-UAS is a water projector, or water cannon. A water cannon was used at the 2016 U.S. Air Force Research Laboratory's Commander's Challenge to bring down a drone during a C-UAS exercise. The Navy is using water cannons and water barrier lines to defend their platforms against high-speed, sea-skimming, antiship cruise missiles. The wall of water provides a low-cost, universal defense system for Navy ships and can potentially be applied to C-UAS. Other water technology utilized for firefighting and antipiracy also has the potential for C-UAS use.

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The Defense Systems Information Analysis Center (DSIAC) is a DoD IAC sponsored by DTIC to provide expertise in nine technical focus areas: weapons systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

A chief service of the DoD IACs is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry jointly conducted by DSIAC.

ABSTRACT

The Defense Systems Information Analysis Center was asked to identify if there have been any studies on using water for a counter-unmanned aerial system (C-UAS). C-UASs are divided into two primary areas—detection and tracking systems and interdiction. One example of interdiction being used for a C-UAS is a water projector, or water cannon. A water cannon was used at the 2016 U.S. Air Force Research Laboratory's Commander's Challenge to bring down a drone during a C-UAS exercise. The Navy is using water cannons and water barrier lines to defend their platforms against high-speed, sea-skimming, antiship cruise missiles. The wall of water provides a low-cost, universal defense system for Navy ships and can potentially be applied to C-UAS. Other water technology utilized for firefighting and antipiracy also has the potential for C-UAS use.

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1.0 TI Request

1.1 INQUIRY

What studies have been done regarding the use of water to counter drones or drone swarms?

1.2 DESCRIPTION

Water mitigation techniques have been used for countering drones and drone swarms. The inquirer asked for more detail on any counter-unmanned aerial system (C-UAS) using water (i.e., water cannons). C-UAS is divided into two primary areas—detection and tracking systems and interdiction. One example of interdiction being used is a water projector, or a water cannon.

2.0 TI Response

The Defense Systems Information Analysis Center (DSIAC) was asked to identify if water is being used for C-UAS use. DSIAC searched open-source data and the Defense Technical Information Center's repository to compile information.

Water cannons, or water projectors, are currently being used for C-UAS purposes. Other technology used by the U.S. Navy and other organizations for antipiracy and firefighting could also be applied to C-UAS.

2.1 WATER CANNONS

One example of interdiction being used is a water cannon, also known as a water projector [1]. Chenega Europe is producing a handheld water projector for C-UAS [2]. In 2016, the use of a water cannon to down an Immersion Vortex 250 drone was demonstrated at the U.S. Air Force Research Laboratory's Commander's Challenge [3].

Water cannons are a potential nonlethal technique that can be used for C-UAS [4]. Current systems target toward firefighting and antipiracy applications for commercial shipping vessels but are limited to a 50–100-m range. Norway's firefighting systems tested what they claim is the world's largest water cannon for maritime firefighting [5]. Although a fire monitor is a fixed, high-capacity water cannon designed for firefighting purposes, it can be used against pirate attacks. Typically, water cannons used for this purpose can discharge water over 10+ m. The firefighting systems can throw water up to 200 m at over 18,000 gallons per minute. These are large systems only suitable for fixed installation or use on large ships, which must use their

motors for station keeping when the system is in use. This technology could have future applications for C-UAS.

Another use of water cannons that could be applied to C-UAS involves antipiracy technology. A water cannon countermeasure used for antipiracy features a remote-controlled water turret that operates like a fire hose in suppressing and forcing away pirates [6]. The intended use is to flood the skiffs. However, it was determined that the pirates would eventually try to avoid this. Within the model, the water cannon forces skiffs out of its range. The water cannons act on one skiff at a time, causing them to flee the ship's proximity. Each of the six water cannons is created individually and tracks its own tasking.

2.2 WATER BARRIER LINE

The Naval Surface Warfare Center Dahlgren Division has investigated technology for the Office of Naval Research that has the potential to be very effective in defending Navy platforms against high-speed, sea-skimming, antiship cruise missiles (ASCMs) [7]. This technology uses a new kill mechanism—a wall of water—to provide a low-cost, universal terminal defense system for Navy ships. The water barrier, or wall of water, is generated from the shallow detonation of multiple underwater explosive charges to protect the ship from attacking sea skimmers. This terminal defense concept can be employed to slow or stop debris and warhead fragments from missiles killed at short range to preclude significant damage to the ship. Furthermore, the water barrier would defeat the fusing and structure of ASCMs that have penetrated the inner self-defense layer.

To support the development and evaluation of the water barrier concept, underwater detonation tests of scaled line charges were conducted in July 1995 to determine the amount of water ejected into the air by the subsurface detonation of continuous and discrete line charges [8]. The above-surface plumes were generated by the underwater detonation of Composition C-4 demolition blocks that were configured into continuous line charges 30–56 ft long. Plumes were also produced from the sequential underwater detonation of discrete line charges that consisted of five to eight 10-lb charges separated by 5 ft and fabricated from C-4 demolition blocks. Line charge depths and horizontal separation of discrete charges were chosen to maximize the amount of water ejected into the air.

2.3 OTHER WATER TECHNOLOGIES

A commercially advertised pirate curtain system consists of a combination of fire hoses used to flood pirate skiffs and erratically flailing hoses with weighted ends that can cause bodily harm to individuals scaling the side of the vessel [6].

Water curtains have been used for defense against chemical attacks and piracy and for stealth in cloaking a ship's signature. There is currently not a specific technology for using water curtains in C-UAS, but a heavy water curtain would potentially badly affect small UASs [9].

Antipiracy fire hoses are modelled on Unifire's antipirate water cannons system [10]. Typical installations on commercial vessels include six water cannons, three each for the port and starboard side. These cannons can be remote operated or automated through integration with a radar system. They fire up to 50 liters of water per minute, at a pressure of 10 bars, and with an effective range up to 90 m. These hoses can be used to keep pirates at bay by using the pressure exerted to keep them outside a critical range, or, against smaller skiffs, they can be used to quickly fill and sink the attacker's vessel. These are also active defense systems because they must also be engaged prior to the pirate attack. This technology could also have potential for future use in C-UAS.

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