DVIDS/U.S. Air Force photo by Staff Sergeant Sean Martin/4076143

A Counter Rocket, Artillery, Mortar weapon system is fired on Kandahar Airfield, Afghanistan, 13 January 2018. It could also be used to counter drones.

The Rise of the Drones: Technological Development of Miniaturised Weapons and the Challenges for the Royal Canadian Navy

by Patrice Deschênes

Introduction

The proliferation and miniaturization of drones of all kinds, but especially the mini-aerial drones, is a hot topic among tacticians of Allied navies who are aware of the increasing vulnerability of their naval forces; a vulnerability for which they are not ready to face. Yet the threat is not new. For at least ten years, ground forces have been confronted with the growing use of mini-drones by non-state actors.

In the conflicts in Syria and Iraq in particular, at least half-a-dozen militant groups have been observed operating drones available commercially, and sold at relatively-low prices in any neighborhood electronics store. Today, even the poorest fighting groups can impose their presence upon the battlefield's airspace and command effective engagements against better armed ground forces. Conventional ground forces were taken aback by this threat to the point that a US Special Forces officer, Lieutenant Colonel Joe Salinas, said that US forces in Syria had effectively lost control of the airspace below 3,500 feet.[1]

For as little as $500.00, terrorist groups can purchase a range of easy-to-operate drones from local retailers, then turn these recreational objects into rudimentary, but no less effective, guided bombs. ISIS used drones with high-definition cameras (usually included with the drone) to remotely guide vehicles filled with explosives to their targets. During the liberation battle of Mosul in Iraq in July 2017, dozens of Iraqi troops were killed or wounded, and combat vehicles were destroyed by grenades and small bombs parachuted by mini-drones.[2] Today, the threat is no longer limited to the battlefields of the Middle East. It is proliferating all over the globe.

Examples of security breach incidents related to commercial UAVs have increased in recent years, with incidents that have highlighted the serious vulnerability of certain strategic facilities and important individuals. For example in 2013, the *Pirate Party*, a German political party, flew a drone without being challenged or intimidated, close to Chancellor Angela Merkel during an outdoor event. Even more frightening, drones have been observed several times in the vicinity of French nuclear installations.[3] Had either of those drones been controlled by terrorist groups, the German head of state could have been easily assassinated, or a possible nuclear disaster could have been unleashed in the heart of France.

The Canadian Press/AP Images/Khalid Mohammed/14338312

An Iraqi officer inspects drones belonging to Islamic State militants in Mosul, Iraq, 27 January 2017.

Aris Messinis/AFP/Getty Images/653711600

A photo taken 14 March 2017 in the northern Iraq city of Mosul shows a drone carrying two grenades in a test flight by Iraqi forces, who plan to use it against Islamic State (IS) group fighters.

Warships are no longer immune to the threat of miniature UAVs, even when moored to their comfortable and secure berths inside highly protected and fortified bases and arsenals. Drones were seen above the Kitsap-Bangor nuclear submarine base in Washington State,[4] and a small *Phantom IV* drone landed on the flight deck of the British aircraft carrier HMS *Queen Elizabeth* in August 2017.[5] Once again, one ill-intentioned individual could have inflicted material damage or even casualties.

Asymmetrical Tactics

Drones available on the market can be modified to become lethal weapons, but they can also be used for a wider range of tactics.

Indeed, drones can be used as a tool for monitoring and collecting information. Equipped with high-fidelity cameras, they can be used by an enemy to obtain precise and detailed information with respect to infrastructures, sensitive equipment, details regarding the surveillance and protection of a target, routine human activities, and targeting information. In an urban environment, the $500.00 mini-commercial drones can provide a potential enemy an excellent level of imaging fidelity without having to invest $400 million in sophisticated imaging satellites.

Drones can also be used to disperse chemical or biological agents in an urban environment. A panoply of commercial drones designed to irrigate agricultural fields is easily accessible, and they would not require any significant modification to disperse toxic agents; an easy and inexpensive way for a terrorist group to create chaos.

Used by state actors, mini drones can also be used as tools for collecting electronic information and collecting other miscellaneous information.

Detection, Tracking, Identification, Neutralization

Mini-drones represent a real danger for naval forces because they are practically impossible to detect at a distance which would allow a complete and effective decision making process. They have minimal radar signatures, and are extremely difficult to detect, even with the naked eye. When detected, mini-drones can be so close to ships or port facilities that their detection has an effect of surprise. And the time required to track them, identify them, and confirm their intentions is pushed to a minimum before the naval protection forces feel compelled to undertake defensive action. This chronological reduction of the decision chain can have serious consequences, including collateral damage, since a decision with respect to the action required to be taken against the detected drones has the potential to not be supported by adequate and relevant information, and to prevent the proper application of a command and control process.

Unlike ground troops in a combat theatre, naval forces usually operate in densely populated urban areas in times of peace. Warships are usually moored in ports frequented by the public and civilians, especially when moored during diplomatic calls. These characteristics make the engagement and the neutralization of mini-drones difficult because they pose a high risk of collateral damage. The prosecution and engagement of a drone in flight with small arms involves the release of a volley of ballistic projectiles without control or precise destination in the air over a distance

Ships operate in densely-populated areas, which makes the use of hard kill/small arms defence against drones impractical, due to the risk of collateral damage.

of up to 700 metres. For visualization purposes, 700 metres can be pictured as twice the width of the Ottawa River separating Quebec from the Canadian Parliament in Ontario. In the event that a force protection team engaged a mini-drone while a ship was alongside, the civilian population in the neighborhoods surrounding the port and the boaters on the harbour would be at risk of becoming victims of collateral damage.

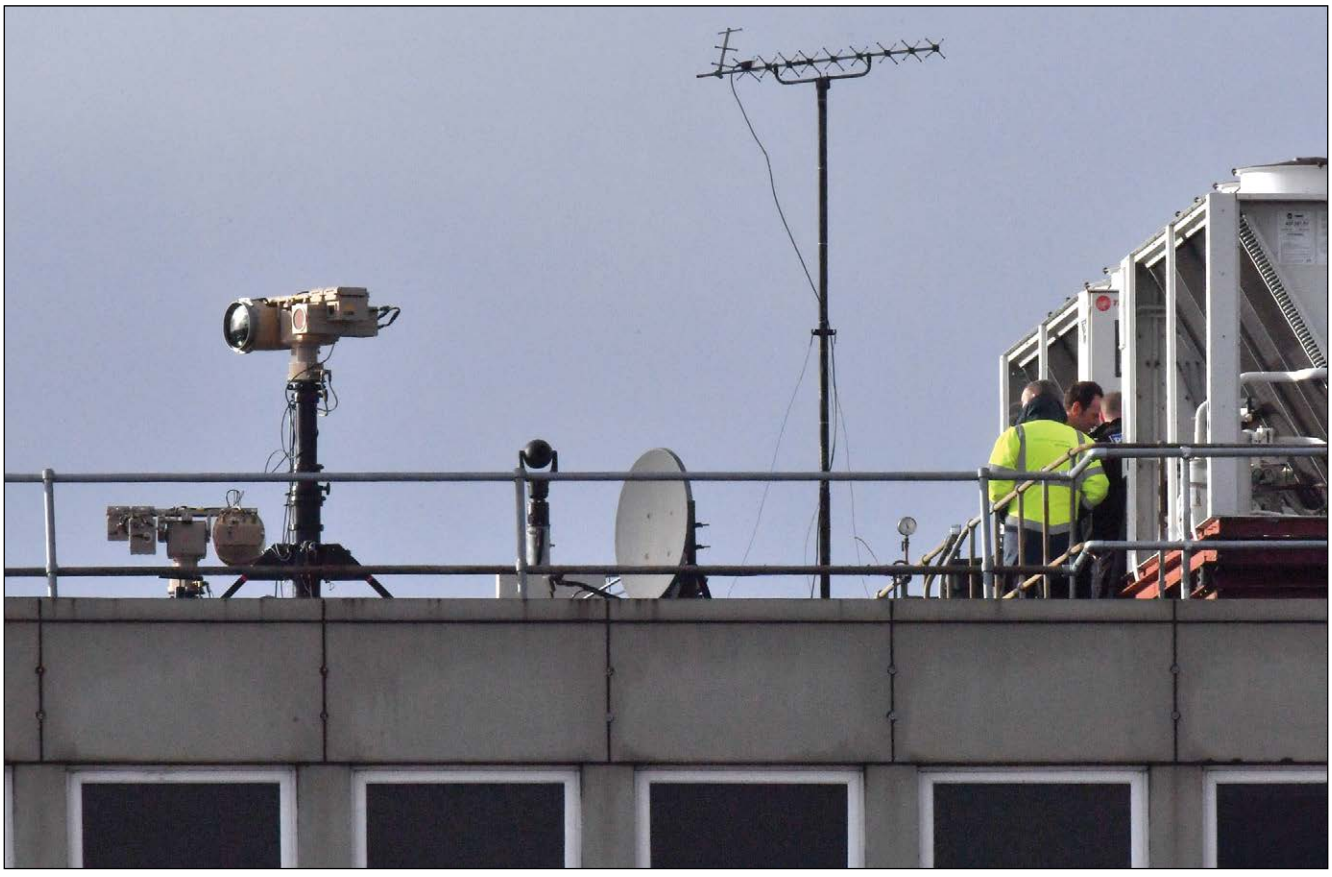
Considering the difficulty with respect to detecting and engaging a single drone, a coordinated attack of several drones would become impossible to counter with the means available today on Canadian warships. The technology that enables a coordinated attack by a swarm of drones already exists, and it is available on the market. New algorithms able to synchronize the flight of several UAVs that are able to sense the position of each other in the sky, and fly in coherent units, have already demonstrated their effectiveness. One particularly spectacular demonstration of drone synchronization was made at the Olympic Winter Games in Pyeongchang, when 1,218 perfectly-coordinated drones have illuminated the opening ceremonies in 2018.

In a naval force protection context, only two-to-five unmanned drones, synchronized and equipped with small quantities of explosives, would be enough to seriously damage one of our state-of-the-art frigates, injure or kill sailors, and put out of commission a ship for an indefinite period of time. Considering that the Royal Canadian Navy (RCN)'s fleets of combatant ships do not have more than four operational vessels per coast at any given time, a single drone attack, for an investment of as little as $ 5,000, would have the potential to incapacitate 25% or more of the RCN's combat capability in the Pacific or Atlantic for a potentially-protracted period of time.

Available Solutions

The market for products available to counter mini-drones is flourishing. The industry has exploded in recent years, and today, there are more than 230 drone detection and defence systems produced by 155 companies in 33 countries.[6] Despite this sudden explosion of available products, the proposed systems, for the most part, have not reached the technological maturity required, or are not suitable for use on board warships in urban centres. Indeed, various systems have been used at various locations and events such as the Boston Marathon, and others, at some airports, and on the periphery of military bases, but they do not provide a satisfactory solution for effective protection of a naval force alongside. In short, the systems on the market suffer from a problem of 'over promising but under delivering.'

The various detection systems, from active radars to acoustic sensors, camera and infrared systems, all have their share of limitations in urban environments that result in the same problems of late detection of the threat, and a high risk of collateral damage. Today, the most effective detection of a possible drone attack is through an early warning from the intelligence services, and the neutralization on the spot of terrorist networks before they can deploy their drones.



John Stillwell/PA Images/Getty Images/1074518728

Counter-drone equipment deployed on a rooftop at Gatwick Airport, which had been closed after drones were spotted over the airfield for two days in December, 2018.

Blighter Surveillance Systems/ http://www.blighter.com/images/images/pr/auds-counter-drone-system-without-stamp-high-res.jpg

AUDS is a counter-drone system designed to disrupt and neutralize unmanned aerial vehicles.

The means available to neutralize mini-drones are also inappropriate for navies. Radio frequency jammers affect the civilian population, and they are not effective, with *some* features being only available on *some* drones, concentrated energy beams have not reached the maturity necessary to neutralize flying objects quickly enough, and nets and other less-lethal means are not effective against the threat of swarm attacks. In short, warships *calling at* or *operating near* the coast or inside a port are today extremely vulnerable to the threat of mini-drones.

To the Research and Development Drawing Boards

Ceasing diplomatic stopovers, installing protective nets around ships in ports of call, or banning and restricting the sales of mini-drones are not acceptable solutions to the threat. The private sector and our research and development centres must 'get down to business' and develop technology and ways to counter the threat of mini-drones adapted to the context of warships.

To do this, innovators must consider the following factors in the development of their system concepts. First, detection systems must be able to detect unidentified flying objects at an appropriate distance, while preventing the risks of electromagnetic interference and other radiation hazards in urban centres. To do this, a hybrid detection system including one-or-more active and passive sensors, combined with electro-optical sensors capable of recognizing characteristic shapes, should be adapted for use on board a ship. In addition, these sensors should be integrated with a combat management system (CMS), (preferably the vessel's CMS), to optimize the decision chain, maximize the threat engagement envelope, and enable a layered defence concept.

Secondly, a mini-drone neutralization system should take into account that naval operations susceptible to the threat of mini-drones take place in urban centres, which creates a high risk of collateral damage, especially when the threat is airborne. Such a system should not be limited to the engagement of a single mini-drone, but should be designed to be able to neutralize a swarm of drones (five-or-more). Simpler solutions, such as the use of restricted-range munitions from remotely-controlled and highly-stabilized weapon systems, combined with advanced electronic systems to take control of drones, should all be explored in order to put in place a system of layered defence.

Conclusion

The rise of the mini-drones is just beginning, and the threat associated with it will only increase. The Royal Canadian Navy and other navies around the world are very vulnerable to mini-drones, and will have to develop effective means of defence *sooner* rather than *later*. The probability of a drone attack occurring today is much higher than the probability of having to defend against an anti-ship missile attack. And yet, the resources allocated to research and development of defence against the threat of mini-drones at this time are negligible. A single successful attack on a Canadian ship has the potential to decommission at least 25% of the RCN's fleet combat capability for an indeterminate period of time, and also to generate a number of civilian casualties.

The existing technology is not adapted to the conditions of operations of warships, and a major research and development effort remains to be initiated. It is strongly suggested that the appropriate resources and efforts be allocated to developing a complete detection and defence system for the Royal Canadian Navy.

Lieutenant-Commander Patrice Deschênes, CD, MDS, *a Naval Warfare Officer, holds a BA in Political Science and a Master of Defence Studies from the Royal Military College in Kingston, and is presently the officer in charge of developing force protection and surface warfare tactics at the Canadian Forces Maritime Warfare Centre in Halifax. Lieutenant-Commander Deschênes deployed to the Persian Gulf during Operation* Augmentation *and Operation* Apollo.

Business Wire/ https://mms.businesswire.com/media/20180117005738/en/635584/5/DroneKill2a_2.jpg?download=1

A quadcopter being shot down with a Liteye/Orbital ATK T-Rex system at the U.S. Army's Maneuver Fires Integrated Experiment, Fort Sill, Oklahoma.

NOTES

1 Andrew Clevenger Tweet: "LTC Joe Salinas, Army spec ops, tells DIB that because of drones, forces returning from Syria say US doesn't control airspace below 3,500 feet," 24 October 2017, at: https://twitter.com/andclev/status/922829571644325890?lang=en

2 W.J. Hennigan, "Islamic State's deadly drone operation is faltering, but U.S. commanders see broader danger ahead," 28 September 2017, at: www.latimes.com/world/la-fg-isis-drones-20170928-story.html

3 "More drones spotted over French nuclear power stations," Agence France-Presse, 31 October 2014, at: https://www.theguardian.com/environment/2014/oct/31/more-drones-spotted-over-french-nuclearpower-stations

4 Hal Bernton, "Who flew drone over Bangor submarine base? Navy wants to know." 25 February 2016, at: https://www.seattletimes.com/seattle-news/crime/whos-flying-drones-over-bangor-submarine-base-navy-wants-to-know/

5 "Tiny drone lands on *Queen Elizabeth* aircraft carrier," 12 August 2017, BBC News, at: http://www.bbc.com/news/uk-scotland-highlands-islands-40910087

6 Arthur, Holland, Michel, "Counter-Drone Systems," Center for the Study of the Drone at Bard College, February 2018.