Chinese UAVs and Emerging Counter-UAV Technologies

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Warfare is a complex phenomenon and, thus, new technologies and counter-technologies are developed regularly by nations to maintain a qualitative edge over the adversary. One of the fields that has seen far-reaching development has been the unmanned systems or the Unmanned Aerial Vehicles (UAVs). The evolution began with having an early warning as well as reconnaissance system and graduated to armed machines capable of engaging targets in real-time while being controlled from hundreds of kilometres away. Besides having greater endurance, this also eliminated the human element from the combat zone.

Chinese UAVs

In India's neighbourhood, China has undertaken rapid strides in development of UAVs. It has been developing a series of sophisticated reconnaissance and armed UAVs over the last decade. Many of its designs are said to be based on reverse engineering of Western UAVs. With increased reliance on unmanned systems in the battlefield and in localised wars, the Chinese UAVs are in great demand due to their lower costs. The Chinese CH-4 UAVs have been recently employed by Iraq in its war against the Islamic State in Syria (ISIS). A number of CH-3s were sold to Nigeria in 2013. According to a Pentagon Report, China plans to produce almost 42,000[1] land and sea-based unmanned systems by 2023. China has unveiled a number of UAVs and Unmanned Combat Aerial Vehicles (UCAVs) in the last three

to four years. Li Jian (Sharp Sword) was the first stealth UAV which undertook its maiden flight in November 2013. The UAV resembled the Russian Mikoyan Skat and the US Navy's X-47B. Powered with a jet engine, the UAV is capable of carrying two bombs in the internal weapon bay.

Non kinetic means of disabling UAVs are gaining prominence.

China's recent unveiling of the largest UAV in Divine Eagle (Shen Diao) showcases its technological leap in stealth technology. Developed by Shenyang Aircraft Corporation's 601 Institute, it is a high altitude UAV having seven anti-stealth radars and is likely to form part of China's early warning line to detect stealth aircraft like the F-22, F-35 and B-2 and cruise missiles. The seven radars provide 360° coverage, including an X/UHF Airborne Moving Target Indicator (AMTI), Active Electronically Scanned Array (AESA) radar on the front, two X/UHF AMTI/SAR/GMTI AESA radars on the twin booms, two X/UHF AMTI AESA radars on either side of the engine nozzles, and two more radars on the end of the booms.[2] The Divine Eagle has a single engine nestled between its tailfins, with a diameter of over one metre (m). By some estimates, it is 6 m in height and 15 m long, with a wingspan of 35 m.[3] Having a five-wheel landing gear, it is capable of operating up to an altitude of 7,500 m with an endurance of over 12 hours. One of the reasons for a double body configuration instead of single fuselage like the Global Hawk, is utilisation of interferometry.[4] Due to air turbulence, it is difficult to maintain a fixed distance between two radar receivers. The connected fuselages serve as interferometers to detect longer wavelength L-band electromagnetic waves (an interferometer increases the resolution or clarity of the returned signal without compromising the range of the radar. It is used to measure small displacements, refractive index changes and surface irregularities). Thus, an interferometer can be used to detect stealth aircraft. A group of Divine Eagle UAVs can form a grid and, thus, are likely to be employed for this role against the American stealth aircraft.

Fig 1

The China Aerospace Science and Technology Corporation (CASC), also known as the 701 Research Institute, has been developing the CH

(Cai Hong) series of UAVs. Its latest UAV, CH-5 undertook its maiden flight in August 2015. Modelled on the US Reaper MQ-9 design, the CH-5 is the heaviest attack UAV. With a wingspan of 20 m, it has a 900 kg payload capability and weighs upto 3 tonnes.[5] The CH-5 is equipped with a wall penetrating radar enabling the ground station to identify targets behind walls or inside buildings, giving the UAV 80 km target detection capability. It can carry up to 8 AR-1 missiles and 2 FT-7 small diameter bombs[6] while having up to 1,000 km operational range and flight endurance of 30 hours. Its predecessor, the CH-4 can carry over 350 kg of armament with five AR-1 missiles and two FT-5 bombs. It has a take-off weight of 1.3 tonnes and a wingspan of 18 m. A CH-4 UAv was used by the Iraqi Air force to destroy an ISIS gun position in the Battle of Ramadi on December 06, 2015. The other notable recent UAVs the Chinese inventory are the Soaring Dragon and Wing Loong II. The Wing Loon II UAV was showcased in September 2015 and can carry 12 air-to-surface missiles. Having an operational ceiling of over 9,000 ft, it has a payload capacity of 480 kg. The Soaring Dragon has an operational ceiling of 60,000 ft and is being developed for both intelligence gathering and armed roles.

Fig 2

Soaring Dragon UAV

Fig 3

Wing Loon UAV

Indian efforts to develop an indigenous UAV have met with partial success. The Defence Research and Development Organisation (DRDO) is now developing the Rustom class of UAVs. The Rustom 2 is a Medium Altitude Long Endurance (MALE) UCAV which may have an endurance of 24 hours and a payload of over 350 kg.[7] India has recently expressed its interest in purchasing 100 armed and surveillance drones[8] from the US to guard against frequent incursions by Chinese troops. India is seeking to buy the Avenger armed UAV and Predator XP surveillance UAV. Capable of flying at speeds

upto 400 knots, the Avenger has an operating ceiling of 50,000 ft and 18 hours endurance. It can carry 1,600 kg of armaments in the internal weapons bay and an additional 1,300 kg on the six external hardpoints. The main armaments are Hellfire missiles with a range of 8 km, GBU-39 small diameter bombs weighing 110 kg with a Circular Error Probability (CEP) of 5 to 8 m and GBU-12/16 JDAM (Joint Direct Attack Munitions) bombs with a CEP of 1.1 m. The Predator XP has an operating ceiling of 25,000 ft and an endurance of 35 hours. It is a multi-mission UAV having a Beyond Line of Sight (B-LOS) data link and capable of auto take-off and landing.[9] It is equipped with multiple Intelligence, Surveillance and Reconnaissance (ISR) systems with infrared thermal cameras and multi-mode radar which offer day and night search capability.

Counter UAV Systems

The US Army's annual exercise "Black Dart", is a live fly and live fire counter UAV exercise aimed at developing counter UAV technologies. Held since 2002, it has enabled generation of ideas and spanned technological advances in this field. As the usage of UAVs increases in the battlefield, new technologies are being developed to reduce their influence and to render them potentially ineffective of causing any damage. The biggest challenge lies in detection, identification and then destruction of hostile UAVs by kinetic or non-kinetic means. The threat is now magnified with easy availability of small, micro or mini UAVs/ drones in the commercial market which are capable of flying low and can be used for terror activities by packing them with explosives and used in Kamikaze style to crash on the intended target. Static installations, high-tech bases or important buildings can be potential targets. With increased application and development of micro and mini UAVs and use in swarms over the intended target, radars have become the most important link in detecting and identifying UAVs. Thus, non-kinetic means of disabling UAVs are gaining prominence and most of the new systems rely on this thought process. Given the surveillance systems available, it will soon become easy to disable any approaching drone or UAV by integrating available sensors with emerging counter UAV technologies.

One of the first such systems tried successfully in 2014 was the High Energy Laser Mobile Demonstrator (HEL MD) for destroying an incoming UAV. Mounted on an all terrain truck, the system successfully destroyed mortars and UAVs by firing a 10 KW high energy laser beam at the target. The present anti-UAV systems

being developed and available rely on a wide range of technologies ranging from disruption of the command network, jamming or destruction of the incoming UAV. One such counter-UAV systems developed by Airbus[10] for protection of static installations functions on the jamming principle. The system detects intrusion from hostile UAVs and provides electronic counter-measures. It analyses signals from different sensors by using operational radars, infrared cameras and direction finders to assess the drone/ UAV and its threat potential. Once the UAV is deemed as hostile, the system can jam the UAV operator's Radio Frequency (RF) and microwave control link. Having a range of 5 to 8 km, it is likely to be available by mid-2016. The other similar counter UAV system available is the 'Falcon Shield Electronic Warfare System'. Developed by Selex Electronic System, Essex, the system enables its operator to detect, locate, identify, and defeat[11] the security threat posed by an intruding drone. The system uses a long range electro-optical surveillance and reconnaissance system, coupled with high definition infra-red thermal imaging camera to detect, track and identify drones. It relies on an electronic warfare platform that enables the operator to take control of intruding drones and land them safely. The Iranians used similar technology in 2011 to take control of a Sentinel UAV and managed to land it within Iran.

The anti-UAV defence system from Blighter Surveillance Systems uses radio beams to interfere with the incoming UAV's command link. It fires a four watt directional radio beam at the UAV, which is more powerful than its control link and, thus, causes the UAV to crash. It is effective against the micro UAVs up to a range of 2 km.[12] Researchers at the Michigan Technological University are working on a drone catching unmanned aircraft. Dubbed as the Robotic Falcon,[13] it shoots a net at the intruder drone approaching any sensitive installation from a distance of about maximum of 40 ft. The incoming drone gets entangled in the net and is, thus, disabled. As the net is attached to the Robotic Falcon, the intruder drone can be retrieved and moved to a designated location and rendered harmless. As the anti-UAV systems are expensive and consist of a number of sensors, a low cost system developed is the Battelle anti-drone gun. Named as the "Drone Defender", it is a portable rifle like raygun device which fires a radio beam upto a distance of 400 m to disrupt control systems to disable the drone.

Conclusion

As the counter UAV challenge increases and new systems are now available to mitigate this challenge, a seamless integration of all systems, visual, acoustic and

electronic, is required to protect vulnerable military and civilian installations. One of the simplest findings of Exercise Black Dart was that "no single technology can defeat the UAVs". Military planners will have to balance costs with technology and data overload to detect, identify and neutralise UAV threats.

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Notes

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2. Jeffery Lin and PW Singer, "China Flies its Largest Ever Drone: The Divine Eagle", February 06, 2015. Available at http://www.popsci.com/china-flies-its-largest-ever-drone-divine-eagle
3. Jeffery Lin, "A Closer Look at China's Divine Eagle Drone", July 10, 2015. Available at http://www.popsci.com/ closer-look-chinas-divine-eagle-drone
4. It is an investigative technique in which electromagnetic waves are superimposed to extract information about waves.
5. China Military Online, "China's Biggest UAV Makes Flight". Available at http://english.chinamil.com.cn/news-channels/china-military-news/2015-09/02/content_6660961.htm
6. The AR-1 missile has a range of 10 km and a 1,000 mm armour penetration capability. It weighs 10 kg. The FT-7 precision guided bombs weigh 130 kg and have a range of 90 km.
7. Neelam Mathews, "India's Own MALE UAV to Fly Soon", AINOnline, November 05, 2015. Available at http://www.ainonline.com/aviation-news/defense/2015-11-05/indias-own-male-uav-fly-soon
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13. "Drone Catcher: Robotic Falcon Can Capture, Retrieve Renegade Drones", January 08, 2015. Available at http://www.newswise.com/articles/view/645752/