COUNTERING THE EMERGING CIVIL DRONE THREAT

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By

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Defining UAV Threat.

On 25 Jan 2015 , a small Unmanned aerial vehicles (UAV) Quad- copter which weighed about two pounds, operated by a hobbyist crashed in White House at around 3 a.m. after its operator lost control its control. The White House radar system which is designed to detect flying objects like planes, missiles and large drones failed to pick up a small drone.[1]

Similarly, in April 2015, a small drone with some radioactive material was recovered from the roof of the office of Japanese Prime minister Shinzo Abe who that time was in Indonesia. No one was injured but, its landing time was not detected.[2]

As per a recent media report,in India during past two years, there has been three sightings of drones near civil aircrafts. On 28 Jan17, a serious near miss was reported by a pilot of Go Air aircraft which while approaching to land at Mumbai airport spotted a drone flying at 12000 feet AGL horizontally separated from the civil flight by just 2 km. This is potentially a dangerous flight safety situation which mortally risked the life

[1]https://www.nytimes.com/2015/01/27/us/white-house-drone.html?_r=0
[2]https://www.theguardian.com/world/2015/apr/22/drone-with-radiation-sign-lands-on-roof-of-japanese-prime-ministers-office

of the air passengers. Number of similar near collisions has been reported by International Air Transport Association (IATA) worldwide between manned aircraft with drones.[3] Nearly 100 UAV sightings are reported every month by the manned aircraft in their vicinity. Hence, flight safety is a major concern with unregulated UAV flying.

Terrorist Use of Drones/RPV's

The other issue that has seized the attention of the security experts world over is on the possibility of use of civil drones by terror groups, inimical elements and criminals. Sensitive sites such as airports, oil and nuclear facilities, borders, prisons, and stadiums are all vulnerable to hostile or accidental intrusion by small drones and require careful security planning and preparation for such an incident. This possibility is high as complete knocked down Kits (CKD) of drones are available any time off the shelf from several online sale sites. Already Hezbollah, ISIS and in Ukraine rebels and pro-government forces in Ukraine are using drones against their adversaries. With advent of drones, the threat of deploying the dirty bombs / chemical /biological weapon by the terrorists has become more potent.

The risk in flight safety and security caused by unmanned aircraft will continue to grow if unmanned vehicles are allowed to proliferate in the civil without proper regulatory mechanism and protective security apparatus in place. The existence of regulatory mechanism will discourage the terrorist group to use drones for their ulterior purposes.

There is a need to have an informed assessment of the threat, lay down national policy and procedures for own safe

[3]Times of India 29 Jan 2017

drone operations in civil domain with minimum constraints so that the new technology is fully exploited by the civil government and business entities, as well as identify counter drone systems and technologies to neutralize the emerging threats.

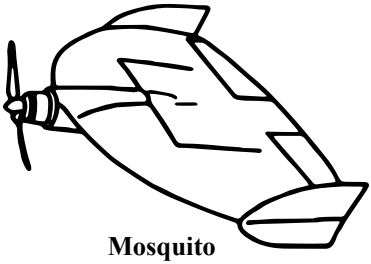
Classification of Drones

That terms like Drone , Remotely Piloted Vehicle (RPV), Remotely Piloted Aircraft (RPA), Unmanned Aerial vehicle (UAV) and Unmanned Aerial System (UAS) are the different nomenclature for the unmanned aircraft and have been use in different times but, all these terms mean the same. Secondly, there is no one standard when it comes to the classification of RPA's. These can be classified by various parameters such as their size, endurance and range,maximum altitude,wing loading, engine type and power and thrust load. Since the study pertains to the counter measures against the RPA's threat, the size and altitude of operation and speed would be the relevant factors for consideration. U.S. Department of Defence (DoD) has classified UAV's according to their size as follows :- [4]

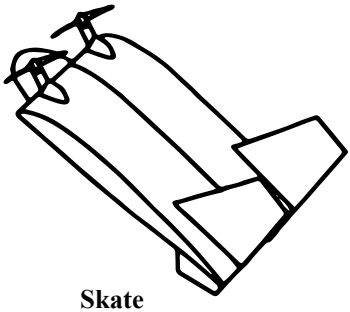
(a) Very small UAV's
    (i) Micro or Nano UAV's
    (ii) Mini UAV's
(b) Small UAV's
(c) Medium UAV's
(d) Large UAV's

[4] DGCA draft rules circulated in apr 2016 have classified the UAV,s as per their weight .These range from Micro UAV,s which are less than 2kg in weight to large UAV.s with their weight greater than 150 kg .

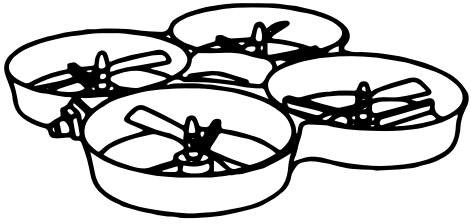
Very Small UAV's. Micro and mini unmanned aerial vehicles are the smallest in UAV technology with dimensions ranging from the size of a **large insect to 30-50 cm long.** These drones can fly at low altitudes that are below 300 meters. These micro and mini UAVs can carry little and lighter things such as listening and recording devices. Transmitters and cameras can also be carried by mini UAVs. Micro UAVs are smaller as compared to mini UAVs. The weight of the mini UAVs is less than 30 kilograms and is best suited for commercial applications. Security agencies can use these for spying etc.



Mosquito



Skate



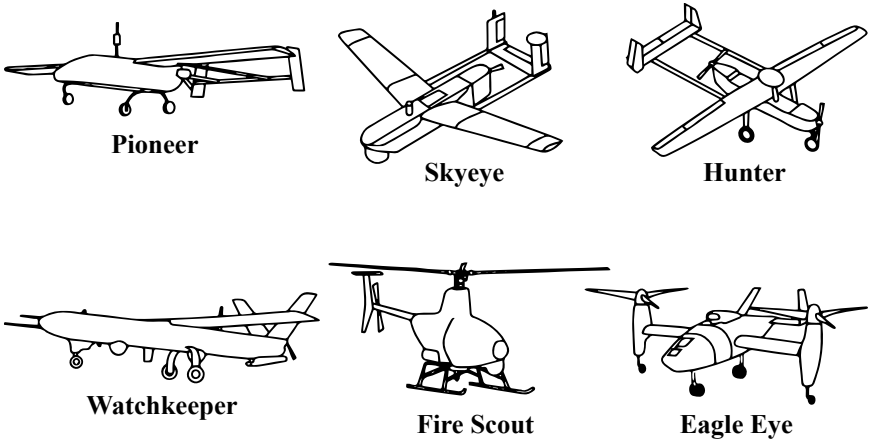
CyberQuad Mini

Examples of very small UAVs

Small UAV's. The Small UAV class applies to UAVs that have at least one dimension greater **than 50 cm and no larger than 2 meters**. Many of the designs in this category are based on the fixed-wing model, and most are hand-launched by throwing them in the air. This class includes UAVs that have a range of 5 km and endurance time of 20 to 45 minutes e.g. Raven, Dragon eye

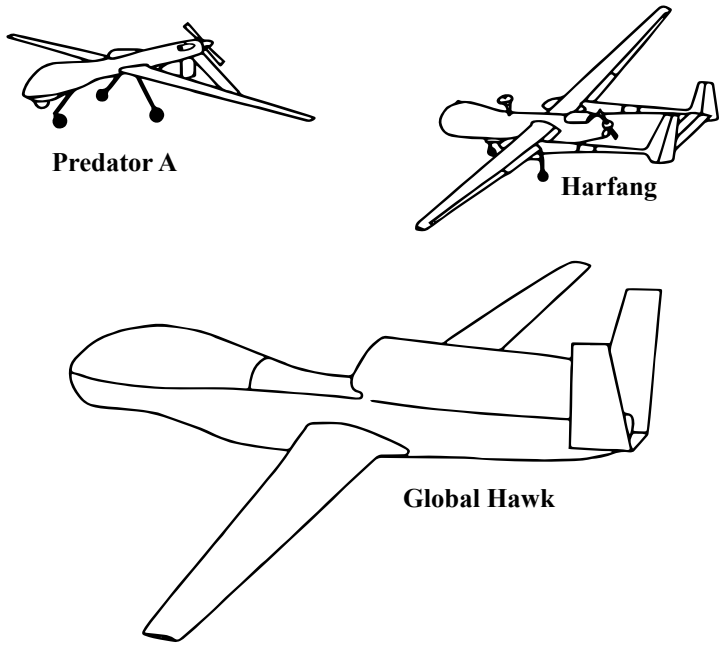
Hand-launched small UAV

Medium UAV's. The medium UAV class applies to UAVs that are too heavy to be carried by one person but are still smaller than a light aircraft. They usually have a **wingspan of about 5-10 m and can carry payloads of 100 to 200 kg**. They are mainly utilized for reconnaissance and surveillance purposes and have ranges **50- 150 km.**



Examples of medium UAVs

Large UAV's. The large UAV class applies to the large UAVs used mainly for combat operations by the military. Examples of these large UAVs are **the US General Atomics Predator A and B** and the **US Northrop Grumman Global Hawk**. [5]



Examples of large UAVs

Future UAV's. These UAVs are still in experimental and testing stage. In the commercial realm of space, we already have unmanned vehicle of Space X and Orbiter Sciences carrying out cargo supply missions to International space Station .Transportation of astronauts too is on anvil in future.

[5] https://www.e-education.psu.edu/geog892/node/5

Civil /Commercial Use of Drones

Use by Government Public Entities. Notwithstanding the Military roles,in time to come, the Government agencies / public departments and business entities are expected to use drones in big way due to their efficacy, efficiency and lower economic cost. In fact, these can become efficient tools for governance to deliver the government products / benefits to the citizens. For these, small unmanned aircraft which fly at low altitudes and slow speeds to others that are very large and have large wing span and fly at medium to high altitude would be employed. Today,numerous civil uses have been developed and still more are emerging. In west, UAV's are being used for safety inspections of infrastructure, such as rail tracks, dams, dykes or power grids. National authorities are using them in disaster relief, e.g. to overfly flooded areas or to support firefighting. Government of India is also exploring the option of using UAVs for works like surveillance in large establishments such as refineries, secure oil pipelines from being broken or stolen, crime detection etc.[6] The features and characteristics of UAV's depend on the roles for which these are employed. Some of the roles in which drones are currently employed are explained below:-

(a) **Surveillance role**. Law enforcement Agencies like police is likely to employ to drones to keep an eye for criminals/ undesirable elements to give security cover to events /dignitaries/ crowded areas. Often Quad-copter which have hovering ability are employed at heights at 100mtrs or even lower.

(b) **Land Survey.** Small in size (wing span 110 cm (43.3 in), height of operation up to 120 mtr with cruise speed 40 -110 km.

[6] http://indianexpress.com/article/india/india-news-india/govt-mulling-to-regulate-unmanned-aerial-vehicles-to-combat-terror-threats-home-secy/

(c) **Crop productivity/Insurance**. In time to come, drones would be employed to map the crop productivity as well as to estimate crop losses due to natural calamities or other reasons. Recently launched Pradhan Mantri Fasal Bima Yojna has permitted use of drones to assess the crop losses to grant compensation– They are likely to use small drones/ Quad-copters equipped with cameras.

(d) **Electric lines /Pipeline Inspection.** Hand launched or sling launched small drones will operate at low altitudes and at low speed to assess the physical condition of the assets.

(e) **Disaster Relief**. Drones can become valuable resource for assessing the damage caused by natural disasters and extent of relief required. This task can be performed by small drones and quad-copters equipped with cameras and flying at low level or hovering over the affected places.

Use by Marketers and Businesses. Apart from the government agencies / public departments, the businesses and marketers too have shown keen interest in UAV's. These can particularly help in quick delivery of the products as well for security surveillance of their facility and warehouses etc.

In a competitive business environment, UAV's will help the marketer / business to cut the product cost by reducing the operating cost with efficiency and timely delivery of the product. A customer would always like to be associated with a company's whose product has better quality,cheaper and the company enjoys efficiency tag against its competitor. In United States Amazon, Wal-Mart and several other retailers are desirous to use the drones for delivery of their products. As on now, U.S. Federal Aviation Authority (FAA) has granted

permission to the Amazon to conduct research for a proposed drone-delivery programme. Under this programme, Amazon has been allowed to fly drone up to 400 feet high and at up to 100 miles an hour over its private property and with in sight of the remote-control pilot or a designated observer. The research is for Amazon Prime Air,for a proposed 30-minute delivery service.

Similarly, Wal-Mart has sought permission to test drones for making deliveries to customers in its parking lots and at customers' homes, The exemption request said Wal-Mart's distribution system "could become more efficient and consumers could be better served." Following these companies, several companies in U.S. are seeking exemptions from the FAA which presently prohibits their use for this purpose.[7]

Another area where drones have already made impact is the field of advertising /films and tourism industry. In the tourism industry, drones have made a mark by presenting the customers innovative and affordable aerial photographs and videos. These help to motivate the prospective customers.[8]

Indian marketers are not going to remain far behind in their quest for efficiency and to bring their costs down. However, at this stage the a entire plan for carrying out drone assisted delivery is still at nascent stage.

Characteristics of Marketers Drones

The drones used by marketers for the product delivery (till this moves in a big way) are expected to be small Quad-copters

[7] http://www.usatoday.com/story/money/2015/10/26/walmart-wants-to-use-drones-to-deliver-packages/74646996/

[8] https://skytango.com/how-drones-are-changing-tourism-marketing/

class[9] with capability to deliver small size parcels with weight up to 4-5 kgs Such drones are expected to fly at lower heights say up to max 5oo feet high at speed lesser than 100 miles an hour with in sight of the remote-control pilot or a designated observer. The machine would navigate with radio control exercised by the operator or autonomously as per the way points set on GPS. The machines are so programmed that if these lose contact with its pilot or GPS signal, it must return to predetermined locations so that the safety of the population at large is not jeopardized.

Areas of Concern.
Full exploitation of the drones in the civil is still far away. Their use is presently constrained mainly due to the near absence of regulatory mechanism in the world including India. At this stage of development of the technology. The other concerns relates to the security, privacy of citizens and lack of technical viability of its use by the marketer, Because of their peculiar characteristics, the traditional defence as against a manned fighter may not work against drones hence, some innovative solutions are required.

Flight Safety. Absence of regulatory mechanism/ laws for operation of drones and UAV's have become a major safety concern for the manned flights. Due to this, in most countries the use of drones in civil is forbidden or highly restricted.

Civil flights are regulated by the civil aviation rules as laid down by the international conventions of International Civil Aviation Organization (ICAO) and domestic regulations. ICAO is a specialized agency of the United Nation which regulates and coordinates the international air travel. In its

[9] Walmart will use Chinese-made DJI drones. Thefiling. DJI, Parrot and Delair Tech are three of the larger drone companies worldwide.

Chicago Convention, ICAO has established rules for the air space, aircraft registration and safety which are followed by all signatories. With in the own air space, flights follow the rules laid down by DGCA which are necessarily in conformity with ICAO rules. No such rules have been laid down by the ICAO or any other international body/ convention for the unmanned aircraft. In fact, ICAO in article 8 of the convention actually forbids the flights of pilotless aircraft in the air space of other nations without specific authorization and if permitted it should be so controlled to obviate danger to the manned civil flights.[10]

The reason for this restriction is that unlike manned civil flight, UAV's / drones cannot communicate or report their in flight positions nor these possess navigational aids which are essential to maintain separation from other aircraft. These machines intend using the same air space which is being used by the manned aircraft but lack means to comply the conditions applicable by the manned aircraft thus,their unregulated operations will pose serious flight safety risks as both will use same airspace. This situation highlights the urgent need to regulate flying of the drones just like manned aircraft to usher an order in their operation, safety and security. To tackle the dangerous flight safety situations, Indian aviation regulatory authority in India, the Directorate General of Civil Aviation (DGCA) has imposed ban on drones till relevant rules are in place but, the prohibition is rarely enforced and drones are widely used and continue to cause flight safety situations.

The absence of the regulatory mechanism also facilitates their misuse by the terrorists and undesirable elements, who can easily procure it and use it for their nefarious purposes.

[10] http://www.icao.int/publications/Documents/7300_orig.pdf

The rule making is a very complex process, since strict rules or banning their flights can be retrograde step and would restrict beneficial exploitation of UAV's for use of the mankind. Therefore, the need is to strike the right balance in their use and safety so that growth in this emerging industry is not constricted.

At best there are fragmented regulatory mechanisms in some states and some others like India have issued draft regulatory proposals. These is a need to have an international agreement/convention under the aegis of United Nation to lay down rules for universal acceptance just like regulations for the manned civil flights with states replicating these with national laws/rules for domestic operations. Stake holders also opine that an enabling legal framework should be introduced with step by step approach, gradually allowing operations, starting from simple operations and growing in operational complexity. Such rules must be compatible with ICAO standards and should be based on international consensus. This would put operators in a position to gain varying practical expertise and progressively develop their businesses.[11]

Presently, NASA relies on unmanned cargo ships to send supplies to International space station (ISS). For this unmanned cargo ships of Space X and Orbital Sciences are being used. Future missions will even carry astronauts for the space station thus; it is just a matter of time that unmanned aerial vehicles will be used both for transporting cargo and astronauts to ISS. Already UCAV are being used effectively to target the terrors threats. All round use of UAV's for civil tasks is also on the anvil in near future. But before this happens, means/systems will have to developed so that drones have

[11] https://www.easa.europa.eu/system/files/dfu/Communication_Commission_Drones.pdf

the ability to follow the security and safety rules and regulation for operation like the civil manned flights such as conforming to Air Defense, ATS clearances procedures, conforming to restriction on flying near the border and avoiding flying over the prohibited areas/zones as promulgated from time to time.

Drones Threat from Anti-national elements and criminals. In our country, the security establishment is alive to the potential drone threat to the public security. During Independence day or similar celebrations, detection devices are deployed to detect the drones or any other airborne threat to the VIP's or congregated public at large. West too is conscious of this threat. The common fear is that drones could be weaponized and converted to an autonomous flying Improvised Explosive Devices (IEDs) by the terrorists /terror groups with intent of harm the population. The threat is viable as the UAV's / Drones can be procured off the shelf by anyone interested.

Possible Illicit Use of Drones.

The drones can be used both by the criminals and inimical powers/ terrorists to commit the followings illegalities:-

Criminal Activities

(a) Public Nuisance.
(b) Air Space Interference.
(c) Infringement of privacy of a person.
    (i) Surveillance.
    (ii) Reconnaissance.
(d) Smuggling.
    (i) lethal-weapons and projectiles.
    (ii) Non-lethal(narcotics).
(e) Kinetic / Kamikaze attack on the chosen targets.

Terrorists Activities

(a) Kinetic / Kamikaze attack on the chosen targets.

(b) For dispersing Weapon of mass Destruction (WMD).
   (i) Chemical.
   (ii) Biological.
   (iii) Radiological/ Nuclear.
   (iv) IED/ Explosives.
   (v) Electronic Attack

The researchers, Ryan J Wallace and John M Loffiin their study have listed several illegal uses of the UAV's. These range from causing nuisance by monitoring / surveillance/ reconnaissance of the private person/ property (this is a criminal activity and likely to elicit fear in some one's mind) to airspace interference which can lead to a serious flight safety situation and put the life of scores of passengers at premium. The terrorist could even use the drones for kamikaze kind of attacks.

The drones could also be used by smugglers to transport contrabands or their lethal or non lethal loads without exposing their presence. Even the smallest of UAV can carry up to two kgs of RDX. One can well imagine the potential damage a UAV can cause if it is detonated.[12] Many however, discount its possibility as the handling of weapon of mass destruction require specialized knowledge. But, the threat can never be discounted especially in dispersing chemical weapon. A particularly novel threat presented by drones is their potential to be used as platforms to commit an electronic attack or electronic theft. The UAV can be equipped to digitally hijack

[12] http://indianexpress.com/article/india/india-news-india/govt-mulling-to-regulate-unmanned-aerial-vehicles-to-combat-terror-threats-home-secy/

a smart phone's wireless signal and gain access to personal information contained on the device. Quite obviously such a technology would be in demand by the intelligence agencies as well as the terrorists[13]

As on now there is no evidence of large scale use of drones by terror groups but, Hezbollah the terror group based in Lebanon is known be regularly sending low flying drones into Israeli airspace. These drones are launched and remotely manned from the Hezbollah stronghold in Lebanon and presumably supplied by its patron and strategic partner, Iran.[14] Similarly, ISIS is also known to use some basic form of drones in Iraq and Syria. These robotic planes give ISIS a de-facto air force for use against their targets.

In Ukraine too, both Ukrainians and Russian-backed separatists are operating UAVs in relatively large numbers. They are reportedly operating more than a dozen variants including fixed- and rotary-wing configurations, each functioning at different altitudes with various sensor packages.[15]

Therefore, there remains a strong possibility in future, with terrorists using the drones for executing terror acts or for snooping on their targets using drones of various types whose sizes vary from large to as small as that of insects. Recently, a new aerial threat has emerged in form of multi-rotor drones, or quad-copters. These are cheap, easy to operate, and the largest models can carry a load, which could potentially

[13] An article ," Examining Aerial System threats and defences :PA conceptual analysis." by Ryan J Wallace and John M Loffi(2015) http://commons.erau.edu/ijaaa/vol2/iss4/1

[14] Article Next Arb Israeli war will be fought with Drones https://newrepublic.com/article/117087/next-arab-israeli-war-will-be-fought-drones.

[15] http://www.nationaldefensemagazine.org/archive/2016/august/Pages/MilitaryMustPrepareForUnmannedAircraftThreat.aspx

be explosives and even weapons of mass destruction i.e. biological and chemical weapons and even radioactive “dirty” bombs.[16]

UAVs seem attractive to terrorists for the following reasons:-

(a) Possibility to attack targets that are difficult to reach by land (cars loaded with explosives or suicide terrorists).

(b) Possibility of carrying out a wide-scale (area) attack, aimed at inflicting a maximum death rate on a population (particularly, through the use of chemical or biological weapons in cities)

(c) Covertness of attack and flexibility in choice of a UAV launch site.

(d) Possibility of achieving a strong psychological effect by remaining incognito.

Evidence suggests, that often places crowded by people: mass gatherings, highly populated city areas, public transportation at rush hour, etc. are generally targeted by the terrorists to maximize the number of victims and to create maximum chaos and panic in public. It is estimated that use of drones to explode even a small improvised bomb in these areas would cause more fatalities with large dispersion than suicide bomber in a crowded place, whose impact will be somewhat shielded by victims in front.

Experts also opine that an aerial vehicle is an ideal tool for deploying biological or chemical weapon. Using a UAV would permit the terrorist to disperse aerosol over a wide area more efficiently than through other means of delivery. The computer

[16]https://fas.org/wp-content/uploads/2014/06/Hezbollah-Drones-Spring-2014.pdf

simulation has established that just 900 gms of weapon grade Anthrax dropped from the drone upwind can infect 90 % of the population of a large city. Similarly, it would be unrealistic to exclude a scenario in which terrorists use radiological ("dirty") weapons with explosives using a drone/RPV. Many experts however, are skeptical about the ability of a "dirty" bomb to cause mass fatalities but, these positively will create chaos and the area would need to be sanitized which is a huge task.[17]

Other Risks/ Limitations

Technical Viability. The short battery life, weather, unreliable location data, aggressive birds and the risk of packages being intercepted by thieves or shot down are some of the hurdles which are cited by the marketers. Moreover, flying over densely populated areas requires sophisticated technology to ensure the drone doesn't fly into someone or something, has awareness of other aircrafts, trackable by air traffic control and has fail safe mechanism.

Task Viability. While marketers will find drones cheaper to use than to hire a person to deliver the products but, how to deliver a product in cities where people live in flats will remain a dilemma. How will it physically enter the house or flat? An error in delivery by few feet could mean a wrong delivery. Secondly, how to ensure safety of the product when these are dropped from above?[18] When will the idea of delivery by drone actually fructify, remains anybody guess. As on now, drone assisted delivery of the products is not being carried out anywhere but, this may become feasible in future once technical and regulatory issues are sorted out. The idea of

[17]http://www.armscontrol.ru/UAV/UAV-report.pdf

[18] http://www.techworld.com/e-commerce/drone-deliveries-wont-take-off-in-uk-any-time-soon-3631320/

drone delivery has already taken a blow in China, which has banned the drone delivery in busy urban areas. As on now, the civil drones outnumber the military drones. Further, there remains a tremendous scope for further growth of drones in civil but, this is mainly constrained due to lack of a regulatory framework which allows only limited public and civil drone operations with its crippling restrictions.[19]

Privacy. The technologies which equip the drones could be abused to spy on unaware individuals. Privacy and civil liberties advocates have raised many doubts about the legitimacy of facial recognition cameras, thermal imaging cameras, open Wi-Fi sniffers, license plate scanners and other sensors.

The European Commission has recently proposed to set tough new standards to regulate the operations of drones for civil usage. According to the work of the commission, the new standards must cover safety, security, privacy, data protection, insurance and liability. [20]

Exploitable Attributes of Drones.

A great deal of measures to counter the drone threat would depend on the general characteristics of drones which while has implications on their employability, also hint at their possible weaknesses which can be exploited by the defence in civil/ military environment to neutralize their threat.

(a) **Command and control**. The drones either operate autonomously on GPS on programmed profile /way points or controlled by an operator with in line of sight. The ranges

[19] https://www.researchgate.net/publication/226253122_Unmanned_Aircraft_Systems_Regulation

[20]http://resources.infosecinstitute.com/privacy-security-issues-usage-civil-drones/

are extended if such connectivity is provided through the Satellite link. In case of loss of contact the machine is programmed to orbit till contact is established or return to its launch station.

(b) Drones generally fly at low speeds. These are not capable of operating in dense AD environment or where it faces active opposition.

(c) Drones can carry out precision attack against static targets.

(d) Lack ability for air to air engagement.

(e) Low situational awareness (A pilot on the contrary has better situational awareness which enables him to attack moving as well static targets,engage targets of opportunity, distinguish friend and foe and carryout combat engagements)

(f) Carries limited arsenal /load.

(g) Size varies from very large (wing span of 15-20 mtr to a very small(mini /micro/Nano UAV in ranges as small as 20-50 cms)

MEASURES TO DEAL WITH UNAUTHORIZED CIVIL DRONE OPERATIONS

The standard defense against the illegal use of drone by a criminal or a terrorist is very difficult to prevent and neutralize for the following reasons:-

(a) The deployment and glitch free operation of the detection devices such as radars is difficult firstly, due to the non-availability of ideal deployment sites and due to screening in the built up areas.

(b) To avoid detections the terrorists/criminals are likely to use small UAV such as a Quad-copter which will have very small radar cross-section, inhibiting its radar detection.

(c) The terrorists could remain incognito by remaining in populated areas.

Wallace and Loffi have listed prevention, deterrence,denial, detection, interception and destruction as the means to counter the UAV threat in civil. This is conforms to standard **Defence in Depth** model with several layers of defence to neutralize the threat.

Prevention. This is the most important layer and depends on existence of most reliable intelligence network that should unravel the dangerous plot and illegal use of the UAV before it actually fructify.

Deterrence. The second layer depends on existence of strict legislation to deter the crime. To achieve this objective, it must have two distinct factors namely, certainty of punishment and the severity of the punishment. The deterrent effect is almost negated if the risk of getting arrested, convicted, and punished is negligible. Severity of punishment also plays a role in deterrence, if the offending person is aware of the rules and consequences of his act. He may desist from committing the offence after carrying out a cost-benefit analysis. In India there is a lot of ambiguity in illegal flying of drone. There is no specific law to deal with the offence. The police either do not take cognizance of the offence or at best charge the violators most often under section 336 of IPC (an act endangering life or personal safety of others). Quite often the tourists, the hobbyists or the wedding photographers have been charged with the violations at some places. These

were generally ignorant of the ban on drone flying.[21] The stringent law and its time bound execution are needed for any of deterrent value. Even in heinous crimes, the conviction takes decades which takes away the sting of the deterrence.

Denial. Promulgation of **No Fly Zones** over the sensitive establishments or areas(e.g. defence establishments, important buildings,nuclear power plants , hydro power generation, dams, air ports, border areas, crowded markets, refineries and other strategically important locations etc) can ensure safety of some areas. Appropriate selection of locations of the sensitive sites can provide some inherent protection. However, one may possibly deny all areas to a terrorist or criminal who may be least interested in the sensitive installation and may only hit at population centers to meet his objective to create mayhem/ disorder.
Another proposed mechanism of UAV threat denial, is by encoding of UAV's navigation software to prevent UAV,s use in certain designated areas. Thus "**Geo-fencing**, "a coded pre-established virtual boundary is set in the drone software by the manufacture to deny access to some areas. DJI a drone producer in United States currently uses geo-fencing to prevent its drones from operating in the Washington D.C. area and around airports.

The unpredictability in the security measures can also lead to a denial of opportunity to the terrorists to strike if the security plan is unpredictable.

Detection of the Drone Threat and its Destruction.

Even after taking all preventive and passive steps to tackle drone threat, there may still be determined terrorist who will attempt a drone strike on his chosen target.

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[21]http://timesofindia.indiatimes.com/city/jaipur/Now-flying-a-drone-can-land-you-in-prison/articleshow/50990613.cms

Taking on active Air defence measures after detecting the threat seems an option. We need elaborate air defence architecture to cover every nook and corner of the country. The cost of such widespread layout with radars and weapons would be prohibitive. Secondly,not all drones have sufficient radar cross section and some belonging to the small or Quad- copter category may not get detected. Thirdly, drones at lower speed even though may be picked up by the radar, may get rejected as spurious returns from the ground as a ground clutter or flock of birds and not presented. Fourthly, the screening effect of the building will impede the radar detection. Passive detection measures such as thermal, acoustic and visual are also the options. In that, only visual option is most reliable. In the built-up and populated areas the first two options i.e. thermal and acoustic would remain unreliable since the area would be inundated with such signals from other sources.

Even if the challenge of detection of small drones is overcome,there will always remain the issue of identifying the friend from foe. The mistaken identity could lead to targeting of the authorised flight belonging to the government agencies or private entity.

Finally, even if detected and identified, the destruction of the threat by a conventional mean using interceptor/ missile and gun combination is not feasible in the urban environment. It has been seen that even an ordinary fire arm can shoot down the violating drone. There are several such shooting instances in the West. Wallace and Loffi in their research paper assert that “Rapid fire guns with suitable ammunition and machine guns are considered as very effective means for neutralizing mini UAVs but, “hard kill systems could generate collateral damage in crowded area with the falling debris.[22]

[22] An article ,” Examining Aerial System threats and defences :PA conceptual analysis.” by Ryan J Wallace and John M Loffi(2015) http://commons.erau.edu/

Use of disruption technology

The drones if not autonomous, are controlled by radio frequency. Technology is available to jam the signals of an approaching drone. Such disruption of the frequency could cause the drone either fall on the ground or return to its users.

Disruption of the drone flight and thus disabling it from carrying out its planned strike is also an active defense measure which can be taken to neutralize or disrupt the flight of the terrorist launched drone. This disruption is carried out three ways i.e. by interfering the command and control of the drone, Jamming and spoofing. This technique is not going to work with autonomous drones which are programmed for the flight. On 04 Dec 2011, an American Lockheed Martin RQ-170 Sentinel unmanned aerial vehicle (UAV) was captured by Iranian forces .While the western media claimed that the UAV was shot down, the Iranian claimed that it was brought down by their cyber warfare unit which took over the control and safely landed the UAV. The drone was largely intact which ruled out the western contention and could have been actually brought down by taking over the control. This incident proved that it is possible to take over the active control of the drone.[23]

Jamming and spoofing are possible on drones which rely on external navigation inputs from Global Positioning System (GPS) satellites, jamming these frequencies will prevent the drone from precisely carrying out its operator-assigned task. However, those UAV's that supplement GPS with the inertial navigation system are relatively immune from such interference.[24] In case of application of jamming same would

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[23]http://edition.cnn.com/2013/02/07/world/meast/iran-drone-video/

[24]An article ," Examining Aerial System threats and defences :PA conceptual analysis." by Ryan J Wallace and John M Loffi(2015) http://commons.erau.edu/

also affect other systems and the affected UAV on loss of signal or interference may resort to hover or return to their launch base.

Working on this premise an American Ohio based research and development firm Battelle has unveiled a non-kinetic Jamming device “Drone defender” which can incapacitate a drone from a distance of up to 400 meters by making it believe that it is out of range. This causes the drone to follow its safety protocol i.e. hover and return to its home. This seems ideal to save restricted airspace and sensitive facilities.
However, before disrupting action can be taken, offending drone needs to be detected by the security agencies in time react in time. Detection of a drone threat is typically achieved at a range of around 2 miles (3 kilometers), whereupon the system analyzes the vehicle’s guidance and communication frequencies.

Drone Defender

With increase in threat perception from the drones in the civil and military, R&D of many defence equipment manufacturing companies are coming up with devices which can counter the UAV,s threat by non- kinetic means. In that, U.S. and Israeli defence industry is in the forefront with their offerings.

Procedural Control

Regulate the Drone Flights. An easier option to control the drone prolitesation is to ban the unmanned flights in the civil. Banning civil drones operations would be a retrograde step. Adopting new advances in technology could eventually bring efficiency in the functioning.

Nowhere in the world including India, formal rules are laid down to regulate the unmanned flying in the civil. DGCA is seized of the matter. It has issued draft rules in the form of a circular in April 2016.The draft circular lays down guidelines which all the UAV operators will be required to adhere in the interest of flight Safety, when rules are formally promulgated.[25] The rules for civil aircraft cannot be ipso facto applied on the unmanned aircraft for want of requisite air navigational facilities and communication which is necessary for position reporting and comply the inflight instructions of the Air Traffic Control(ATC) organization for safe flying and transit .

The draft circular lays down that only Indian national or business entity which has business with in India and registered in India are eligible to operate UAV for which a Unique Identification number will be issued by DGCA on submission of specific request with requisite documents.

[25] Air Transport Circular XX of 2016 accessed at http://www.dgca.nic.in/misc/draft%20circular/AT_Circular%20-%20Civil_UAS(Draft%20April%202016).pdf

The draft circular further lays down several requirements for civil drones operation such as, clearance procedure of UAN flight, areas cleared for UAV operation, height band of operation, coordinating agencies, ground visibility needed etc.

In addition the following provisions will facilitate identification of the UAVs.

(a) Drone manufacturers be regulated to ensure their drones work on a specific set of frequencies so that jamming them when necessary does not interfere with communications or radio and TV reception.

(b) Governments should make it mandatory for drone manufacturers to integrate a kind of radio transponder aboard that continually broadcasts its identity, GPS location and unique registration.[26]

(c) Sensitive sites such as airports, oil and nuclear facilities, borders, prisons, and stadiums are all vulnerable to hostile or accidental intrusion by small drones and require careful security planning and preparation for such an incident. to safe guard these installation, measures like virtual geo-fence can be considered.

(d) Hobby flying is allowed in designated areas only.

(e)Record of all sales of all RPV/ drone is maintained.

The rules once implemented will make it difficult to carry out unscheduled operations but,inimical operator could however, may not follow the regulations. It will be challenge to deter such operations.

[26]http://www.saher-uk.com/sites/default/files/Countering%20Drones%20 2016%20Agenda.pdf

Impose Import restrictions. MTCR restricts the export of UAV's which have ranges over 300 Km to non MTCR compliance countries. Hence, it will be impossible for the inimical groups to procure UAV's with longer ranges. China is not a signatory to MTCR. It carries out unrestricted export of drones despite its claim of MTCR compliance. Internally with in the country there is no such restriction on import of UAV from abroad. Government needs to step in to lay down restrictions on specifications (range and Payload) for UAV's procured from the external/ internal market so that it is not misused. However, this issue will always remain debatable due to their prospective use by the marketers.

Conclusion

Drones/UAVs are the emerging threats not only for the military but, also for also for the civil society. This could attain threatening dimensions when these carry out unregulated indiscriminate flying in the air space while being used by the civil government, businesses and hobby enthusiasts. Today, their destructive capability and threatening potential has become a challenge for the security providers. There is a need to regulate their use and identify and neutralize/ground those which threaten the national security and safety security of the civil society.

Formulation of regulatory rules for drone operations is still work in progress in many countries including India. In some quarters, there is demand to hold a multilateral convention or treaty to regulate UAVs manufacture and operations. In India, DGCA has issued a draft guidelines that dictates that all unmanned aircraft intended to be operated India will require a "unique identification number" issued by DGCA. The rules governing their flights are somewhat based on the rules as applicable for the manned flights. It also proposes to designate restricted/ prohibited areas for flying by drones/ UAV's based on factors such as sensitivity and security of the

place(such as Security of designated VVIPs, defence/national institutions, historical /economic assets,airports, nuclear and other strategic assets in the country). The civil use of drones is expected to grow manifold as unmanned vehicles offer the government and the public entities a better and efficient mechanism to deliver public benefits. Similarly, the businesses also see it as an efficient, cost-effective and safe option to perform the tasks in just a fraction of man-hours. With their wide spread use in the civil tasks, the world drones market which is currently estimated to be currently pegged at $ 2 billion is expected to balloon $127 billion by 2020 as per consulting group, Price Water Cooper.

The terrorists and other criminal elements are not oblivious of the uses of drones for furtherance of their nefarious designs. They are expected to employ these to commit various criminal and terror acts. This development poses a very serious challenge for the homeland security. This challenge further brings in focus a need to have a regulatory mechanism so that it becomes difficult if not impossible for these elements to seize these tools for their use. Besides, other non conventional model will have to be employed to neutralize these emerging threats. In that disruptive technique or even sniper shooting at the violating VAV's could succeed. Of course before employing any mean, the collateral damage to similar systems will have to be considered. In final analysis, the technological developments are double edged with benefits for the society and associated threats of misuse by the inimical elements. We need to manage these groups with combination of punitive laws and procedures to deter them from committing mischiefs.