SYNDICATE – 07

WILL A NEW DIMENSION OF ISTAR BE OPENED WITH THE INTRODUCTION OF MICRO DRONES

FACULTY OF DEFENCE AND STRATEGIC STUDIES

GENERAL SIR JOHN KOTELAWLA DEFENCE UNIVERSITY

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DS COMMENT

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7. 5619 O/C MHDD Ruchiranga
8. 5621 O/C VM Basnayake
9. 5622 O/C AMTS Athapaththu
10. 5623 O/C D Vidura
11. 5683 O/C ATP Alwis
12. 5754 O/C WARD Jayathilake
13. 5755 O/C IAAP Bandara

Supervised by:

Military DS : ……	Academic DS : ……..
Sqn Ldr GMC Ganegoda	Dr.WTS Rodrigo
Date……..	Date ……..

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CONTENT

LIST OF ABBREVIATIONS

1.	ISTAR	-	Intelligence Surveillance Target Acquisition and Reconnaissance
2.	UAVs	-	Unmanned Aerial Vehicles
3.	DS	-	Directing Staff
4.	ISR	-	Intelligence, Surveillance, and Reconnaissance
5.	US	-	United States
6.	GPS	-	Global Positioning System
7.	TBS	-	Turner Broadcasting System
8.	GCPs	-	Ground Control Points
9.	DD	-	Direct Dereferencing
10.	WCD	-	Wireless Collision Detection
11.	RCFC	-	Religious Campaign for Forest Conservation
12.	LiDAR	-	Light Detection and Ranging
13.	GCP	-	Good Clinical Practice
14.	SPY	-	Securely Protect Yourself
15.	ISR	-	Intelligence Surveillance and Reconnaissance
16.	RAF	-	Royal Air Force
17.	RF	-	Radio Frequency
18.	EO	-	Electro Optical
19.	GNSS	-	Global Navigation Satellite System

CHAPTER ONE

INTRODUCTION

1.1 What is ISTAR?

1. The concept of ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) refers to the integrated capacity to acquire process, exploit and disseminate intelligence information, with appropriate content and in an appropriate time span enabling it to be used in the planning and development of military operations.

1.2 What are Micro Drones?

2. Micro Drones are small-scale unmanned aerial vehicles (UAVs) carrying payloads such as cameras and sensors. Such Micro Drones enable us to obtain a bird's eye view of the environment which is helpful in many applications such as environmental monitoring, surveillance or disaster management

CHAPTER TWO

DRONES

2.1 What are drones?

- **D**on't fly near airports or airfields.
- **R**emember to stay below 400 feet and at least 150 feet away from buildings and people.
- **O**bserve your drone at all times.
- **N**ever fly near aircraft.
- **E**njoy responsibly.

3. Outer space. Hurricane disaster zones. Antarctica. Your front door. One of these destinations is a little less extreme than the others, but that's the point for drones. Drones, sometimes referred to as "Unmanned Aerial Vehicles" (UAVs) are meant to carry out tasks that range from the mundane to the ultra-dangerous. These robot-like vehicles can be found assisting the rescue of avalanche victims in the Swiss Alps, at your front doorstep dropping off your groceries and almost everywhere in between.

4. Originally developed for the military and aerospace industries, drones have found their way into the mainstream because of the enhanced levels of safety and efficiency they bring. These robotic UAVs operate without a pilot on board and with different levels of autonomy. A drone's autonomy level can range from remotely piloted (a human controls its movements) to advanced autonomy, which means that it relies on a system of sensors and LIDAR detectors to calculate its movement.

5. In the recent past, UAVs were most often associated with the military, where they were used initially for anti-aircraft target practice, intelligence gathering and then, more controversially, as weapons platforms. Drones are now also used in a wide range of civilian roles ranging from search and rescue, surveillance, traffic monitoring, weather monitoring and firefighting, to personal drones and business drone-based photography, as well as videography, agriculture and even delivery services.

6. Different drones are capable of traveling varying heights and distances. Very close-range drones usually have the ability to travel up to three miles and are mostly used by hobbyists. Close-range UAVs have a range of around 30 miles. Short-range drones travel up to 90 miles and are used primarily for espionage and intelligence gathering. Mid-range UAVs have a 400-mile distance range and could be used for intelligence gathering, scientific studies and meteorological research. The longest-range drones are called “endurance” UAVs and have the ability to go beyond the 400-mile range and up to 3,000 feet in the air.

7. Because drones can be controlled remotely and can be flown at varying distances and heights, they make perfect candidates to take on some of the toughest jobs in the world. They can be found assisting in a search for survivors after a hurricane, giving law enforcement and military an eye-in-the-sky during terrorist situations and advancing scientific research in some of the most extreme climates on the planet. Drones have even made their way into our homes and serve as entertainment for hobbyists and a vital tool for photographers.

2.2 How drones built?

History of drones

8. Many trace the history of drones to 1849 Italy, when Venice was fighting for its independence from Austria. Austrian soldiers attacked Venice with hot air, hydrogen or helium-filled balloons equipped with bombs.

9. The first pilotless radio-controlled aircraft were used in World War I. In 1918, the U.S. Army developed the experimental Kettering Bug, an unmanned "flying bomb" aircraft, which was never used in combat. UAV technology continued to be of interest to the military, but it was often too unreliable and costly to put into use. After concerns about the shooting down of spy planes arose, the military revisited the topic of unmanned aerial vehicles. Military use of drones soon expanded to play roles in dropping leaflets and acting as spying decoys.

Modern drone History

10. A Wall Street Journal report claims widespread drone use began in 2006 when the U.S. Customs and Border Protection Agency introduced UAVs to monitor the U.S. and Mexico border.

11. In late 2012, Chris Anderson, editor in chief of wired magazine, retired to dedicate himself to his drones company, 3D Robotics, Inc. (3DR). The company, which started off specializing in hobbyist personal drones, now markets its UAVs to aerial photography and film companies, construction, utilities and telecom businesses, and public safety companies, among others.

How drone works?

12. While drones serve a variety of purposes, such as recreational, photography, commercial and military, their two basic functions are flight and navigation. To achieve flight, drones consist of a power source, such as battery or fuel, rotors, propellers and a frame. The frame of a drone is typically made of lightweight, composite materials, to reduce weight and increase maneuverability during flight. Drones require a controller, which is used remotely by an operator to launch, navigate and land it. Controllers communicate with the drone using radio waves, including Wi-Fi.

2.3 Categorization of Drones

Different types of drones

13. Drones or UAVs are designed with capabilities to fly in air without a pilot. Their movements are mainly controlled by a remote unit in most of the cases whereas few highly advanced designs are operated from computers.

14. There are so many varieties of drones that you can easily find in world and all of them are working for different applications so we cannot define any set criteria for their classification. Depending upon the need or applications, they can have variable size and design.

15. One of the most common applications of drone technology is in military as it helps to control surveillance related issues with ease. Places where humans cannot enter directly can be easily monitored by an air flying unit and it can also capture photographs of critical locations. Here we are going to discuss various types of drones and for ease of understating they are categorized into four basic sections: Numbers of propellers used inside, their size, flying range and equipment.

According to number of propellers

Single rotor helicopters

16. Single rotor helicopters look exactly like tiny helicopters and can be gas or electric powered. The single blade and ability to run on gas helps its stability and fly for longer distances.

Tricopter

17. There are three different types of powerful motors inside a tricopter, three controllers, four gyros and only one servo. The motors are simply placed at every extreme end of three arms and each one of these is holding a location sensor.

Quadcopter

18. Then a multirotor is designed with four rotor blades then it becomes quadcopter. These devices are usually controlled by specially designed brushless type DC motors. Two of the motors use to move in clockwise direction whereas other two run in counter clockwise direction

Hexacopter

19. Hexacopter will serve you for many potential applications with its 6 motor mechanism where 3 work on clockwise direction and other three move in anti-clock wise direction. Hence, these devices are able to gain higher lifting power as compared to quadcopters.

Octocoper

20. Octo means eight; so octocopter is going to serve you with its powerful eight motors and that send power to 8 functional propellers. This craft naturally have much flying capabilities as compared to units discussed above and are also highly stable.

Fixed wing drone

21. Here is entirely different category from all above units. There designs are quite unique as compared to commonly used multi rotor type drones. You will find a wing on them and they appear like traditional airplanes. These drones are not able to stand stable in air as they are not much powerful to fight against gravitational force.

According to size

Small drones

22. They can be designed with a common size range varying from a large sized insect to a 50 cm long unit. Two most common designs in this category are: Mini Drones and Nano/ Micro Drones.

Medium drones

23. This category of drones presents heavier units but are lighter and smaller then aircrafts. These drones can carry weight up to 200 Kg and have average flying capacity of 5 to 10 minutes. One of the most popular designs under this category is UK watch keeper.

Large drones

24. Large drones are somewhat comparable to size of aircraft and are most commonly used for military applications. Placed that cannot be covered with normal jets are usually captured with these drones.

2.4 Comparing of Drones

UAV Categories	Acronym	Range(km)	Climb rate(m)	Endurance(hours)	Mass(kg)
Tactic					
Micro	µ(Micro)	<10	250	1	<5
Mini	Mini	<10	150 to 300	3000	150
Close Range	CR	10 a 30	3000	2 to 4	150
Short Range	SR	30 a 70	3000	3 to 6	200
Medium Range	MR	70 a 200	5000	6 to 10	1250
Medium Range Endurance	MRE	>500	8000	10 to 18	1250
Low Altitude Deep Penetration	LADP	>250	50 to 9000	0.5 to 1	350
Low Altitude Long Endurance	LALE	>500	3000	>24	<30
Medium Altitude Long Endurance	MALE	>500	14000	24 to 48	1500

2.5 Usage of Drones in different fields

Military

25. Probably the oldest, most well-known and controversial use of drones is in the military. The British and U.S. militaries started using very basic forms of drones in the early 1940's to spy on the Axis powers. Today's drones are much more advanced than the UAVs of yesteryear, equipped with thermal imaging, laser range finders and even tools to perform airstrikes. The most prominent military drone in use today is the MQ-9 Reaper. The aircraft measures 36 feet long, can fly 50,000 feet in the air undetected and is equipped with a combination of missiles and intelligence gathering tools.

Shipping and Delivery

26. Delivery drones are usually autonomous UAVs that are used to transport food, packages or goods to your front doorstep. These flying vehicles are known as “last mile” delivery drones because they are used to make deliveries from stores or warehouses close by. Retailers and grocery chains all over the country are turning to drones as more efficient delivery alternative, instead of relying on delivery drivers with inefficient trucks. These drones can carry an impressive 55 pounds of goods to your front door without you ever having to leave the house. Amazon, Walmart, Google, FedEx, UPS and many other big brands are all currently testing out different versions of delivery drones.

Emergency rescue drones

27. Sometimes it’s just not safe enough to send humans into a rescue situation due to the scope or severity of the disaster. That’s where drones come in. In the case of a capsized boat or drowning individual, officials can throw an Autonomous Underwater Vehicle (AUV) into the water to assist in the rescue. If there’s an avalanche, drones are deployed to look for those caught in the snow. Aircraft maker, Kaman, has even developed a pilotless helicopter, called the K-MAX, designed to carry more than 6,000 pounds of cargo. The K-MAX has already been used in China and Australia to assist in fighting fires.

Outer space

28. NASA and the U.S. Air Force have been secretly testing out unmanned aircraft geared towards space travel. The X-37B UAV is the Air Force's ultra-secretive drone that looks like a miniature space shuttle. It has been quietly circling the Earth for the last two years, setting a record for longest flight from an unmanned aircraft (more than 719 days). Although vague, the Air Force has said "the primary objectives to the X-37B are twofold: reusable spacecraft technologies for America's future in space and operating experiments which can be returned to, and examined, on Earth." It seems that drones have been made a priority when it comes to the future of space exploration and innovation.

In the field of agriculture

29. This is the biggest achievement of drone technology as they are now able to serve farmers for many purposes. Drone can help farmers to save their money as well as crops by keeping an eye of failing plants. They can study the large sized farm lands along with proper monitoring of irrigation systems. Farmers can now hope for all information updates quickly and drones can also help them to spray fertilizers, pesticides and water for crops at right times.

Drones for safety surveillance

30. These tiny devices can help people to achieve success in public safety and crowd surveillance. Drones are capable enough to report criminal activities in large gatherings. They also find applications in careful monitoring at border areas so that drugs and migrant smugglers can be easily captured. Drones serve like an intelligent army that can protect nation from so many problems and that is why most of the countries these days are working on development of highly advanced drone units.

2.6 Possibilities and limitations of Drones

31. Low operation speed: UAVs fly at low speed making them slower compared to manned aircraft. Some drones are built to be stationary in an area like the Boeing A160T Hummingbird. Their slow speed enables them to provide accurate surveillance in an area but also at a cost of faster surveillance as well as ability of the enemy to spot the drone easily.

32. Vulnerable to hackers: UAVs vehicles are controlled at remote area thus they require a data link with the base control. Hackers can intercept the data link network and access your control system. Once your enemies have access to link via their local mobile telephone network, they can affect your monitoring in the area or even trace your remote location. This will result in the compromising of the entire mission.

33. Invasion of privacy: Drones survey an area through a remote control. The high-power zoom lenses, see-through imaging, and its night vision make it easy to capture images or record activities in an area. When carrying an investigation, people prefer to use drones which can fly to an area undetected and watch movements in the surrounding area. But the problem is with these developments the privacy of the common people are also geopardized since this can be used by the enemies or other organizations to gather discriminating information regarding personnel.

34. Desensitize people: Drones can be used in war zones to automatically kill people through a switch of a button. This can cause post-traumatic stress disorder in people who are controlling the drones in the killing of people in remote areas. Sitting in an office or a remote area shooting things at war zones is confusing once you walk out into the real world.

35. Collateral damage: Although drones can be used precisely, sometimes collateral damages occur. Missiles and explosives fired by military drones lead to death to people caught in the targeted area. According to a report by Amnesty, a missile fired from a drone killed a 68-year old woman outside her home.

36. Cause unemployment: Wide use of drones has led to unemployment for the aircraft pilots since drones do not need a pilot to control them. Unfair battle: People killed by drones do not get a chance to defend themselves and sometimes innocent people are killed in the process.

37. Battery life: The battery life limits the flying time of the drone and sometimes you need to have multiple batteries fitted on the drone to extend its flying time. Cold temperatures in an area reduce the battery life.

38. Weather changes: Weather changes in an area affects the use of drones. Most drones are designed to operate at a speed of 30mph thus you cannot use them in an area with a wind speed of less than 20mph. Flying drones in rain or snow can damage the electronic components and interfere with the communication between the drone and the controller.

39. Cost: Buying a drone fitted with all the features needed for your use may be very expensive. The federal law requires drones of different uses be fitted with specific software, hardware, and camera features and this may be costly. Special training is required for those going to operate the drones which add to its cost.

a. Drones can be seen by enemies easily, therefore they may escape from those places.

b. Signal range of drones are limited. Therefore they can be only used in a small area.

40. Many drones' batteries have a short battery life, so they can be only used for the activities which spend a less time.

CHAPTER THREE

ISTAR

3.1 Elaboration of ISTAR

I - Intelligence
S - Surveillance
TA - Target Acquisition
R - Reconnaissance

41. ISTAR stands for intelligence, Surveillance, target acquisition, and reconnaissance. In its macroscopic sense, application of ISTAR links many field functions along to help a combat force in using its sensors and managing the data they gather.

42. Information is collected on the field through systematic observation by deployed troopers and a range of electronic sensors. Surveillance, target acquisition and intelligence operation are strategies of getting this information.

Intelligence

43. The data is passed to intelligence personnel for analysis, so to the commander and his workers for the formulation of battle plans. Intelligence is processed info that's relevant and contributes to an understanding of the bottom, and of enemy inclinations and intents. The inclusion of the "I" is vital because it acknowledges the importance of taking the raw data from all the sensors and process it into helpful knowledge. Intelligence is simply information that is vital to a mission and in the process of decision making. Drones are used to collect still images, video recordings or live video of targets such as people, vehicles or specific areas. They can be used by governments, militants, law enforcement agencies or commercial agencies to gather information and intelligence that can help with decision making.

Surveillance

44. Surveillance means the close observation of a person or a target. It can also be the observation of a perimeter. It includes monitoring of behavior, activities for the purpose of information gathering influencing managing or directing.

45. Drones can be used to search for and access areas that are difficult or inaccessible to humans on foot or on the ground. Most drones are quieter than manned aircraft, can fly at lower altitudes and are cheaper to operate. The use of military and police surveillance drones in dangerous environments, such as battlefields or crime scenes, can prevent people from being in danger. Army and Defense - Google is currently working with the Pentagon to develop AI for unmanned combat and is already using the technology for border patrols, storm monitoring, security checks and security monitoring.

Reconnaissance

46. Reconnaissance is the military observation of a region to locate an enemy or ascertain strategic features. The main reason a recce is done is to get an idea about a location or the current situation in a battlefield or to make sure that you are prepared for the odds and to get an upper hand once the battle starts.

47. Drones collects important intelligence data on potential threats, movements from non-combatant and allied forces to ensure operational success in joint maneuvers at the brigade level. This system monitors combat movements during aggressive reconnaissance or reconnaissance operations, determines threat sites and provides real-time topographic information Espionage concepts are fully embedded in hardware and software solutions

Target Acquisition Purposes

48. Target acquisition is the detection and identification of the location of a target in sufficient detail to permit the effective employment of lethal and non-lethal means. The target data is transmitted from the air vehicle over a distance of more than 100km to the ground station, allowing the target data to be used for the effective operation of other assets such as long-range artillery, intelligent artillery munitions, rockets and missiles. This system can be deployed in all weathers by day and night.

49. Military drones can carry supplies, weapons or cameras. They can be used to deliver airstrikes on remote targets. These drones typically carry light-weight bombs and missiles that are delivered with precision to select targets. While target acquisition missions, drones are used to determine if strikes on enemies were effective overall. This is especially important in fast-moving missions where reports need to be turned over quickly to leadership for next mission decisions.

3.2 Current Scope of ISTAR

50. When talking about the current scope of ISTAR it needs to be talked about separately,

51. Intelligence

a. Initially intelligence gathering was done entirely by the human beings where most of the soldiers had to go undercover and take a huge risk in order to gather even the slightest bit of information that could have been gathered very easily using the modern technologies present.

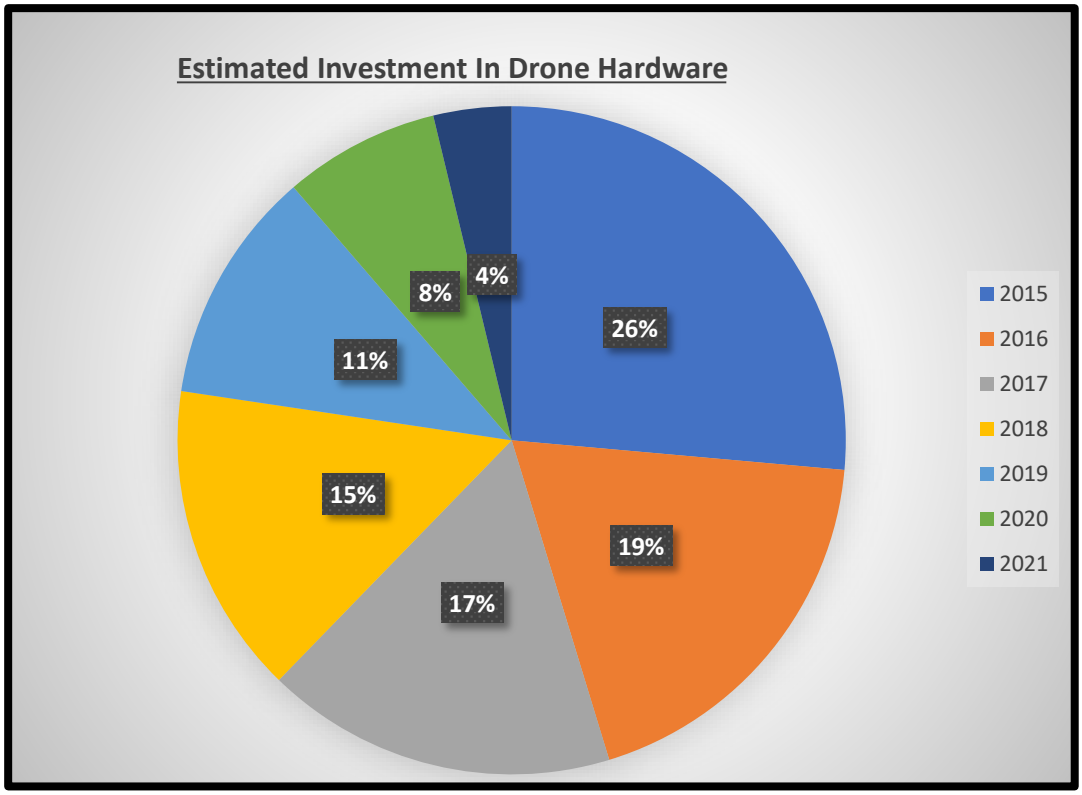
b. With the development of the drone technology humans did not need to put their lives at jeopardy instead they had the ability to deploy a drone which had the ability to access confined spaces as well compared to a human and gather information necessary in order to get the intelligence they needed regarding to their mission.

52. Surveillance

a. Surveillance also just like intelligence was gathered solely by humans but with the introduction of drones this too became easy since the drones had the ability to cover a large area when compared to a human and unlike a human the drone did not feel any physical fatigue.

53. Target Acquisition

a. Target acquisition is the detection and identification of the location of a target in sufficient detail to permit the effective employment of lethal and non-lethal means. The two main types of target acquisition can be categorized as hostile and friendly targets. Drones are used in military purposes to identify hostile targets for assault and in civilian rescue mission whereas in non-military purposes, drones serve to identify personnel and security purposes and even to deliver objects by recognizing the receiver.



54. Reconnaissance

a. Reconnaissance is the art of military observation of a region to locate an enemy or ascertain strategic features. The drone technology nowadays plays a vital role as a supporting accessory for reconnaissance during military operations. Drones are used to extract information from hostile ground and to scout the area ahead in a battleground while avoiding. The endangerment of any human life and also with much less cost.

b. Whether it's remote-controlled Aerial Vehicles (UAVs), miniature heavier-than-air craft or Flying Mini Robots, drones are rapidly growing in quality. But still they're within the infancy stage in terms of mass adoption and usage, however drones have already broken through rigid ancient barriers in industries that otherwise appeared impenetrable by similar technological innovations.

c. Over the past few years, drones became central to the functions of assorted businesses and governmental organizations and have managed to pierce through areas where positive industries were either stagnant or insulation behind. From quick deliveries at time of day to scanning inaccessible military bases, drones have proved to be immensely helpful in places where man cannot reach or is unable to perform a task on time and in an economical manner.

d. Whether drones unit controlled by a remote or accessed via a smartphone app, they possess the power of reaching the foremost remote areas with little to no hands needed and wish the tiniest quantity of effort, time, and energy. This is often one of the biggest reasons why they are being adopted worldwide, significantly by these four sectors: Military, Commercial, Personal, and Future Technology. Drones are around for quite twenty years, from technically manning sensitive military areas to luring hobbyists throughout the globe, drone technology has developed and prospered within the previous couple of years. People, business entities, and governments have come back to understand that drones have multiple uses, that include:

1. Aerial photography for journalism and film
2. Express shipping and delivery
3. Gathering information or supplying essentials for disaster management
4. Thermal sensor drones for search and rescue operations
5. Geographic mapping of inaccessible terrain and locations
6. Building safety inspections
7. Precision crop monitoring
8. Unmanned cargo transport
9. Law enforcement and border control surveillance
10. Storm tracking and forecasting hurricanes and tornadoes

3.3 Limitations of ISTAR

55. Intelligence gathering is as old as human civilization. Good Intelligence generally leads to success, whereas failure to gather timely Intelligence has invariably resulted in defeat and ruin. Gathering Intelligence is not easy. The trouble about Intelligence collection was stated by US Vice President Dick Cheney. He stated, “We know what we know; we know what we don’t know; we don’t know what we don’t know.”

56. The last is most dangerous, yet many a people-—laymen as well as experts—how some seem to have implicit faith in the ability to obtain complete information on our adversaries. This unfortunately is not correct. If drones were not available and all intelligence gathering, surveillance was to be done by the humans themselves it wouldn’t be easy as it is now. The reason for this is that there are many limitations when it comes to humans starting from physical fatigue and the inability of humans to access confined spaces. Is it wasn’t for the development of technology and the invention of drones ISTAR would have been limited to a very small scale. Even though drones were invented they still had various limitations.

57. Drones contribute towards intelligence gathering quite a lot. Unlike other agents of intelligence collection, Drones possess the ability to cover a wide scope of area. The problem when obtaining satellite imagery is that it do no provide us with clear images hence making it difficult to spot an object if it is far away. This is one of the limitations of ISTAR that needs to be addressed.

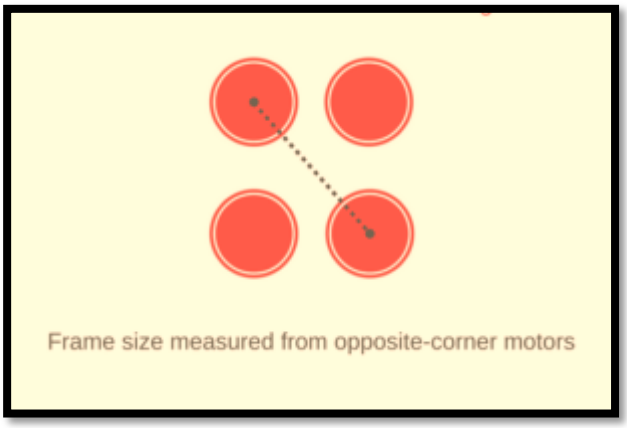
58. A mistake in navigation, reporting of target position, or movement by the target since since last report may result in missing the target. Since the area on ground recorded by aircraft camera is finite, the photo tasking must be accurate and area dimension matching with aircraft/UAV capability. The sensors on board have limitations with respect to prevailing weather conditions. In brief electro optical sensors cannot see through mist, fog, clouds, dust haze, smoke haze and rain. Pure optical cameras require good transparency in the atmosphere. Infra-red sensors can see by day as well as night but are affected by cloud, rain, fog clouds, dust haze, smoke haze and rain. Pure optical cameras require good transparency in the atmosphere. Infra-red sensors can see by day as well as night but are affected by cloud, rain, fog etc. All sensors are susceptible to various types of decoys.

CHAPTER FOUR

4.1 Micro drones

59. A micro drone is the micro sized drone and the smallest of the drones yet designed. According to the classification of drones the micro prefix should be defined as 100mm to 150mm. the tiny whoop, which has a frame of 110mm is generally called a micro quadcopter. Drones are a complicated subject when considered in the structure and its mechanism. But when considering its physical structure it is very simple to understand.

How to Measure Size



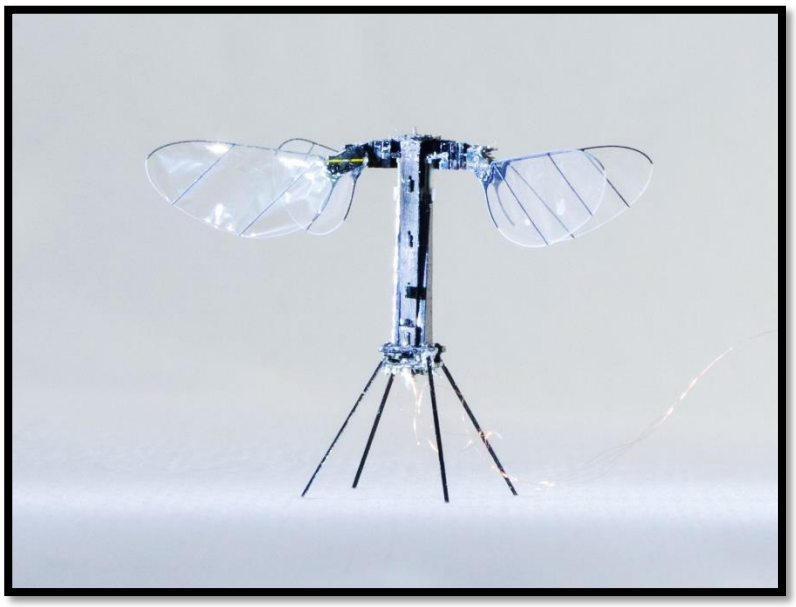
60. The frame size of a quadcopter is the distance from opposite corner motors. So if you measure from the front left motor to the back right motor, that distance (in millimeters) is the frame size.

61. The only thing here is that sometimes manufacturers round up or down. So they might call it a 180 frame but really it's a 175 mm from motor to motor. Not a huge deal unless you're super picky about details like that.

Class	Frame	Prop (Max)	Weight (Max)	Battery (Max)
Tiny Whoop	No Limit	31 mm	35 g	1s lipo
Micro	No Limit	66 mm	150 g	2s lipo
3s	305 mm	6″ (152 mm)	800 g	3s lipo
4s	305 mm	6″ (152 mm)	800 g	4s lipo
Open	No Limit	No Limit	800 g	No Limit

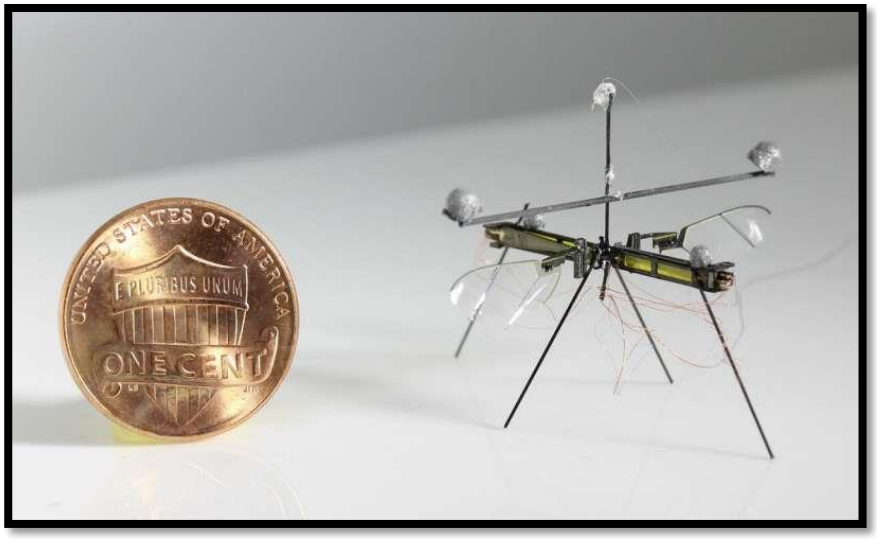
62. Micro Drones in use

a. Robo bee X- wing



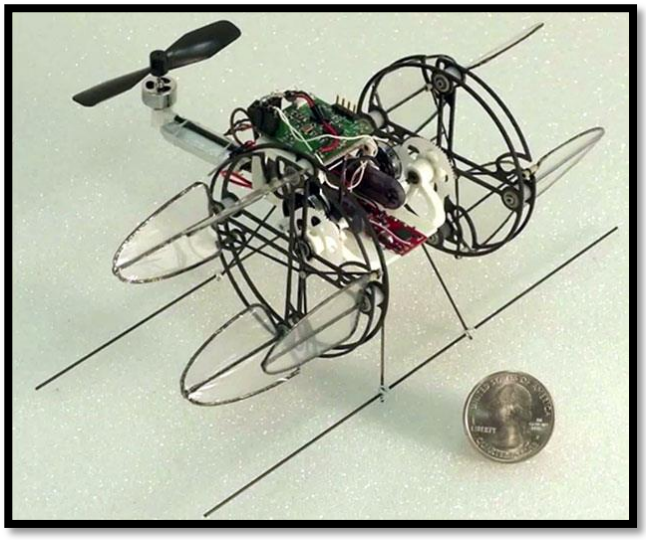
1. RoboBee—a flying machine half the size of a paperclip that could flap its pair of wings 120 times a second. It was always tethered to a power source, limiting its freedom. Now, though, RoboBee becomes RoboBee X-Wing and consists of solar cells and an extra pair of wings that carries the weight of this very small drone.
2. Needless to say, the RoboBee X-Wing is far too frail to carry a battery, which would be several times heavier than the rest of the vehicle. So for the moment, the robot's engineers are powering RoboBee X-Wing's components by solar power directly. This comes from small solar cells perched on a rod well above the four wings, to avoid interrupting airflow.

b. Robofly



1. Insect-size robots could have numerous useful applications, for instance, aiding search and rescue (SAR) missions, simplifying the inspection of infrastructures and speeding up agricultural processes. Despite the advantages associated with their size, these robots can be very difficult to build, as their fabrication involves assembling several tiny components. "RoboFly is a flapping-wing micro-robot inspired by flying insects," Yogesh Chukewad, one of the researchers who carried out the study, told TechXplore.

c. Cyclocopter



1. A cyclocopter is a considerably different looking air craft, bigger in size than usual micro drones but within the limitations, that uses airfoils rotating around a horizontal axis to generate lift and thrust. These things are tricky to build. In fact, there's only a small handful of research groups working on cyclocopters at all, and at the moment, they're focusing on small scales. It's weighs around 29 grams in mass, and could be a tiny step towards replacing helicopters and multirotors with something better.

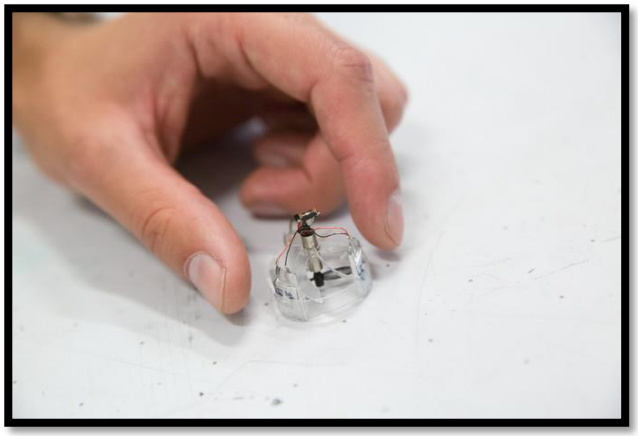
d. Aerius

1. Aerius is a perfect indication of how humans have shown their desire in building small things. At some point our society moved from one that revered objects billed as the world's largest and became obsessed with tiny things. The remote control that you use to fly it is larger, but can still fit into a pocket, and doubles as a storage case for the quadcopter.
2. Aerius is considered to be the smallest drone in the market and can be easily controlled. The battery life of this device is known to be shorter than others. Its axis claims it is the world's smallest quadcopter, with the body measuring just under 1.2 inches wide and about 0.8 inches tall. Each of the four blades is just 0.8 inches wide.

e. Sky nano 2

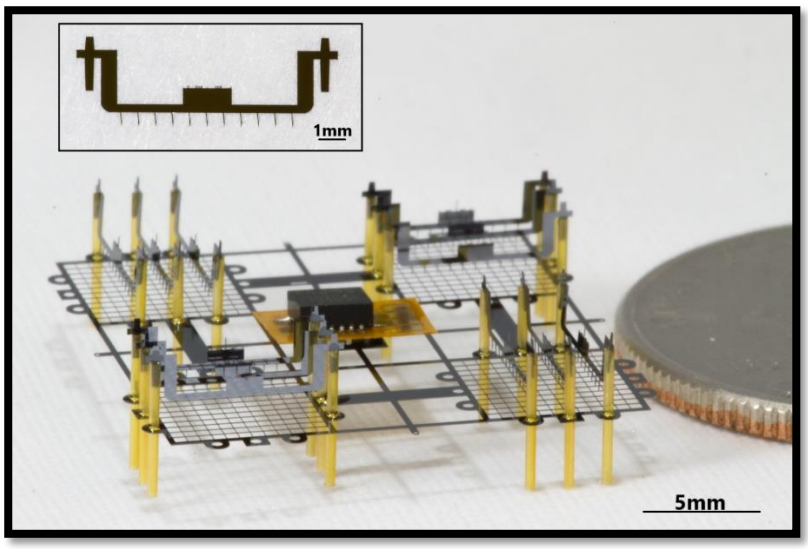
1. This drone is known to be the world's smallest camera drone. Its special adjustable gyro sensitivity and 6-axis flight control system and the 4 channels with 2.4 Ghz frequency, adds a certain exotic nature to this attractive camera drone.it weighs around 17g with the with a height of a mere 2.2cm.

f. Picolissimo



1. Piccolissimo has only two moving parts: a propeller and the body of the robot itself. Made out of light, 3D-printed plastic, Piccolissimo's body spins in the opposite direction as the propeller. Precisely timed speed changes, controlled by an infrared signal, can therefore turn the robot one way or another. Picolissimo is the smallest drone ever created and is controlled by infrared signals for control. It weighs less than 2.5 grams and is about the width of a quarter.

g. Ionocraft



1. This is a more unconventional drone compared to the other micro drones. It has no moving parts and uses Electrohydrodynamic (EHD) thrusters, sometimes called ion thrusters,* use a high strength electric field to generate a plasma of ionized air. The ions (mostly positively charged nitrogen molecules) are drawn toward a negatively charged grid, and along the way, they smack into neutral air molecules and impart momentum to them, which is where the EHD thrust comes from. This is the ionocraft, currently under development at UC Berkeley. It's tiny— just 2 cm x 2 cm, weighing 30 mg, plus a 37-mg IMU.

Limitations of micro drones

63. These attractive micro drones are currently being used but does not have a number of consumers as large as normal drones. The certain limitations that it possess could be the main reason. These limitations causes the lesser number of manufacturing done which has delayed the drones easily reaching the drone market.

a. Micro Controllers And Other Accessories Must Be Smaller In Size
b. Sophisticated Computing And Data Processing
c. Size Of The propulsions
d. Aerodynamics

64. Other than these there are limitations we find in the day to day usage of micro drones.

a. Low battery life.
b. Slow moving ability
c. Lack of prop guard strength
d. Not using controllers (the earlier designs)
e. Requires experience in handling.
f. Not easily found for sale.
g. Durability

65. How to overcome ?

a. Remote Power Sources
    1. RF charging
    2. Tiny solar cells.

b. Remote Computing System/Cloud Computing
c. Eliminate Repeated Sensors And Cameras

66. Will a new Dimension of ISTAR be opened with the implementation of Micro Drones?

a. Micro drones can be the next big innovation that will define the course of mankind. In order to successfully implement micro drones in various fields a 3 step process could be followed mainly.
    1. Identifying the limitations of micro drones
    2. Overcoming the limitations
    3. Implementation of micro drones to ISTAR

4.2 Future of ISTAR with Drones

67. Drone technology is a fast growing area with the newest inclusion of Micro drones and Mini Drones to its arsenal. Drones are more commonly used presently in both urban encounters and also combat purposes. Since the introduction of UAVs and drones to the military platforms, many countries have successfully implemented its services to their day to day activities and has made ground breaking innovations to strengthen the ISTAR operations.

Drones usage in current military outset.

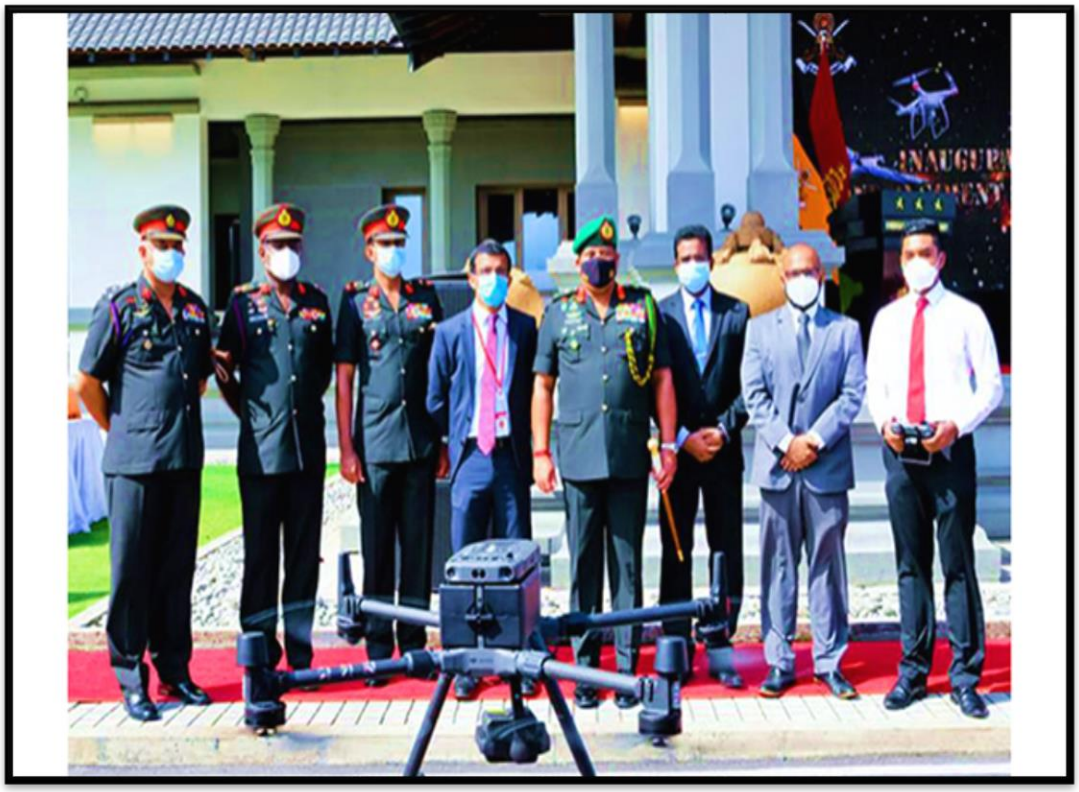
68. Currently drones are mostly used in military for surveillance and reconnaissance purposes where as UAVs are more commonly implemented for the Target acquisitions. Drones are used to approach targets of a relatively shorter range to successfully gather information without any harm towards human life.

a. Enemy surveillance.
b. Battle ground reconnaissance.
c. Providing information for operations within short and normal distance.

Sri Lanka Army Drone Regiment (Artillery)

69. The Sri Lanka Army established a new Drone Regiment on 12 November 2020. Drawing on experiences gained during the 30 years of conflict. This regiment equipped with Unmanned Aerial Vehicles (UAVs) is expected to be affiliated with the Regiment of Artillery and will be an evolutionarily step towards being a more technologically proficient force.

70. According to the Army, the new regiment has been developed under a plan by the current Commander of the army **Lt. Gen. LHSC De Silva**. The new 15th Drone Regiment in the Sri Lanka Artillery is well-equipped with high-tech cameras that enable operations within short & medium distances and quadcopters with observation cameras for surveillance purposes in military or non-military applications.



71. The main target of this Drone regiment is to control the corona virus in Sri Lanka, track down violators of movement restrictions between Provinces and in areas under lockdown.

a. Ex- Sri Lankan police reported at least 20 people have been arrested for breaking lockdown regulations, after having been surveilled using the military's drones.

Reconnaissance and Surveillance

72. The new drone regiment provides a tactical platform for operational level surveillance, precision target acquisition, engagement, post-battle damage assessment capabilities and to assist disaster mitigation and nation-building efforts.

73. The new division is an expansion of the Sri Lankan military's well-established use of drones, or Unmanned Aerial Vehicles (UAVs). During the armed conflict, and during the final phase which saw tens of thousands of Tamils killed, UAVs were extensively used by the military during its offensive.

The Future of Military With Drones

74. The drone technology evolves day by day with the newest advancements of its related fields. The military outset can be immensely more benefited than it already is with these said advancements and could result in improvements on the advantages for the ISTAR in military aspects.

a. Perimeter surveillance.

1) In military operations, obtaining a thorough knowledge about the surrounding areas is considered of utmost importance. Although the land surveillance using drones is already in effect, the sea reconnaissance is still in the radar age. The use of advanced drones can open a new chapter of advanced surveillance for the naval operations and also result higher results in reconnaissance for naval operations. For this the ships needs to be equipped with the ground or mobile platforms for the advanced drones that are suitable to be used in these relevant environments.

b. Approaching the enemy.

1) Drones are naturally low cost objects in manufacture and also easier in handling that UAVs and its most important feature in military use is that there is no endangerment of human life. The drones can be included in the field approaches where the normal reconnaissance or patrol teams can be equipped with a drone along with trained personnel in order to handle the equipment.

c. Hostile and friendly target recognition.

Even though the target acquisition is already a possibility, identifying the target are yet difficult and needs personal human involvement. Drones can be programmed for automatic deployment and with the help of surveillance cameras and even artificial intelligence, drones can be programmed to recognize and differentiate hostile and friendly targets.

d. Accessing civilians or friendly forces in hostile or unapproachable areas.

i. Accessing hostile ground is a very common difficulty faced by military forces where necessary deliveries need to be done undetected. Where a UAV or a light air craft cannot be used, a drone can be easily used as a substitute to provide food, water or other necessities for civilians and military requirements such as ammo or physical instructions such as maps.

Future use of drones in urban encounters or non-military situations.

75. Drones are an era defining technology where there are endless possibilities of implementation and improvement. Many aspects of day to day human life can be made easier by the future developments of drones and even the newest micro drone technologies.

a. Non-military surveillance.

1) Even though this is to be considered as a non-military aspect it can be still related to human security. Police surveillance and also undercover operations can defuse terrorist or criminal activities by observing undetected from a safe distance in order to support the law enforcement authorities.

76. Entertainment purposes.

a. Drone cameras are already a part of the camera production equipment's. But these cameras can at times be disturbing for the entertainers and the spectators. The improved versions of mini or micro drones with the smaller sizes and less noise and also the improved camera capacity will solve these issues and at the same time provide a much more realistic experience in these entertainment events such as music festivals, award ceremonies, theatres etc.

77. Providing new and improved camera angles.

a. Drone cameras are known for getting pictures and videos from the birds eye view. But the smaller in size and more versatile drones can approach many other angles in photographic requirements to provide more realistic and exciting picture angles.

78. Supporting civilians in situations like COVID-19

a. Approaching subjects without physical involvement is a specialty among drones. These drones can be used to deliver food, medicine and other related necessities and also acquiring blood or tissue samples from infected people or infected areas without the risk of contamination can be used as a huge advantage in situations like the current global pandemic of COVID-19.

CHAPTER FIVE

5.1 Future of ISTAR

79. UAVs have to be launched for each mission. Since they fly much closer to earth, the photographic scales are larger and resolution better. UAVs flying at 1-kilometer height can record objects 1 centimeter in size. Its Infrared sensors can make Image of aircraft or tank. Yet USAF's claim that it is true only for recognizable military objects. It is unlikely to detect decoys, enemy soldiers interspersed among a background population or in heavy forests; mortars and anti-tank and anti-aircraft missiles hidden in trucks or caves and properly secured weapons of mass destruction.

80. The airborne intelligence, surveillance, and reconnaissance sector is one of the fastest-growing segments of the defense industry. Most ISTAR missions are currently carried out by expensive drones that are vulnerable in certain operating environments. In response, several new technologies and platforms are emerging to meet the evolving collection requirements of the military. At the same time, armed forces around the world are adopting new procurement. practices that are changing a traditionally stable industry

Aircraft/UAV Imagery

81. Unlike a satellite, aircraft and UAVs have to be launched for each mission. Vertical photography has many more advantages over oblique photography. Some places, like across the international border are better served by oblique Photography. All sensors are susceptible to various types of decoys.

Next-generation drones

82. Total sales in the airborne ISR segment are approximately $16 billion. The US is the largest single market, with $6 billion in ISR appropriations in the 2019 DOD budget.

Increased Survivability

83. UAV manufacturers can better meet the DOD's evolving ISR needs by designing drones with stealth capabilities. Advanced materials and designs can lower the radar cross-section of a given platform. Drones can also be equipped with hardened, jam-resistant data links to prevent enemy disruptions.

84. Operating at altitudes beyond the range of most ground-based radars and surface-to-air missiles can also increase survivability. This requires platforms that have sufficient collection capabilities and the ability to operate beyond the troposphere (which extends to seven miles altitude) and even into low-earth orbit (up to 1,200 miles).

Orbit Optimization

85. To maintain continuous coverage over a given ISR target, the military creates operational "orbits" that use drones to collect multiple forms of ISR .Drones can collect electronic signals (SIGINT), images (IMINT), and full-motion video (FMV) military says. Current platforms such as the Reaper can support all three forms of ISR collection, but they are expensive to procure and operate. Military leaders can meet their collection requirements at lower cost

New types of platforms

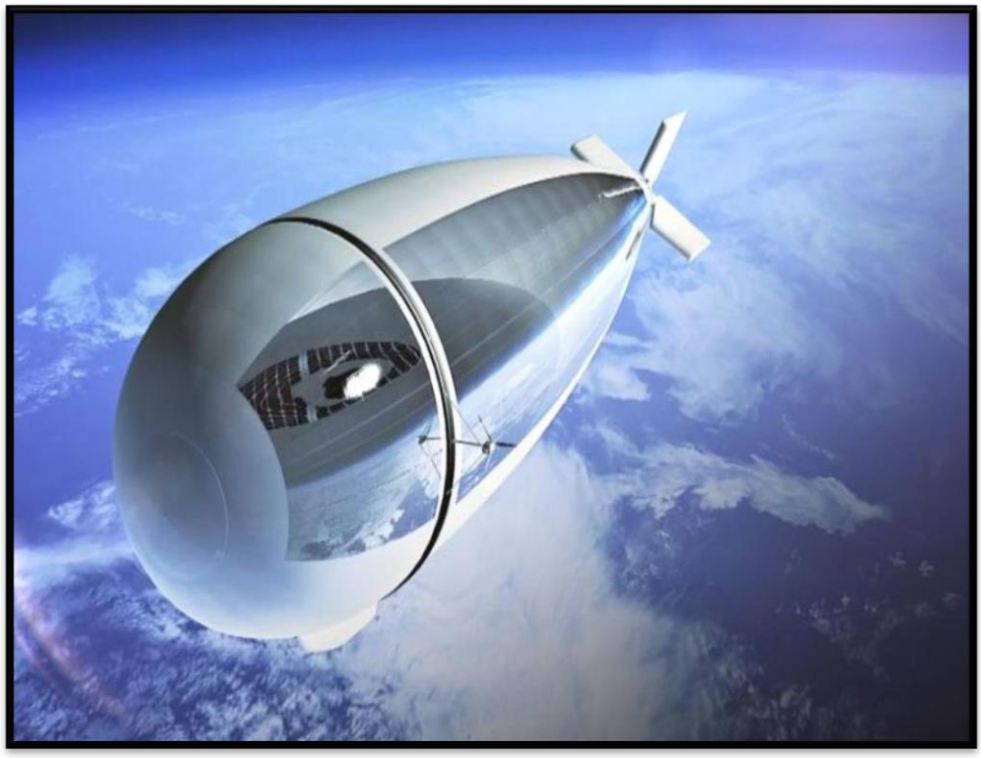
86. OEMs in the defense industry and ISR service providers will need to leverage next-generation drones.

a. High-Altitude Balloons

1) High-altitude balloons operate in the mid-to-high altitudes of the stratosphere. Defense players are developing and testing balloon platforms with ISR capabilities.

b. High-Altitude Pseudo Satellites (HAPS)

1) Also operating in the mid-to-high altitudes of the stratosphere, HAPS platforms have endurance and range similar to those of high-altitude balloons. Several US and foreign defense firms, including Boeing and Airbus, are developing HAPS technology. Also operating in the mid-to-high altitudes of the stratosphere, HAPS platforms have endurance and range similar to those of high-altitude balloons. Several US and foreign defense firms, including Boeing and Airbus, are developing HAPS technology

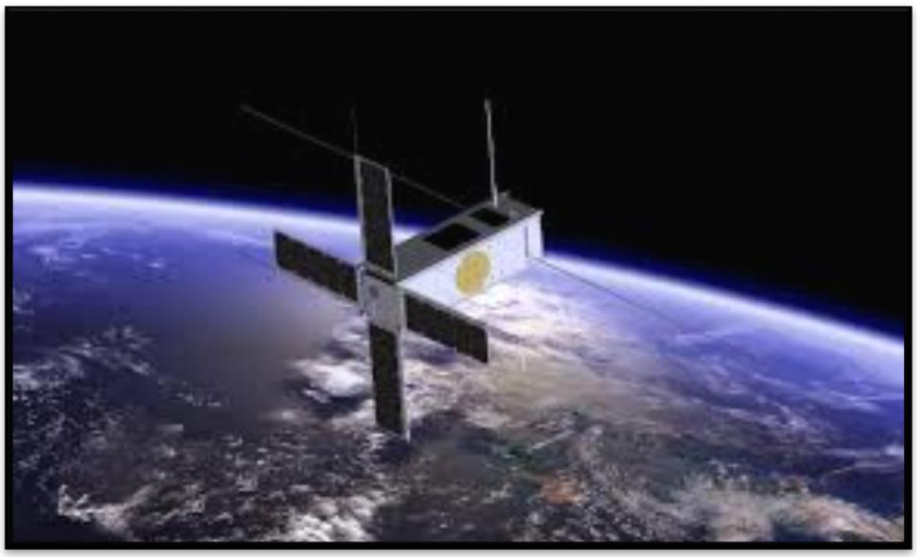


c. Low-Earth Orbit (LEO) Small Satellites

1) Operating in the mesosphere to the lower altitudes of the ionosphere, LEO "small sates" have an unlimited range and very long endurance. They are more expensive to acquire than HAPS and high-altitude balloons.

New DOD Procurement Models

87. The U.S. Defense Department is changing the way it sources ISTAR capabilities. Traditional procurement is notoriously slow and cumbersome. To bring promising technology into the field faster, the DOD is increasingly identifying emerging capabilities from sources outside of the military-industrial base



Contractor-Owned, Contractor-Operated (COCO) Approach

88. The COCO model positions the business to provide ISR capabilities as an ongoing service to the government. It transfers risk from the government to the company, while allowing the company to demonstrate capabilities with prototypes. There are some ways to improve the ISTAR technology by using micro drones, for an example

89. All of Bluebird UAS were designed to support the performance of all required ISR missions and the operational concept of independent Intelligence gathering by dismounted soldiers in combat. These UAS are fully suitable to perform those tasks, based on the following capabilities:

a. Easy & low weight backpacked carried systems for high mobility.

b. Rapid system deployment by a team of one / two soldiers, quickly and reliably Almost all weather operations.

c. Fully autonomous and pre-planned mission flying capability to support ease of use suitable for any shortly trained soldier.

d. Wide variety of payload carrying capabilities and system configurations can be used and selected by the customer in order to support a wide diversity of missions.

e. Highly Reliable recovery system to guarantee a safe and pin-point pre-determined landing.

f. Exceptionally short turn-around time between flights.

g. Quick system packing which allows fast movement to a different location if needed.

h. Automatic launch from a ground launcher / hand held pneumatic launcher to enable launching behind a cover or from a roof of a building with no need for terrain adaptation.

i. Extended range operations to support even unique deep operations.

90. The back-packed or vehicle mounted UAV system provides a very stable ISR platform, which combined with a stabilized day and night video payload and coupled with proprietary ground exploitation software, allows for GPS marked imagery to be relayed in real time to the ground station.

5.2 Possibilities in successfully opening a new dimension of ISTAR with the use of Micro Drones.

Can a New Dimension of ISTAR Be Opened With the Introduction of Micro Drones?

91. Currently the micro drone technology is being successfully used in various fields. With the advancement of micro, mini drone and drone technology, ISTAR has changed its scope and has challenged the future with the promise of evolving with the modern technologies. The newest addition to the military drones, the Black Hornet, is the smallest military drone ever made and the new technological advancements into the micro drones will provide a premise for the ISTAR methods to evolve in gathering information and fulfilling its purposes in military and non-military data acquisitions.

92. Restrictions in implementing Micro Drones

a. Why micro drones are very expensive?

1) Due to all the innovation, equipment, and programming that makes them fly, drone quadcopters are exorbitant. The idea of being excessively costly for the quadcopter isn't totally unwarranted.

b. Why Drones Make Noise?

1) Drones emit a buzzing sound, which is caused by motors and propellers that produce it during rotation, and thus they create vibrations. Therefore, drones that are larger in size and thus of the aforementioned components will be much louder than smaller ones.

c. What are the threats when we use Micro Drones?

1) The use of unmanned aerial vehicles (UAVs) has increased exponentially over the last decade for a broad range of applications. The recent commercial availability of a new generation of small UAVs has emphasized the growing threat posed by these machines. This paper is aimed at reviewing the security threats posed by UAVs in areas such as terrorist attacks, illegal surveillance and reconnaissance, smuggling, electronic snooping, and mid-air collisions, in addition to discussing on the categories of UAV intrusions in terms of intention and level of sophistication of the operators. Mitigation steps for UAV intrusions are also discussed, focusing on geo-fencing, detections systems (radar, and acoustic, radio frequency (RF) emission and electro-optical (EO) sensing), electronic defence (command link jamming and appropriation, and Global Navigation Satellite System (GNSS) jamming and spoofing), and kinetic defence (shooting down UAVs and net capture using interceptor UAVs).

93. How this Micro Drones effect to the national security?

a. Since the early introduction of Unmanned Aerial Vehicles (UAVs), drones are looked upon as being associated with major security issues, rendering them legitimate targets that are prone to various cyber-attack types. Moreover, they can also be used as a potential attack vector for malicious users.

94. What are the risks of drones?

a. One of the biggest risks, it said, was from radio frequency interference, resulting in loss of control, and, in the worst cases, fatalities. Other problems include invasion of privacy, aerial surveillance and data collection.

95. Problems of using drones

a. Screen's transmission is not smooth

1) The effects of screen transmissions can be divided into two areas: receiving distance and interference problems. The former is a more frequently encountered problem. In fact, different brands of UAV will specify the effective image transmission and remote-control signal receiving distance from hundreds of meters to several kilometers; near the critical point. Image transmission stability will be worse, and as long as the effective distance of about 70% has had the opportunity to pass the screen, the figure is not smooth. Basically, this method does not solve, but rather slowly shortens the flight distance to restore the image transmission picture.

2) As for the interference problem, we should pay attention to whether there is interference in the flight route of the operating UAVs such as overhead cables or a mobile communication tower base. In general, the drone will fly past disruptors and return to normal.

96. Blocked GPS signals

a. If the UAV receives more GPS satellite signals, the accuracy and stability of the flight will be better. Sometimes there are GPS reception problems in open areas. The reason is that it is disturbed by underground cables, or the location is beside rocks or walls that are blocking the satellite signal.

b. At this time, we should go to another flying place and ensure the new place is over 100 degrees for receiving satellite signals so that it can operate as usual.

97. Abnormal flight direction

a. Although we advise to calibrate the compass before each flight, I believe a lot of players think it is too busy to do this work, so sometimes they found the drone's flight direction is wrong or the drone is tilted in one direction.

b. Solution: control the drone landing and compass correction. We also should pay attention to whether the remote control settings are right. If necessary, we can restart or reset the remote control to solve the problem.

98. UAV signal lost

a. Although the UAV technology has become quite mature, the problem of lost signals occasionally occurs. When signals are lost, first we should keep calm. The majority of UAVs with GPS positioning function will use the lost return mechanism; even if they do not return, the lost signal UAV will hover in the air. The pilot should approach the UAV in order to shorten the distance of the UAV to the remote control, and try to reconnect. If it is necessary, you can restart the remote control, let them hook up again, and you can control the right to recover the aircraft in general.

CHAPTER SIX

CONCLUSION

99. With the technological advancements in the 21st century, the future of intelligence and the mannerisms of gathering information faces significant opportunities for advancements through various aspects. The prospects of Intelligence, Surveillance, Target Acquisition and Reconnaissance as they already are being benefited by the drone technology can possibly advance into unexplored surfaces by the newest addition of micro drones using its aspect to positive effect.

100. The effectiveness of this process is to be carefully analyzed and discussed with taking into consideration the limitations the micro drone technology presently faces and also study the pros and cons of opening a new dimension of ISTAR through the introduction of the Micro Drone technology and how to effectively exercise its possibilities in defence and other related sectors.

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