Imaginary Intelligence Via Satellites

https://doi.org/10.31713/MCIT.2023.014

Mugabil Huseynov
Military Scientific Research Institute
of National Defense University
Baku, Azerbaijan
huseynovmugabil@gmail.com

Elshan Hashimov
National Defense University
Azerbaijan Technical University
Baku, Azerbaijan
hasimovel@gmail.com

Abstract— **This article gives basic information about all types of satellites. The types of satellites reveal the functions, purposes and applications. Information is provided on the sections required to use a satellite. The features of reconnaissance satellites are characterized. Analytical factors of satellite imagery, their pros and cons were compared. The role and functions of satellite imagery in current and probable future wars are declared**

Keywords—component; satellite, reconnassiance satellite, activ and passiv satellites, satellite imegenary, Russian-Ukrainian war.

I. INTRODUCTION

There is a lot of information about satellites nowadays. The use of this technology is very common today. Satellite is already familiar with all the structures. But people know little about the structure, function and purpose of this technology. There is very little information about the satellites used especially for military purposes and their working mechanism. It is useful to first learn basic information about satellites to know our capabilities and to further assess the enemy's capabilities.

II. SATELLITES

Objects orbiting around a celestial body in a circular or elliptical shape are called satellites. Satellites are naturally and artificially divided into two types.

Natural satellites: satellites that revolve around planets due to various natural causes during the period of the planets. The moon is a natural satellite of planet Earth, planet Earth is a natural satellite of the sun [7].

Artificial satellites: are satellites produced by humans for scientific research, communication or observation.

The world's first artificial satellite was launched into orbit by the USSR on 4 October 1957. The release of this satellite, which was announced as Sputnik-1, officially marked the beginning of the "space age" [6].

The main areas of utilization of services provided by satellite communication operators:

- Commercial
- Military
- Governmental
- Civilian

The satellites orbiting the Earth serve the following purposes:

- Communication and communication;
- Remotely observing the Earth's surface;
- Technology development;
- GPS navigation services;
- Technology Demonstration;
- Space Surveillance;
- Space research;
- Surface Science Research [5].

Since near-Earth satellites are more susceptible to gravity, they are forced to rotate faster to balance this force. Thus, satellites close to Earth have a higher Earth rotation rate, while distant satellites have a slower or synchronous rotation rate [7].

Artificial satellites move in four orbits around the Earth:

- low Earth orbit (LEO);
- medium Earth orbit (MEO);
- highly elliptical orbit (HEO);
- geosynchronous orbit (GSO) / geostationary orbit (GEO) [5].

III. SATELLITE STRUCTURE

Satellites consist of three parts: the service section, the operational payload and the mechanical section.

Service Section:

The Satellite Servicing Section is the unit that keeps the satellite in space, balances its movements, and communicates with stations on the ground. This section consists of the engine system, the attitude control system, and the thermal management system.

Operational payload:

Satellites are lifted into space for a variety of reasons. Satellites lifted into space for warning purposes provide warning between two regions. A satellite lifted into space for reconnaissance purposes acquires various images on the ground and provides transmission to a ground station. The systems installed for the purpose of

space-lifting satellites, i.e. for mission tasks, are called the operational payloads [5].

Mechanical section:

The mechanical section connects the satellite dish, solar panels, receivers and other electronic systems and balances their loads as they ascend into space.

Satellite classification:

The classification of satellites by size is as follows

- Very heavy satellites - weighing up to 7000kg;
- Heavy satellites - weighing up to 5001 - 7000 kg;
- Large satellites - weighing up to 4201 - 5000 kg;
- Intermediate satellites - weighing up to 2501 - 4200 kg;
- Medium satellites - weighing up to 1201 - 2500 kg;
- Small satellites - weighing up to 601 - 1200 kg;
- Mini-satellites - weighing up to 201 - 600 kg;
- Micro-satellites - weighing up to 11 - 200 kg;
- Nanosatellites - weighing up to 1.1 - 10kg;
- Pico satellites - weighing up to 0.1 - 1 kilograms;
- Femto-satellites - weighing up to 0.1kg. [7].

Nowadays, due to ease of use and spatial elevation as well as cost effectiveness, small satellites are considered more suitable. Satellites are classified as scientific research satellites, meteorological satellites, positioning satellites, news satellites and remote reception satellites for use.

One of the most widely used areas of these systems, which has developed rapidly since World War II, is the military field. It works with electromagnetic energy emitted or reflected by objects.

In 1994, France, Russia, Israel, Brazil, China, India, Japan and Russia developed their own imaging satellites, The decision by the US Congress in February 1995 to release satellite images smaller than 1 meter was a major turning point in the field of imaging and target assessment [13].

IV. RECONNAISSANCE-SATELLITE SURVEILLANCE AND SATELLITE IMAGERY

The first reconnaissance satellite was launched into orbit by the United States in 1960. This satellite, known as CORONA, was designed to receive images from the USSR and other foreign countries. These images were then used to identify military installations and other strategic targets. This was the beginning of the era of satellite reconnaissance [3].

Despite its recent history, rapid advances in technology may make it worthwhile to explore the use of satellite imagery in terms of topographic applications within three generations [8].

Satellite images of the first generation (1970 - 1982) - the most significant satellites of this generation are Landsat-1, 2 and 3, Skylab and Soyuz. The main purpose of using these satellites was to produce small and medium size maps of the Earth with images acquired by receivers (sensors) with a visibility capability of 30 meters. However, a limited number of maps such as 1:250,000 and 1:500,000 could be made from the acquired images.

Second Generation Satellite Images (1982-1997) - The most important of these generations of satellites are Landsat-4 and 5, SPOT-1, 2 and 3, Space Shuttle, Soyuz, Salyut, Space and ERS-1 satellites can be noted. In particular, the images of these satellites, which were aimed at printing large scale maps such as 1:50,000 and 1:100,000 and updating existing maps, are much improved compared to the first generation satellite images [8].

Satellite images of the third generation (1997 and later periods) - Ikonos, EarlyBird, QuickBird, Landsat-7, SPOT-5, IRS-1C, as the most important of the satellites of this generation, Aster satellites can be recorded. In particular, the images obtained from these satellites can be used in the preparation of topographic maps at a scale of 1:10000 to 1:25000. The satellites of this generation had the greatest factor that distinguished them from others - the ability to distinguish by 0.5-1 meters in the received panchromatic images and by 2 meters in the multispectral images [8].

Receivers (sensors)**:**

Reconnaissance and surveillance satellites use two types of receivers (sensors) for passive and active operation [4].

1. Passive receivers (sensors) are microwave instruments designed to receive and measure natural emissions generated by the earth's surface and its atmospheric components. In short, these types of receivers require an external energy source (basic sunlight) to operate [2].
2. Active receivers (sensors) are a radar device used to measure signals transmitted by a sensor, reflected by the ground surface or atmosphere, broken or scattered. Briefly, these types of receivers produce the necessary energy themselves and send it to the object [2].

Passive receivers:

- Optical and electro-optical

Active receivers:

- SAR
- LIDAR

Types of images obtained from passive receivers (sensors)

- Single band image (Panchromatic)
- Multi-band image
- Multispectral image
- Hyperspectral image [3].

V. ADVANTAGES AND DISADVANTAGES OF SATELLITE IMAGERY

Advantages:

1. It is easy to obtain and utilize due to the development of modern technology;
2. It can cover a large territorial unit outside of a period of peace or war;
3. Has the ability to conduct reconnaissance and surveillance at any depth and without trespassing;
4. Has the ability to acquire real time images from the sensors they carry;
5. Detailed analyses are provided in conjunction with data from other intelligence activities;
6. It has broad control over all elements in our area of interest;
7. Most of the operational satellites have the ability to image the same area over a time interval ranging from 1-2 to 30 days;
8. The level of reliability and accuracy is the highest;
9. Since the acquired images are in digital format, there is no need for additional costs such as digitizing the product [3].

Disadvantages:

1. Expensive, maintenance requires some time and financial resources;
2. Some receivers are sensitive to the effects (sensors) of atmospheric and meteorological agents;
3. Camouflage measures used by the enemy have a negative effect;
4. It is difficult and expensive to obtain continuous images to track moving targets;
5. Specially trained personnel and software are needed to analyze the acquired images;
6. Can be deceptive like other types of reconnaissance;
7. Image readiness for use may not fulfil immediate needs as time will be required.

Eight main key factors to help evaluate and analyze the acquired images:

1. A figure shows the boundary lines, shape, or appearance of a target;
2. Magnitude is the size of an object and the area it covers;
3. Pattern is the systematic arrangement of bodies on the ground in a unique way;
4. Tone expresses the brightness of the light reflected from the target and the color visible in the image. This factor is influenced by a number of external factors:

- Meteorological conditions;
- Time of image output;
- Seasons;
- Brightness;
- The surface structure of the object.

5. Shadow is that the sunlight falling directly on the target reflects a clear image of the target on the ground surface;
6. Relation to the environment, to identify an object or region, comparisons must be made to determine what other existing factors are related to that object or region and why they are used;
7. Location is a position that takes into account other factors that exist near one of the targets;
8. Structure is the imaginary part of the objectives visible in the image.

The most important factor for personnel directly involved in the evaluation of the acquired images is the quality of the acquired image and minimal scalability. These features form the basis of the evaluation. The definition of bodies in the image taking into account the mentioned ones is as follows:

Resolution and accuracy of the images are first important thing for person who is dealing directly with interpreting (reading, analyzing) images. Those specifications are main issue of imaginary inelegancy. According abovementioned issues decertation of things on image should be done as follow steps.

- Recognition is to determine whether an object belongs to an image. (e.g. tank, single lane bridge etc.).
- Diagnosis is to determine whether the object in the image belongs to a certain type (T-72 tank, MIG-29 fighter jet, etc.).
- Technical analysis is a detailed disclosure of the characteristics of the object in the image.

Areas used for satellite imagery reconnaissance:

- Deep target detection;
- Determination of target location and structure;
- Determination of target coordinates;
- Preparation of target area model.
-

VI. SATELLITE IMAGERY USE IN RUSSIAN-UKRAINIAN WAR

In November 2021, Russia deployed between 100,000 and 150,000 armies in undercover training to Ukraine's borders. On 15 February 2022, Russian President Vladimir Putin officially announced that he had withdrawn his army from the Ukrainian border. In response, Ukrainian, American and British intelligence agencies claimed that troops had not been withdrawn from the region based on satellite imagery, and they shared satellite imagery with the global community via social media to confirm the data [9].

It is known that some independent operators (companies) such as Capella Space, ICEEYE and Satellogic are officially co-operating with the Ukrainian state. Many independent companies voluntarily support Ukraine, and these companies are cleverly using the situation to both demonstrate their abilities and develop their capabilities. By sharing satellite images of Russia's military aggression against Ukraine on social media, they draw the world's attention to the conflict and also show that the news they are spreading through the images is absolutely true [10].

In addition to these companies, Google has made objects belonging to the Russian army visible in its Google Maps application, taking the stealth function over the objects [11].

During the Ukrainian-Russian war, the use of a number of activities such as monitoring the progress of operations with satellite material, obtaining intelligence information, evaluating the results of firing, detecting and evaluating targets, were publicized in social networks. It is well known that satellite imagery has played an impotent role in recent and wars and it has been used for special purposes, but never military analyzed satellite images have been published on social networks during any war. It is indicating that the development and widespread use of technology such as satellite imaginary should be considered in war tactics and Military Decision Making Process.

One of the three main experiments learnt from the Russian-Ukrainian war is the transparency of the war zone. Now days you can get images of buttle field and whole area of interest from satellite easily [12]. This shows that the wars of the future will involve species intelligence. The main effort will be focus on how to get information faster and before than enemy. It means that future operations will be more depend on reconnaissance.

VII. Conclusions

- All the systems mentioned have the capability to immediately transmit the received data to the respective stations in real time form or real time with data linking capabilities.
- The systems are aimed at detecting all military or civilian targets or activities and can operate day and night.
- Natural phenomena (bad weather, fog, etc.) Actions to address the impact on the systems are ongoing.
- More emphasis is being placed on developing systems that can be used in a coordinated manner with other systems.
- UAV and satellite imagery have become more widely used.
- Satellite imagery has become more widely used in modern warfare. Satellite planning should be considered in the ongoing military decision-making process. Two factors need to be addressed here. One is the planning and analysis of satellite imagery in operational planning and progress, and the other is the consideration of the timing of their implementation, and the second is the consideration that the adversary also receives satellite imagery. There is a mechanism for acquiring and analysing satellite imagery and reporting the results, and the need to calculate the time required to implement this process.

The future war will involve satellite imagery, privacy and surprise will often be impossible, and there will be a greater need for the ability to detect not the enemy but the ability to detect faster than the enemy.

References

[1] M. Frąckiewiczin, *The History and Evolution of Spy Satellites*. [Online]. Available: https://ts2.space/en/the-history-and-evolution-of-spy-satellites/. [Accessed: October 13, 2023].

[2] C.G. Manning, *What are passive and active sensors?* [Online]. Available: https://www.nasa.gov/general/what-are-passive-and-active-sensors/. [Accessed: October 13, 2023].

[3] KKYY 30-7-1, Görüntü ve Hedef İstihbaratı Uygulamaları Yardımcı Yayını. (Imaginary And Targeting Intelligence Applications, support volume), Ankara, 2008.

[4] KKY 30-4, Hava Foto Keşif ve Kıymetlendirme Yönergesi, (Aerial Photography Reconnaissance and Evaluating Doctrine), Ankara, 2001.

[5] P. Rome, *Every Satellite Orbiting Earth and Who Owns Them.* [Online]. Available: https://dewesoft.com/blog/every-satellite-orbiting-earth-and-who-owns-them. [Accessed: October 13, 2023].

[6] A. Onion, M. Sullivan, M. Mullen and C. Zapata, *This Day In History*. [Online]. Available: https://www.history.com/this-day-in-history/sputnik-launched. [Accessed: October 13, 2023].

[7] ANUM, *Satellite: Definition, Types, & Facts*. [Online]. Available: https://www.embibe.com/exams/satellite/. [Accessed: October 13, 2023].

[8] H. Çelik and F. Yildiz, *Investigation of the accuracy of orthoimages produced from Aster satellite imagery*. [Online]. Available: https://harita.gov.tr/uploads/files/articles/aster-uydu-goruntulerinden-uretilen-ortofotolarin-dogrulugunun-arastirilmasi-1063.pdf. [Accessed: October 13, 2023].

[9] F. Gardner, *According to satellite images, Russia's presence on the Ukrainian border continues*. [Online]. Available: https://www.bbc.com/turkce/haberler-dunya-60431937. [Accessed: October 13, 2023].

[10] A. Datta, *GeoInt, OSINT Comes Off Age For Near Real Time Coverage of Ukraine Conflict*. [Online]. Available: https://www.geospatialworld.net/blogs/geoint-osint-comes-off-age-of-ukraine-conflict/. [Accessed: October 13, 2023].

[11] A. Kholodnova, *Google Maps has opened all military and strategic sites in Russia*. [Online]. Available: URL:https://babel.ua/en/news/77843-google-maps-has-opened-all-military-and-strategic-sites-in-russia-now-everyone-can-see-them-in-good-quality. [Accessed: October 13, 2023].

[12] "The future of war," The Economist, A Special Report, 2023, pp. 1–11.

[13] Y. Dehqanzada, and A. Florini, "Secrets for sale: How commercial satellite imagery will change the world," Washington, DC: Carnegie Endowment for International Peace, 2000.