AD-A065 610 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 22/2

PHOTOGRAPHIC SURVEILLANCE SATELLITES,(U)

OCT 78 C FENG

UNCLASSIFIED FTD-ID(RS)T-1657-78

| OF |

AD A065610

END

DATE FILMED

5--79

DDC

AD-A065610

FTD-ID(RS)T-1657-78

1

FOREIGN TECHNOLOGY DIVISION

PHOTOGRAPHIC SURVEILLANCE SATELLITES

By

Ch'un Feng

78 12 22 418

EDITED TRANSLATION

FTD-ID(RS)T-1657-78 31 October 1978

MICROFICHE NR: FTD-78-C-001464

PHOTOGRAPHIC SURVEILLANCE SATELLITES

By: Ch'un Feng

English pages: 11

Source: Hang K'ung Chih Shih, Nr. 3, March 1978, pp. 9-11

Country of Origin: China
Translated by: LINGUISTIC SYSTEMS, INC.
F33657-78-D-0618
James Wing
Requester: FTD/SDSS
Approved for public release; distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.	PREPARED BY: TRANSLATION DIVISION FOREIGN TECHNOLOGY DIVISION WP-AFB, OHIO.

Photographic Surveillance Satellites

Ch'un Feng

Photographic surveillance satellites are the military surveillance satellites most frequently used in military space surveillance activities at present. This article introduces the history, types, and working principles of such satellites.

As the proverb says, the higher you stand, the farther you can see. When we climb to the top of Mount Shiang -- "Evil Sees Sorrows", looking all over, the Lake Kunming, the majestic walls of Tien An Gate, the towering Peking Resturant, the ancient and famous White Pagoda ... all appear right before our eyes. We can fully enjoy the beautiful sight of our great nation's capital Peking. If you carry along a camera, you can take pictures of the view for permanent memory. Taking a camera to mountain tops and to the sky to photograph large areas of scenery on earth has a history of over a hundred years. Just because it possesses an advantage of "complete viewing", so "aerial photography" had been used quite early as an effective tool for military surveillance. As early as in the mid nineteenth century, someone had used balloons for photographic surveillance and cannon aiming. At that time, someone also had tried photographic experiments by tying a camera onto a kite. At the end of the nineteenth century, when airplanes were introduced, cameras were then put inside the planes. During the first world war, surveillance pictures taken by airplanes numbered several thousands. In the second world war, the number increased to ten thousand daily. These camera photographed large amounts of military intelligence on enemies' airports, military ports, arms factories, and various types of military facilities, as well as troop concentration, movement, and distribution, and transportation of supplies, performing a lot of actions in the military conflicts.

The introduction of artificial earth satellites pushes aerial photography into a new stage. Because satellites have the advantages over airplanes in speeds, altitudes, and field of view, and also have no vibration during motion, they can take clear pictures of large areas of the ground at very high altitudes. These advantages attracted great interests in using satellite photography for research on survey of the earth. Especially, its potential applications to military surveillance made the two great powers, U. S. A. and U. S. S. R., hungry for it. Right at the end of the second world war, the American imperialists immediately studied the feasibility of using satellites for photographic surveillance. Later, this type of spy satellites became one of the American imperialists' earliest satellites for military applications. In an attempt to dominate the world, the two superpowers strongly developed this type of satellites, and through various means stole military intelligence from one another, from our country, and from other nations. In the past few years, about a quarter of the two thousand and odd space vehicles were used for photographic surveillance. The Soviet revisionists were even madder. In the last ten years, they launched 34 or 35 satellites of this kind every year. In March of 1969, when the Soviet revisionists invaded our nation's noble land Chen Bao Island, they launched ten photographic surveillance satellites in a short period of two months. Although the Soviet revisionists' satellites were numerous, they could not change their predetermined fate of destruction. The event of Chen Bao Island ended with our victory and the Soviet revisionists' failure.

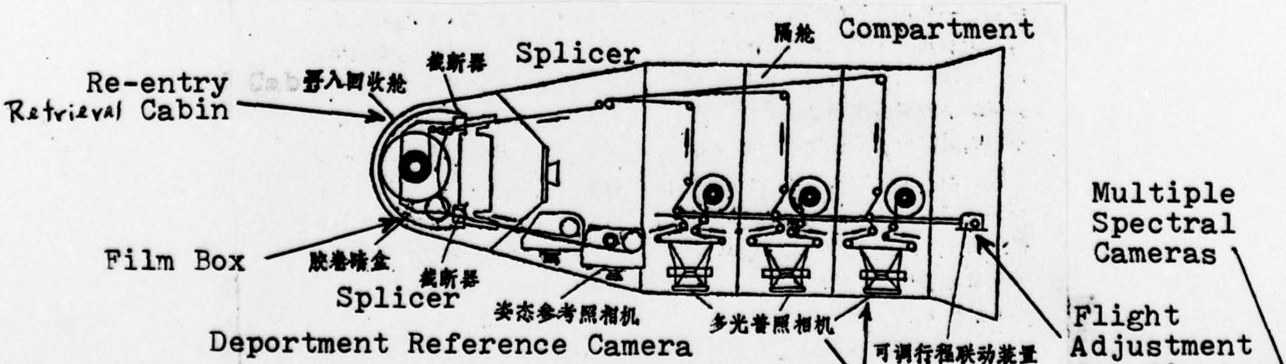
Of course, satellites as a photographic surveillance tool are rather quite useful. The smallest size of objects on earth that they can distinguish depends on the orbital altitude and the quality of the imaging system. The optical system for photographic surveillance presently used can distinguish ground objects the size of 0.3 meter. This resolving power not only can accurately determine the location of an intercontinental ballistic guided missile silo, but can also distinguish the difference of the silo sizes. The ground resolution of 0.3 meter is sufficient to identify by means of pictures the models of airplanes, tanks, and cars, even to recognize individuals. The multiple spectral techniques developed in the sixties gave new life to the traditional method of optical photographic surveillance in identifying camouflaged targets. The development of infrared imaging technique further makes it possible to spy on enemy's movement at night by satellite surveillance, and to track submerged nuclear submarines. Hence, the use of satellites for photographic surveillance has very important military values.

Photographic surveillance satellites can be grouped into two basic types,according to the methods by which the surveiilance pictures, taken by the satellites, are received. In one type, the exposed films taken on the satellites are retrieved on ground. This type is called retrieval photographic surveillance satellites. In the other type, the messages on the films are transmitted by radio signals to the ground. This type is called radio-transmission photographic surveillance satellites. Below is a brief introduction of these two types.

The Retrieval Type

Picture transmission is a key problem in satellite photographic surveillance. As far as surveillance is concerned, the quicker the results of the surveillance are known, and the finer and clearer the targets in the pictures can be seen, the better. Of course, it would be nice to be able to photograph and view instantly, like field television transmission. But, this is limited by the present level of technology. In the near future, such an idea may become a reality. When it does, we will enter into a new stage of real-time surveillance. At present, if an ordinary television camera is installed on a satellite and carried up to a height of 200 kilometers, using a 45-degree angle lens, the pictures it will take can only resolve a ground target of greater than 10 kilometers. This obviously cannot satisfy our requirements. On the other hand, the higher the resolution of the pictures, the amount of messages in each picture is also greater. In a picture of 23 centimeter square, if it has a resolution of 100 parallel lines per millimeter, then the amount of messages it contains will take about half of an hour to transmit by an ordinary television frequency band width. The flight time of a satellite moving on a low orbit over a ground station is only ten minutes. This means that, in each pass, only one third of the picture can be transmitted to ground. Obviously, similar difficulties exist in using radio signals to transmit pictures with high resolution. To solve this problem requires raising greatly the power of message transmission, and reducing the amount of messages in the pictures to be transmitted, thus lowering the resolution of the pictures. Before communication techniques have yet achieved sufficient rates of message transmission, a compromise can be made. That is to retrieve directly on ground or in air the films which have been exposed on a satellite. The picture resolution obtainable with optical photography is an order of magnitude higher than other types of imaging techniques. Therefore, this retrieval method has the advantage of being capable of obtaining highly resolved pictures.

A retrieval photographic surveillance satellite is generally equipped with cameras having narrow angle lens of long focusing lengths and large apertures in order to obtain high resolution pictures. It can also carry several cameras for multiple spectral photography (Fig. 1). Over the pre-designated targets, the



图一 回收舱型侦察卫星结构示意图

Fig. 1. Schematic Diagram of a Retrieval Surveillance Satellite.

satellite takes pictures following the ground commands or automatic sequencing controls. The exposed films are stored inside dark boxes in the retrieval cabin. When all the photographic jobs have been completed, the retrieval cabin (Fig. 2) is first

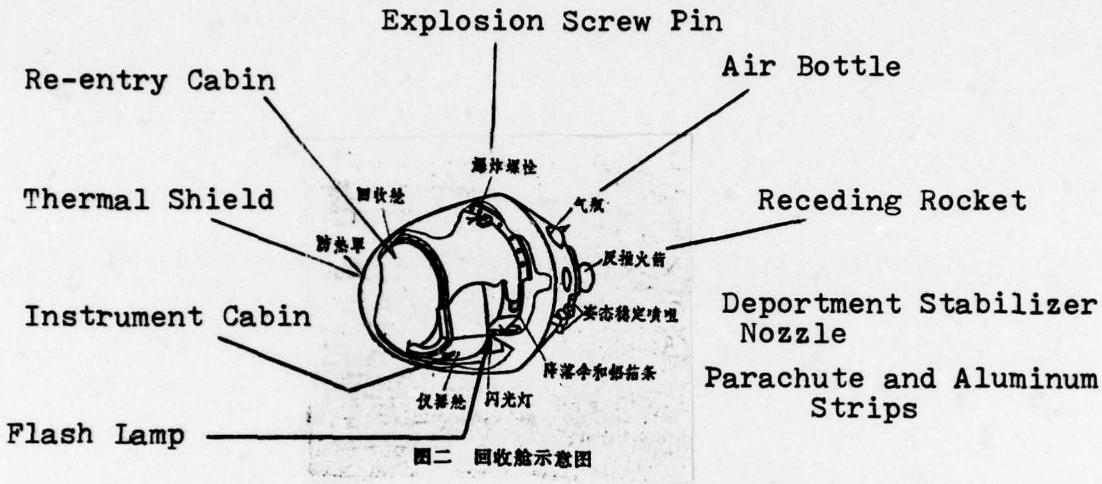


Fig. 2. Schematic Diagram of a Retrieval Cabin

launched from the main body of the satellite. Following the ground cammands, the retrieval cabin then starts the receding rocket over the pre-determined site. After deceleration, the retrieval cabin containing the films is further separated from the other components and enters the re-entry orbit (Fig. 3).

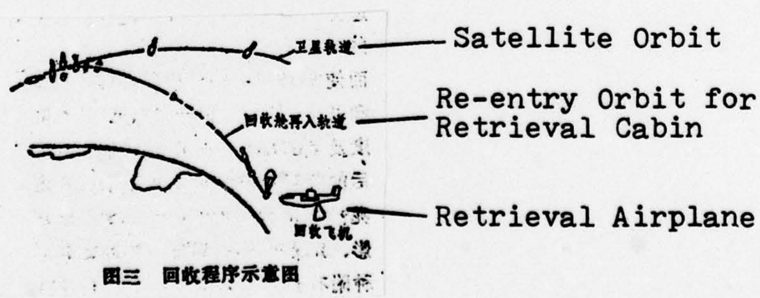


Fig. 3. Schematic Diagram of the Retrieval Process

After going through the high-density atmospheric layer, it rejects the thermal shields and, at the same time, broadcasts radio signals. Some even put out aluminum strips for detection and tracking by ground radar. At the height of about 15 thousand meters from the ground, the parachutes open and the speed further slows down. At that time, an airplane equipped with retrieval equipment would circle above the retrieval area, and will pick up the target in air as soon as it is discovered. If the aerial retrieval fails, the retrieval cabin with the films fallen on sea or land can continue to send out radio signals so that the ground crew can further search for it. In the entire retrieving process, the timing for firing the receding rocket must be accurately controlled. An error of 0.1 second can make a deviation of several kilometers from the landing site. The retrieved films are immediately developed and forwarded to the respective agencies for evaluation and analysis.

The Radio-transmission Type

Retrieval photographic surveillance satellites are generally equipped with narrow angle lens cameras. The pictures they take cover small areas, and their surveillance capability is limited by the volume of the films. Also, the retrieval is generally made only after the satellites have completed the entire photographic job, in about ten days' of motion on the orbit. Therefore, they are suitable for use in detailed surveillance (abbreviated DS) of a specific region or a new target of interest, but are not ideal for monitor surveillance (abbreviated MS) of large areas. With the development of satellite communication techniques, pictures of medium resolution can be obtained by direct radio-transmission of the films which have been processed on the satellite. In general, these radio-transmission photographic surveillance satellites are equipped with wide-angle lens cameras for MS of the ground. If a suspicious target is found to require DS, a retrieval type of photographic surveillance satellite can then be launched to take high-resolution pictures.

pictures. The complemental use of these two types of satellites can better complete the job of strategic surveillance.

The advantage of the radio-transmission type is fast collection of intelligence, making "real-time surveillance" possible; the disadvantage is that the resolution of the images on the pictures (originally of high resolution) is greatly reduced by the optical-electrical conversion and radio transmission. From this, we can see that the radio-transmission type sacrifices a certain amount of resolution as a price to obtain fast collection of intelligence.

Fig. 4 is a schematic diagram of the photographic system in the radio-transmission type of surveillance satellites. As a

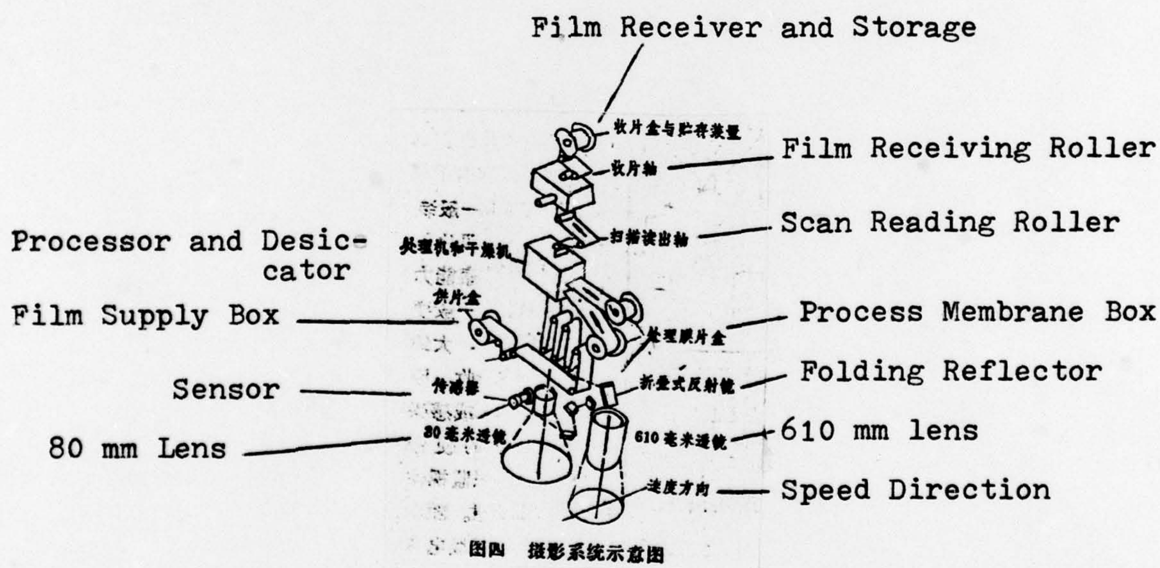


Fig. 4. Schematic Diagram of the Photographic System

satellite moves at high speeds on the orbit, in order not to blur the pictures in the time frames of exposure due to earth's rotation, the camera on the satellite, like those on airplanes, has a system of compensation for speed-altitude, recession, and deportment. How are the exposed films processed on the satellite? The processing is different from our conventional method of using liquid developers and fixers. It uses a type of processing membrane that has a developer attached. The exposed film and this processing membrane are pressed together by a roller for about three to four minutes and then separated. At this time, the exposed film becomes somewhat moistened. It is then put into a desiccator for drying at a constant temperature, and its moisture content is further removed by a desiccant. After these processes, the film is developed. It is next sent to the reading scanner (Fig. 5) which converts the image into video frequency signals to broadcast to the earth. In the reading scanner, the electron bundles emitted from the horizontal scanner strike on the vertically sweepable fluorescence material, and produce light. The light is focused on the film through a lens, forming a light dot of about six micrometers in diameter. The horizontal sweep of the electron bundles made by the horizontal

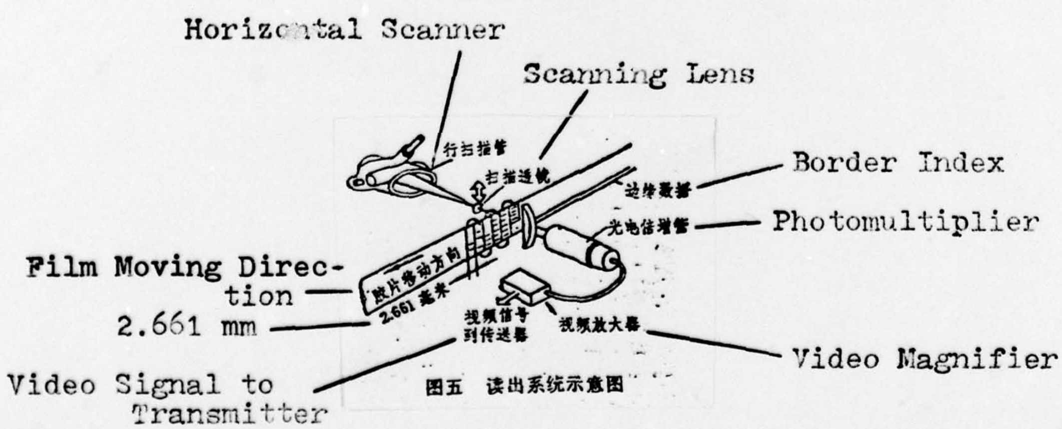


Fig. 5. Schematic Diagram of the Reading System.

scanner and the vertical sweep by the scanning lens produce a scanning of a certain width (such as the 2.661 millimeters in the figure) on the film. In addition, the film is moving sideways so that the entire picture is scanned. The intensity of the transmitted light from the light dot on the film is a function of the image density. The transmitted light, through a focusing system, is collected by a photomultiplier, which produces and amplifies electrical signals. The size of the signals is directly proportional to the intensity of the transmitted light. The message from this reflected picture is broadcast through antennas to the ground. At present, the resolution of the picture using this method of transmission can distinguish a ground object the size of about 0.9 meter at an altitude of 160 kilometers.

Characteristics of the Orbit

The selection of the reference number for the satellite orbit is very important in raising the effectiveness of photographic surveillance. To obtain pictures of high resolution, besides increasing the focus length and aperture of the camera and using light-sensitive films with finer grains, the orbital altitude should be as low as possible. But, at low altitudes, the air resistance is high, and the lifetime of the satellite will be shortened. The DS type satellites generally are maintained at orbits about 150 kilometers from the ground. In order to keep them idling on the orbit for many days, the satellites are usually equipped with small automatic rockets which initiate on pre-set times to adjust the orbital reference number, thus preventing them from falling into the atmosphere. Of course, the satellites so equipped also are capable of automatic aerial photographing over pre-designated areas when needed. For the MS type satellites which require longer lifetimes, the altitude from the ground should be more than 160 kilometers, somewhat higher than the DS type.

The principal equipment on photographic surveillance satellites is the optical camera. It produces and identifies images on light-sensitive films from the various colors and contrasts formed by ground objects by means of reflection, absorption, and transmission of the sunlight during the day. Therefore, better evaluation results can be obtained by selecting the proper entering angle of the sun rays, and by making use of the change in the degree of contrast of the objects. Using the proper orbital reference number, it is possible to maintain a constant relative position of the satellite's orbital plane and the sun. This orbit is called solar synchronized orbit. With this orbit, it is only necessary to select the launching time of the satellite in order to obtain the expected surveillance results. For example, if we want to perform a multiple spectral surveillance of the earth, the sun's position should better be over our heads. The light is strongest at this time of the day, and the shadows of the objects on the ground are also smallest. Hence, we send the satellite into the orbit at noon. If we choose to launch it in the morning, then the area over which the satellite passes will be in either the morning or the evening for that region. At that time, the sun rays' entering angle is the smallest; the ground target would show a long shadow and will not be difficult to discover.

In the past several years, photographic surveillance satellites have been much modified and improved. Now there is a satellite which has both the DS and MS functions. It can also use simultaneously various imaging techniques, (such as multiple spectral techniques, infrared thermal imaging, and side-viewing radar, etc.) so as to complement each other and achieve an all-weather surveillance capability. At present, from satellite launching to receiving surveillance pictures requires several days' time. In order to satisfy the practical military demands, the current trend is toward the development of "real-time surveillance". This requires, on the one hand, research and manufacture of high-resolution telephoto systems, and, on the other hand, development of largecapacity mid-relay satellite systems. Surveillance pictures can then be transmitted on real time.

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
A205 DMATC	1
A210 DMAAC	2
B344 DIA/RDS-3C	9
C043 USAMIIA	1
C509 BALLISTIC RES LABS	1
C510 AIR MOBILITY R&D LAB/FIO	1
C513 PICATINNY ARSENAL	1
C535 AVIATION SYS COMD	1
C591 FSTC	5
C619 MIA REDSTONE	1
D008 NISC	1
H300 USAICE (USAREUR)	1
P005 DOE	1
P050 CIA/CRB/ADD/SD	1
NAVORDSTA (50L)	1
NASA/KSI	1
AFIT/LD	1
LLL/Code L-389	1

ORGANIZATION	MICROFICHE
E053 AF/INAKA	1
E017 AF/RDXTR-W	1
E403 AFSC/INA	1
E404 AEDC	1
E408 AFWL	1
E410 ADTC	1
FTD	
CCN	1
ASD/FTD/NIIS	3
NIA/PHS	1
NIIS	2