AERIAL SURVEILLANCE & IMAGERY

4.1 SURVEILLANCE

Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting. Surveillance is therefore an ambiguous practice, sometimes creating positive effects, at other times negative. It is sometimes done in a surreptitious manner. It most usually involves observation of individuals or groups by government organizations (though there are some exceptions, such as disease surveillance, which monitors the progress of a disease in a community without for that matter directly observing or monitoring individuals).

Figure 4 - 1 Surveillance

The word surveillance may be applied to observation from a distance by means of electronic equipment (such as CCTV cameras), or interception of electronically transmitted information (such as Internet traffic or phone calls). It may also refer to simple, relatively no- or low-technology methods such as human intelligence agents and postal interception.

Figure 4 - 2 Surveillance using CCTV

Surveillance is very useful to governments and law enforcement to maintain social control, recognize and monitor threats, and prevent/investigate criminal activity. With the advent of programs such as the Total Information Awareness program and ADVICE, technologies such as high speed surveillance computers and biometrics software, and laws such as the Communications Assistance for Law Enforcement Act, governments now possess an unprecedented ability to monitor the activities of their subjects.

Figure 4 - 3 Surveillance using electronic camera

Surveillance equipment is a broad term encompassing a wide range of equipment used to observe what people are doing, either overtly or covertly. Although many people think of surveillance equipment as being in the realm of spies and espionage, the most common surveillance equipment seen today is the simple closed-circuit television (CCTV) camera. These cameras are seen in banks, football stadiums, many stores, or around the streets of countries such as the United Kingdom. Although the term may be

used to describe any surveillance device, today, it is most often used to describe electronic devices, as opposed to analog devices such as binoculars or fingerprinting equipment.

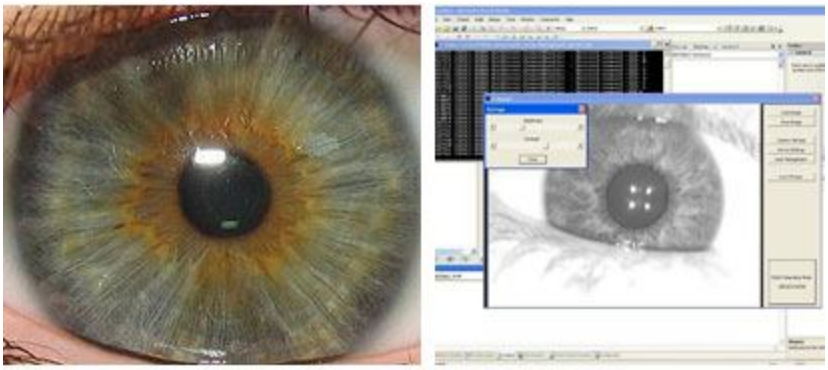


Figure 4 - 4 Biometric Surveillance to identify eye retina

Surveillance cameras are the simplest form of equipment used, and because of their relative affordability, and ease of installation, they are widely used. For example, in the United Kingdom there are more than four million CCTV cameras throughout the country. In China, surveillance cameras are used with increasing frequency, and are used in conjunction with advanced facial-recognition software, and tracking systems, with the stated goal of ultimately creating a registry of every citizen. In the United States, due to privacy concerns, the use of CCTV cameras for surveillance is more limited, but many municipal governments install them under the auspices of traffic monitoring, and later open them to law enforcement.

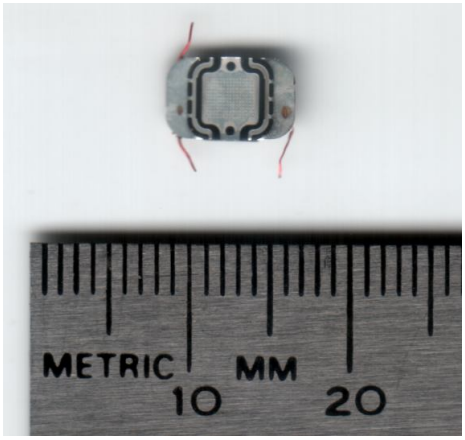


Figure 4 - 5 RFID chip pulled from new credit card

Radio Frequency Identification (RFID) tagging is the use of very small electronic devices (called "RFID tags") which are applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. The tags can be read from several meters away. They are extremely inexpensive, costing a few cents per piece, so they can be inserted into many types of everyday products without

significantly increasing the price, and can be used to track and identify these objects for a variety of purposes.

Many companies are already "tagging" their workers, who are monitored while on the job. Workers in U.K. went on general strike in protest of having themselves tagged. They felt that it was dehumanizing to have all of their movements tracked with RFID chips. Some critics have expressed fears that people will soon be tracked and scanned everywhere they go.

Verichip is an RFID device produced by a company called Applied Digital Solutions (ADS). Verichip is slightly larger than a grain of rice, and is injected under the skin. The injection reportedly feels similar to receiving a shot. The chip is encased in glass, and stores a "VeriChip Subscriber Number" which the scanner uses to access their personal information, via the Internet, from Verichip Inc.'s database, the "Global VeriChip Subscriber Registry". Thousands of people have already had them inserted. In Mexico, for example, 160 workers at the Attorney General's office were required to have the chip injected for identity verification and access control purposes.

A more advanced form of surveillance equipment is biometric equipment. This is equipment that looks at specific characteristics of a person to identify them. For example, fingerprint scanners are an example of a biometric system, as are retinal scanners. More advanced scanners may analyze the gait of a person as they are walking to identify them, or may track their voice as they speak in order to identify them. Although some of these systems, such as fingerprint scanners, may be overt, others, such as gait analyzers, may be covert.

4.2 AERIAL SURVEILLANCE

Aerial surveillance equipment is another advanced form of surveillance that has seen a huge boom in the last few years, as miniaturization has become more advanced and prices have dropped. Small aerial drones are able to use lasers, infrared scanners, and cameras to track subjects on the ground.

Digital imaging technology, miniaturized computers, and numerous other technological advances over the past decade have contributed to rapid advances in aerial surveillance hardware such as micro-aerial vehicles, forward-looking infrared and high-resolution imagery capable of identifying objects at extremely long distances.

Figure 4 – 6 Aerial Surveillance using aircraft

For instance, the MQ-9 Reaper, a U.S. drone plane used for domestic operations by the Department of Homeland Security, carries cameras that are capable of identifying an object the size of a milk carton from altitudes of 60,000 feet, and has forward-looking infrared devices that can detect the heat from a human body at distances of up to 60 kilometers. In an earlier instance of commercial aerial surveillance, the Killington Mountain ski resort hired 'eye in the sky' aerial photography of its competitors' parking lots to judge the success of its marketing initiatives as it developed starting in the 1950s.


Figure 4 – 7 Aerial Surveillance using Balloon

The United States Department of Homeland Security is in the process of testing UAVs to patrol the skies over the United States for the purposes of critical infrastructure protection, border patrol, "transit monitoring", and general surveillance of the U.S. population. Miami-Dade police department ran tests with a vertical take-off and landing UAV from Honeywell, which is planned to be used in SWAT operations. Houston's police department has been testing fixed-wing UAVs for use in "traffic control".

The United Kingdom, as well, is working on plans to build up a fleet of surveillance UAVs ranging from micro-aerial vehicles to full-size drones, to be used by police forces throughout the U.K.

Figure 4 – 8 Aerial Surveillance using UAV “Predator”

4.3 AERIAL PHOTOGRAPH

Aerial photography is the taking of photographs of the ground from an elevated position. The term usually refers to images in which the camera is not supported by a ground-based structure. Cameras may be hand held or mounted, and photographs may be taken by a photographer, triggered remotely or triggered automatically.

Figure 4 – 9 Aerial Photograph

Platforms for aerial photography include fixed-wing aircraft, helicopters, multirotor Unmanned Aircraft Systems (UAS), balloons, blimps and dirigibles, rockets, kites, poles, parachutes, and vehicle mounted poles. Aerial photography should not be confused with Air-to-Air Photography, when aircraft serve both as a photo platform and subject.

4.3.1 Types of aerial photographs

Oblique photographs

Photographs taken at an angle are called oblique photographs. If they are taken from a low angle earth surface–aircraft, they are called low oblique and photographs taken from a high angle are called high or steep oblique.

Figure 4 – 10 Oblique photographs

Vertical photographs

Vertical photographs are taken straight down. They are mainly used in photogrammetry and image interpretation. Pictures that will be used in photogrammetry are traditionally taken with special large format cameras with calibrated and documented geometric properties.

Combinations

Aerial photographs are often combined. Depending on their purpose it can be done in several ways, of which a few are listed below.

- Panoramas can be made by stitching several photographs taken with one hand held camera.
- In pictometry five rigidly mounted cameras provide one vertical and four low oblique pictures that can be used together.
- In some digital cameras for aerial photogrammetry images from several imaging elements, sometimes with separate lenses, are geometrically corrected and combined to one image in the camera.

Orthophotos

Vertical photographs are often used to create orthophotos, alternatively known as orthophotomaps, photographs which have been geometrically "corrected" so as to be usable as a map. In other words, an orthophoto is a simulation of a photograph taken from an infinite distance, looking straight down to nadir. Perspective must obviously be removed, but variations in terrain should also be corrected for. Multiple geometric transformations are applied to the image,

depending on the perspective and terrain corrections required on a particular part of the image.

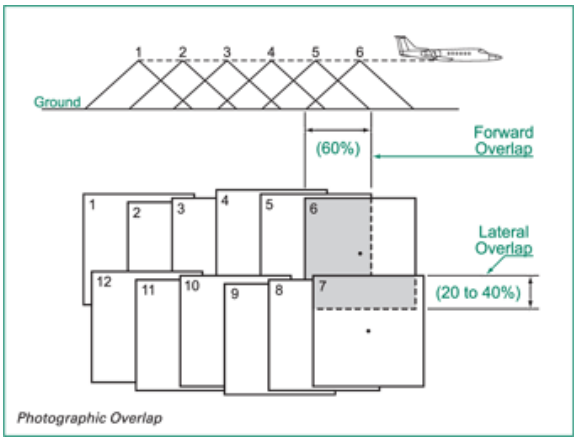


Figure 4 – 11 Overlapped Orthophoto

Orthophotos are commonly used in geographic information systems, such as are used by mapping agencies (e.g. Ordnance Survey) to create maps. Once the images have been aligned, or "registered", with known real-world coordinates, they can be widely deployed.

Large sets of orthophotos, typically derived from multiple sources and divided into "tiles" (each typically 256 x 256 pixels in size), are widely used in online map systems such as Google Maps. OpenStreetMap offers the use of similar orthophotos for deriving new map data. Google Earth overlays orthophotos or satellite imagery onto a digital elevation model to simulate 3D landscapes.

4.3.2 Aerial photography platforms

Radio-controlled aircraft

Advances in radio controlled models have made it possible for model aircraft to conduct low-altitude aerial photography. This has benefited real-estate advertising, where commercial and residential properties are the photographic subject. Full-size, manned aircraft are prohibited from low flights above populated locations. Small scale model aircraft offer increased photographic access to these previously restricted areas. Miniature vehicles do not replace full size aircraft, as full size aircraft are capable of longer flight times, higher altitudes, and greater equipment payloads.

Recent (2006) FAA regulations grounding all commercial RC model flights have been upgraded to require formal FAA certification before permission to fly at any altitude in USA.

Figure 4 – 12 RC Heli with Camera

In Australia Civil Aviation Safety Regulation 101 (CASR 101) allows for commercial use of radio control aircraft. Under these regulations radio controlled unmanned aircraft for commercial are referred to as Unmanned Aircraft Systems (UAS), where as radio controlled aircraft for recreational purposes are referred to as model aircraft. Under CASR 101, businesses/persons operating radio controlled aircraft commercially are required to hold an Operator Certificate, just like manned aircraft operators. Pilots of radio controlled aircraft operating commercially are also required to be licenced by the Civil Aviation Safety Authority (CASA).

Figure 4 – 13 RC Aircraft Model with Camera

Due to a number of illegal operators in Australia making false claims of being approved, CASA published and maintains of approved UAS operators.

Multirotor Unmanned Aircraft Systems

A number of multirotor UAS are purposely built for aerial photography.

- Octocopters (8 rotors)
- Hexacopters (6 rotors)

- Quadcopters (4 rotors)
- Tricopters (3 rotors)

Multirotors have been the platform of choice for professional aerial photographers because they are mechanically simpler than helicopters, thus reducing the risk of mechanical failure. Correctly built and tuned they also offer less vibration and greater stability.

Figure 4 – 14 RC Hexacopter with Camera

Multirotors generally have at least 2 rotors, however with the additional rotors, their payload lifting capacity and redundancy increases. If a 6 rotor aircraft loses power to one rotor it will lose yaw control. If an 8 rotor aircraft loses power to 1 rotor, there is negligible effect on control. This is an important design feature because unlike helicopters with a variable pitch rotor, multirotor aircraft do not have the ability to autorotate.

4.3.3 Basic Concept of Aerial photography

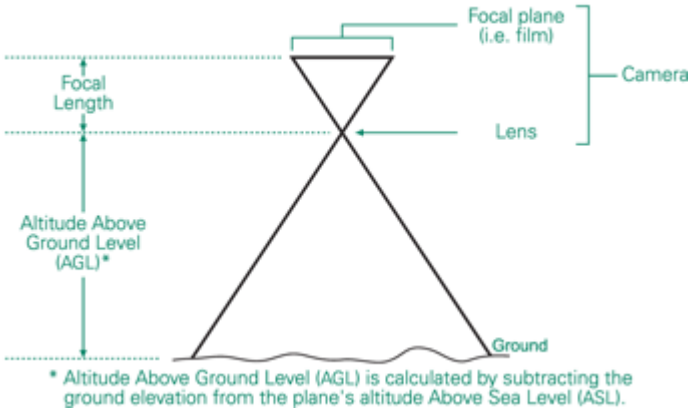
Focal length: the distance from the middle of the camera lens to the focal plane (i.e. the film). As focal length increases, image distortion decreases. The focal length is precisely measured when the camera is calibrated.

Scale: the ratio of the distance between two points on a photo to the actual distance between the same two points on the ground (i.e. 1 unit on the photo equals "x" units on the ground). If a 1 km stretch of highway covers 4 cm on an air photo, the scale is calculated as follows:

How to calculate scale on a photo. Calculate the scale taking the ratio of the distance between two points on a photo to the actual distance between the same two points on the ground.

$$\frac{\text{PHOTO DISTANCE}}{\text{GROUND DISTANCE}} = \frac{4\text{ cm}}{1\text{ km}} = \frac{4\text{ cm}}{100\,000\text{ cm}} = \frac{1}{25\,000} \quad \textbf{SCALE: 1/25 000}$$

Another method used to determine the scale of a photo is to find the ratio between the camera's focal length and the plane's altitude above the ground being photographed.



If a camera's focal length is 152 mm, and the plane's altitude Above Ground Level (AGL) is 7 600 m, using the same equation as above, the scale would be:

$$\frac{\text{FOCAL LENGTH}}{\text{ALTITUDE (AGL)}} = \frac{152\text{ mm}}{7\,600\text{ m}} = \frac{152\text{ mm}}{7\,600\,000\text{ mm}} = \frac{1}{50\,000} \quad \textbf{SCALE: 1/50 000}$$

Scale may be expressed three ways:

- Unit Equivalent
- Representative Fraction
- Ratio

A photographic scale of 1 millimetre on the photograph represents 25 metres on the ground would be expressed as follows:

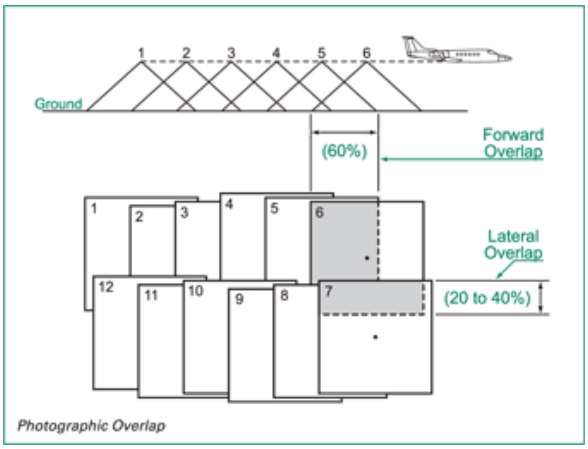
- Unit Equivalent - 1 mm = 25 m
- Representative Fraction - 1/25 000
- Ratio - 1:25 000

Two terms that are normally mentioned when discussing scale are:

Large Scale - Larger-scale photos (e.g. 1/25 000) cover small areas in greater detail. A large scale photo simply means that ground features are at a larger, more detailed size. The area of ground coverage that is seen on the photo is less than at smaller scales.

Small Scale - Smaller-scale photos (e.g. 1/50 000) cover large areas in less detail. A small scale photo simply means that ground features are at a smaller, less detailed size. The area of ground coverage that is seen on the photo is greater than at larger scales.

Overlap: is the amount by which one photograph includes the area covered by another photograph, and is expressed as a percentage. The photo survey is designed to acquire 60 per cent forward overlap (between photos along the same flight line) and 30 per cent lateral overlap (between photos on adjacent flight lines).



Stereoscopic Coverage: the three-dimensional view which results when two overlapping photos (called a stereo pair), are viewed using a stereoscope. Each photograph of the stereo pair provides a slightly different view of the same area, which the brain combines and interprets as a 3-D view.

Roll and Photo Numbers: each aerial photo is assigned a unique index number according to the photo's roll and frame. For example, photo A23822-35 is the 35th annotated photo on roll A23822. This identifying number allows you to find the photo in NAPL's archive, along with metadata information such as the date it was taken, the plane's altitude (above sea level), the focal length of the camera, and the weather conditions.

Flight Lines and Index Maps: at the end of a photo mission, the aerial survey contractor plots the location of the first, last, and every fifth photo centre, along with its roll and frame number, on a National Topographic System (NTS) map. Photo centres are represented by small circles, and straight lines are drawn connecting the circles to show photos on the same flight line.