FO 4311/6311 -Spatial Technologies Laboratory 1
1A - Types of Remotely Sensed Data

The objective of this exercise is to familiarize you with a few of the formats and types of remotely sensed data which are currently available for problem-solving operations in resource management.

I. Formats

A. Hardcopy
  1. Size/format (enlargement factor)
  2. Media: print, positive transparency, negative

B. Digital
  1. magnetic tape; 9 track, 1600/6250 b.p.i.
     8mm cartridges
     floppy disks

  2. CD Rom

II. Types

A. Geometry - Vertical vs. Oblique
  What is the difference between Vertical and Oblique
  What is the difference between High and Low Oblique?
  What are the advantages and dis-advantages of each type?

B. Spectral - film, filter, season, wavelength coverage
  1. panchromatic
  2. black & white infrared
  3. Ektachrome aerial color
  4. color infrared
  5. SLAR (side-looking aerial radar)
  6. LIDAR - multi-return aerial laser
  7. multispectral digital data - analog form

C. Interpretive Properties - by film, filter, season combination

III. General Questions

1. What photo information is available from the photo?
2. What are the sources for obtaining imagery?
3. What are the advantages and disadvantages?
4. What are the primary uses?
5. What are the wavelengths/energy relationships?
6. What filters are normally used with it?

7. What wavelength(s) is it most sensitive to with and
without a filter; i.e. wavelength shift ?
8. How does the cost compare to other films?

8. Compare and contrast the different spectral coverages with respect to the ability to discriminate hydrologic and cultural features and forest types?

10. How does season and scale affect the interpretative properties of remote imagery and your ability to "see"?

Be prepared to answer the above questions! No formal report is required, but be prepared!

FO 4311/6311 - Spatial Technologies Laboratory

1B. - Stereo-Vision and Preparation of Photos for Viewing

The objectives of this exercise are: (1) improve your knowledge about the mechanics of stereo-vision and ways of achieving stereo-vision, (2) test your ability to discriminate small differences in parallax, thus your ability to "see" height on stereo-pairs, (3) obtain practical experience in seeing stereo with stereo-pairs, (4) teach you the proper procedures for setting up photographs for stereo-viewing, and (5) inform you as to proper care of aerial photographs. The laboratory will be conducted in the following phases:

1. Define Stereo-Vision
2. The Mechanics of Stereo-Vision
3. Methods of achieving Stereo-Vision
    a. Pocket Stereoscope
    b. Mirror Stereoscope
    c. Ocular
    d. Anaglyph
4. Stereo-Acuity Test
5. Stereo-Pairs; setting up for viewing
    a. Definition of Stereo-Pairs
    b. Practice Pairs - pocket and mirror stereoscopes, light table.
6. Preparation of Photos for Stereo-Viewing
7. Care of aerial photos
8. Identifying photo images

Stereoscopic Vision

The third dimension of depth perception is obtained when objects are viewed with two eyes, a process called stereoscopy. When each eye focuses on the same object from a different viewing position and transmits a slightly different image to the brain, the brain fuses the two images into a three-dimensional image of the original object. The result is known as <u>binocular or stereoscopic vision</u>.

Preparation of Photos for Stereo-Viewing

<u>Introduction</u>: In viewing a stereo-pair of photographs, the left eye looks at the left photograph and the right eye at the right photograph. It is essential that the photographs be oriented in the exact relative position as which they were taken. Proper orientation is very important because (1) it insures obtaining the maximum relief effect, (2) it contributes to the accuracy of the work, and (3) above all, it minimizes eye strain, a vital consideration where work is continuous for a period of time.

Two procedures must be accomplished in order to orient a pair of photographs for proper steroviewing: first, the center or principal point of each print must be located; and second, the line of flight from the center of one photograph to the center of the other must be determined.

Step 1: Locate and Label Principal Point

To facilitate the location of the center, an indicator is accurately adjusted in the aerial camera to record marks on the film from which the center can be determined. These marks are known as fiducial marks. Marks vary with the different types of cameras; note the difference in fiducial marks between ASCS photography and NASA imagery. Lines drawn to connect opposite fiducial marks will intersect at the optical center of the print (i.e. film plane). This point is known as the **principal point (PP)**. Older prints may have brackets in the corners, or in the case of some Canadian photos, a small cross at the principal point.

Lines projected to obtain the principal point should not be drawn across the full width of the print; extend the lines near the center of the photograph only to form a small cross at the center. This avoids unnecessary defacement of the print and possible later confusion. When the principal point (PP) is located, a small pin prick is made through the point and a circle drawn around it with compass and red ink to facilitate future recognition. In order to facilitate future mapping operations with the prints, all principal point circles should be drawn the same diameter. Circles should be two-tenths (0.2) of an inch in diameter, with the line as thin as possible.

Step 2: Determine Line of Flight with Conjugate Principal Points

The second step, determining the line of flight, is accomplished by the locating principal point of each photograph on each of the adjacent prints. In order to do this, each exposure must be made with at least 55% overlap. Otherwise, the center of one photograph would not appear clearly on the adjacent ones. The optical center of one print (PP), when transferred to an adjacent one, is called the **conjugate principal point (CPP)**. Conjugate points can be located and pricked by visual inspection of ground detail. If sufficient, identifiable detail around the point is lacking, the prints may be carefully aligned under the stereoscope and the conjugate principal point located by optically superimposing the principal point of one photo onto the adjacent photo of the stereo pair. Align the prints several times to assure that you have obtained the maximum stereo-relief possible, and check the tentative location of the CPP each time (see section below on Obtaining Optimum Stereo).

To optically transfer the PP of the left photo to the right photo, the right photo is overlapped on top. While viewing the "common" area under the stereoscope, move the pencil from right to left on the right photo until the tip appears to be in the pen prick at the center of the PP circle. When the location of the CPP is confirmed, prick the CPP, and draw a circle in black ink; 0.2 inches in diameter.

The Flight Line

The line of flight between the two exposures of a stereo pair is called the air base. The length of a corresponding line drawn between the principal point and the conjugate principal point on a photograph is called the stereo base. Since a plane seldom flies exactly in a straight line, the line passing through one conjugate point and the principal point on a photograph will seldom pass in extension through the other principal point. This variation in the direction of flight, caused by drift and/or crab, is why it is necessary to locate the points on each print and use the line of flight as a basis for orientation rather than just aligning the edges of the prints.

Orientation and Stereo-Viewing of Photographs

Introduction: Although it is convenient, it is not necessary to draw the flight line in ink on the photograph. Location of the principal points and conjugate principal points completes the necessary preliminary preparation of the set of prints for stereoscopy.

Normal eye separation distance: Determining the normal eye separation distance is the next step in orienting photos for stereo viewing and should be accomplished as follows:

> Pair off with an adjacent student. Look straight ahead with eyes focused as far in the distance as possible. Have the other student stand in front of and slightly lower than you and hold up a piece of paper just under your eyes. The position (distance separation) of the pupils should be marked on the paper. Measure and make a note of this distance; it is your interpupillary distance that will be used in all subsequent stereo operations.

Orienting stereo-pairs for stereoscopic viewing:

> A. The first step in orienting the pair of photographs for stereoscopic examination is to turn them so the shadows fall more toward than away from the observer. The mind is so accustomed to this arrangement that there is a strong tendency to see relief in reverse if the shadows fall away from the point of observation. A few minutes examination of a single print will usually illustrate this phenomenon, known as a pseudoscopic effect.
>
> B. The second step is to superimpose one print on the other so that the recognizable gross features overlap. It is then apparent which is the right hand print and which is left. If the overlap is so great and the field of vision so small that corresponding features cannot be brought into the field of view for the pocket stereoscope, the prints are probably reversed. Reversal of the prints is very possible with the greater separation of a mirror stereoscope. With print reversal, topographic relief will appear in reverse as with incorrect orientation of shadows, only much more strongly. Occasionally a **psuedoscopic** effect is obtained intentionally to facilitate interpretation of detail, or to measure the depth of a well or pit.
>
> C. The third step is to align the photographs along the line of flight (use a straight edge) and to separate the principal point of one photo from the conjugate principal point of the stereo-pair a distance equal to (or slightly less than) the interpupillary distance.
>
> D. The last step is to open the stereoscope to the measured eye separation (interpupillary) distance, and place it up over the stereo-pair so that the long axis of the lenses is parallel to the flight line. Look through the stereoscope. If objects and features are perfectly aligned,

instant stereo-vision will result; however, if objects tend to be separated or "drag" together, use the following procedure to obtain optimum stereo-vision.

Obtaining Optimum Stereo-Vision:

A. Optimum Lens Separation: While looking through the stereoscope, observe carefully the relative height of some object. While maintaining your sight on this object, cautiously decrease the lens separation distance by a fraction of an inch. Return to the lens separation to the original position and then pull lenses further apart, all the while watching the selected object. If the original separation distance was correct, movement in either direction will cause an apparent decrease in the height of the object. However, if the separation distance was not initially correct, a point of maximum apparent height will be found at some point during the changes of the separation distance. Record this separation distance and repeat several times to obtain an average. Keep this average for future reference.

B. Optimum Print Separation: After initially determining the best lens separation distance, increase or decrease the print separation distance, holding the lens separation distance constant, to find the distance where the images fuse (i.e. remain "together") and appear to be in the "sharpest" focus.

C. Repeat Steps A and B until the lens and print separation distances remain constant. Record the optimum print and eye separation distances.

Stereo-Viewing of the Effective Area: With a pocket stereoscope, only a small portion of the total stereo area (approximately 14 cm) may be viewed on the end of one photo of the stereo pair. To view the area under the end of photograph, you can reverse the overlap or roll up (i.e. turn up) the end of the photograph between the lenses and slide the stereoscope (parallel to flight line). Use one hand to roll the end up and the other hand to slide the stereoscope. Be careful not to bend the photo and break the emulsion.

Care of Aerial Photos

Aerial photographs are expensive to purchase and can be damaged with improper handling, storage, marking, and use. New photography is flown every 5-10 years (ASCS=7-10, NAPP=5), so in most forest resource operations you will be using the same photographs for many years.

Marking on Photos: For temporary marks and gross to medium accuracy (i.e line width), use a grease pencil. Grease pencil marks are coarse, but they can be easily removed with benzene or acetone. A cotton swab moistened with an organic solvent should be lightly rubbed over the marks and immediately followed by a dry swab. The cleaning procedure can be repeated as often as necessary.

For more accurate markings, use a soft (H) pencil. Do not apply more than light pressure to the pencil or the emulsion of the print may be depressed and broken.

Permanent marks can be made with India ink or a permanent, thin, felt-tip pen, but remember the ink cannot be removed.

Do not use a ball point pen!

Taping Photos Down: When taping a photo to any surface, use only a small strip of drafting tape in the extreme corners. If you use regular masking tape, the tape should not be left in place more than a few days; it will become brittle over long periods and the adhesive will adhere tenaciously to surfaces. If the tape is extremely sticky, press the tape onto a table surface then remove it and put it on the photo.

When the tape is to be removed, lift the end of the tape attached to the photo and gently peel directly back, from the photo toward the other surface. If care is not taken, the emulsion may pull off with the tape.

Pricking PP and CPP's: Pin pricks should be made as small as possible; a large hole will decrease the accuracy of later work.

Rolling Photo's During Stereo-Viewing: Be careful not to bend the emulsion surface when rolling the photo end.

Storing Photos: Photographs should be stored flat. When photos are bent, the emulsion will crack.

Using Photos in the Field: When photographs are used in the field, they should be protected from rain and dirt with a hard plastic cover or sleeve. Most forestry supply firms sell a field cover for aerial photographs; they are worth the expenditure.

Remember that your lab grade and/or your job depends partially upon the accuracy of your work and that accuracy is partially dependent on the condition of the photos. Treat them properly.

Identifying Photo Images

While you are learning to align photos for stereo-viewing, take time to observe the images and see how many objects you can identify. Being able to identify objects in terms of their significance to resource management is an important part of photogrammetry. **Photo interpretation** is the art and science of identifying objects or conditions on aerial photographs and determining their meaning and/or significance. The recognition elements you will learn to use in identifying objects are:

Shape Shadow Tone or color Association

Size Site Texture Pattern

As you explore the photos in stereo, see if you can identify the following objects:

Roads - blacktop vs. gravel vs. woods
Water - river vs. creeks vs. lakes vs. ponds
Rights-of-ways - powerlines vs. gas lines
Agricultural fields - cultivated vs. pasture vs. idle
forest stands/types - pine vs. hardwood;
plantations vs. natural stands
dense vs. scattered crowns
structures - house vs. barn vs. church vs. store
topography - ridge vs. slope vs. bottom

Which of the recognition elements did you use to identify the various photo objects?

FO 4311/6311 - Spatial Technologies Laboratory

1C. - Stereo-Perception Tests

I. Floating Circles Test: Mark the circle with an X in the row,column location corresponding to the "floating" circle in each row. There will be at least one and sometimes two floating circles in each row, not necessarily each column. Do not guess! It is better to not circle one than to circle one incorrectly. Each wrong answer counts 4 points, including the one you failed to mark.

BLOCK A

Row	Column 1	2	3	4	5	6	7	8
A	O	O	O	O	O	O	O	O
B	O	O	O	O	O	O	O	O
C	O	O	O	O	O	O	O	O
D	O	O	O	O	O	O	O	O
E	O	O	O	O	O	O	O	O

BLOCK B

Row	Column 1	2	3	4	5	6	7	8
A	O	O	O	O	O	O	O	O
B	O	O	O	O	O	O	O	O
C	O	O	O	O	O	O	O	O
D	O	O	O	O	O	O	O	O
E	O	O	O	O	O	O	O	O

BLOCK C

Row	Column 1	2	3	4	5	6	7	8
A	O	O	O	O	O	O	O	O
B	O	O	O	O	O	O	O	O
C	O	O	O	O	O	O	O	O
D	O	O	O	O	O	O	O	O
E	O	O	O	O	O	O	O	O

BLOCK D

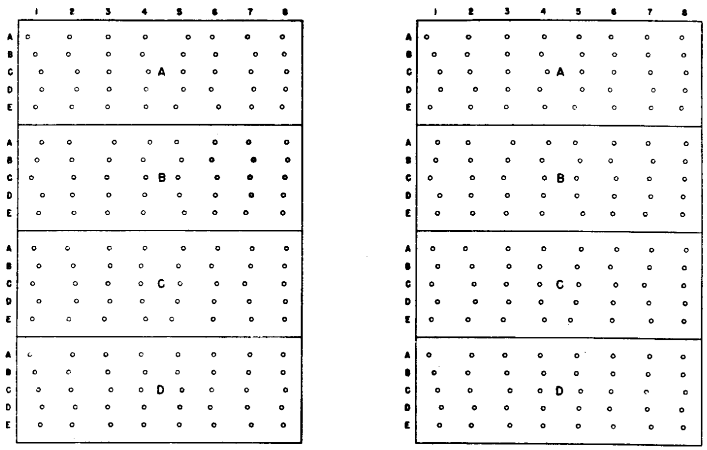
Row	Column 1	2	3	4	5	6	7	8
A	O	O	O	O	O	O	O	O
B	O	O	O	O	O	O	O	O
C	O	O	O	O	O	O	O	O
D	O	O	O	O	O	O	O	O
E	O	O	O	O	O	O	O	O

II. Inverted Pyramid Test: There are two pairs of triangles, an upper and lower pair. One looks like a pyramid, and the other looks like a triangular hole. Which is the pryamid? **UPPER LOWER**

III. Hidden Message Test: When you have the stereoscope opened to the proper separation distance, you will see "floating" words which form a complete sentence. Write the sentence below.

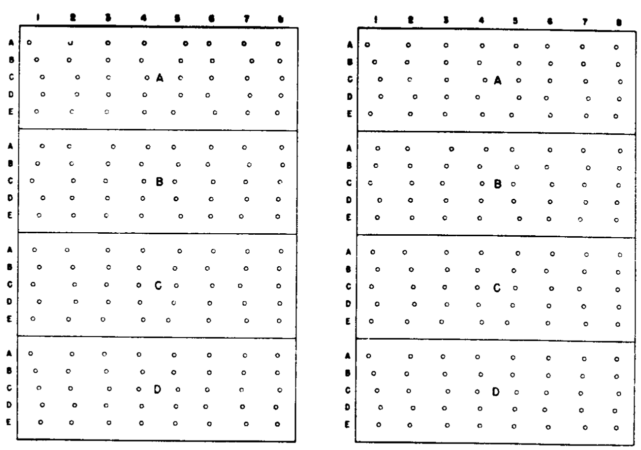
Stereogram I

(Lens separation - 2.25 inches)



Stereogram II

(Lens separation - 1.9 inches)



Inverted-pyramids test.

Hidden-message test.