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Digital Faces
How Satellites See

Age
Grades 4-12, adapted for each grade level

Subjects
Art, Language Arts, Math, Science

Duration
At least two one-hour class periods, part may be assigned as homework

Skills
analysis, drawing, graphing, interpretation, observation

Key Vocabulary
analog, digital, digitize, grid, pixel, range, remote sensing, resolution, scale

Objectives
Students will be able to: 1) digitize and interpret photos; 2) recognize and begin to interpret remotely sensed images, such as aerial photos and satellite images; 3) understand the significance of computers in satellite imaging; 4) determine the range and resolution necessary for given investigations.

Method
Students will bring in a photo of themselves or some other person. Use simple, high contrast photos. Students will "digitize" the photos using various grid sizes and shades of gray to gain an understanding of image resolution and how much information is needed to answer various questions. In part two, students will observe satellite and aerial images and extend the understanding they have gained to interpreting these images. It is important to follow this activity with **Zooming In** and **Ground Truthing Your Image.**

Background
Remote sensing, for the purposes of this activity, means obtaining information about the Earth's surface and atmosphere from airborne or space-borne sensing instruments. Remotely sensed images are produced at various resolutions, depending on their intended use. The proper range and resolution are critical if the images are to be useful. Limited data will not answer the questions posed, while too much data can be confusing and wastes valuable computer time and storage space. Simply put, enough is enough. If one wants to view a forest, for example, one does not need, nor want, to see each tree.

There are many examples of this is daily life. When viewing a billboard on the highway, there are various levels of information we can gather from the sign, depending upon our position. When far away, we can see that it is a billboard, but we can't tell what it says — so there is a level of recognition, but it is not complete. At the optimal distance, we can tell it is a sign and can read what it says. When we are very close to it, we can again see that it is a sign, but we cannot read it. So, we need to be neither too close nor too far away to see the entire message. When too close or too far away from something, we cannot get a perspective on the whole thing (see Goldilocks Effect activity). There is more to interpreting images, however, than resolution. There are also visual cues that aid our understanding. Students will discover what some of these cues are, both in the faces they draw and in the aerial and satellite images they observe.

Materials

For part I: Large (8"x10") black and white head shots of students (pictures of themselves as younger children are often a good subject), or full-page black and white magazine photos of famous faces. A copying machine that can reduce and enlarge, and transparencies to make various size grids on transparencies, graph paper, pencils.

Procedure

1. Each student selects a photo and lays a 1/8 inch or 1/4 inch grid over it. They set this image next to a piece of 1/4 inch graph paper and set up an identical system of coordinates on the x and y axes, one on the photo and one on the blank graph paper.

2. The students then transfer the image onto graph paper, simplifying the image into boxes and all of its shades into three tones: the lightest colors become white (leave paper blank), the middle tones become gray (color lightly with pencil or a light color), and the darkest third of the shades become black (color heavily with pencil or a dark color). If a particular pixel (box) is approximately half white and half black, it should be averaged to become gray. If a pixel is more black than white it becomes black. And likewise, if a pixel is more white than black, it becomes white. This represents a digitizing process in three shades of gray. **Note:** Students should avoid the temptation to "make it look right" by, for example, making the eyes stand out; they should pretend to be digitizing robots, simply averaging each pixel, selecting the proper shade and filling it in. **Variation:** Instead of using just white, gray and black, students could use three different colors. It is best to use colors which contrast strongly with each other, like red, blue and green. This can be likened to "false color" photography.

   Students may find it easier to go down one row at a time, from left to right, using a ruler, scanning and filling in each subsequent box in the row, just like a computer. It is also possible to let students work in teams, one as scanner, one as digitizer. The scanner will call out the x-y coordinates and the shade value (white, gray, black), and the digitizer will fill in the pixels on a separate grid.

   For younger students, a numbered grid can be prepared beforehand, with the individual grid squares coded with different numbers which correspond to different colors to form an image of some well know image, such as Waldo or Mickey Mouse. Assign colored squares to the children and have them match them to grid locations called out by the teacher or have them match them to coded numbers on the grid. Then see who can first recognize the image.

3. Allow students about 30 minutes to get the hang of it and to see how far they get. The rest may be assigned as homework to save classroom time.

4. When they are finished, your students should observe the image they have created and analyze it. At this resolution, does the image offer enough information? That depends on the questions you want to answer!

Have your students pose different questions and consider whether their image answers each question. For example: Is the image recognizable? Can you tell it is a face? Can you tell who it is? Can you tell what or who it is by viewing it from across the classroom?

5. For the second class period, the students lay a finer - 1/8 inch - grid (more pixels) over the photo and perform the experiment again. (If this is too difficult for some of the younger students, say grades 4-6, you could do this part of the activity on a board or overhead projector with your students gathered around to help and observe.) Another way your students can add more information to their images, besides changing grid size, is to add more tonal values by making several shades of gray. The students continue adding information by increasing the number of tones and number of pixels until they can tell who the person in the photo is. The students can then analyze what questions could be answered by the images they create at each level of detail.

Extension

Use your students' digitized images to make a poster to display in the school explaining the steps & showing the final products.

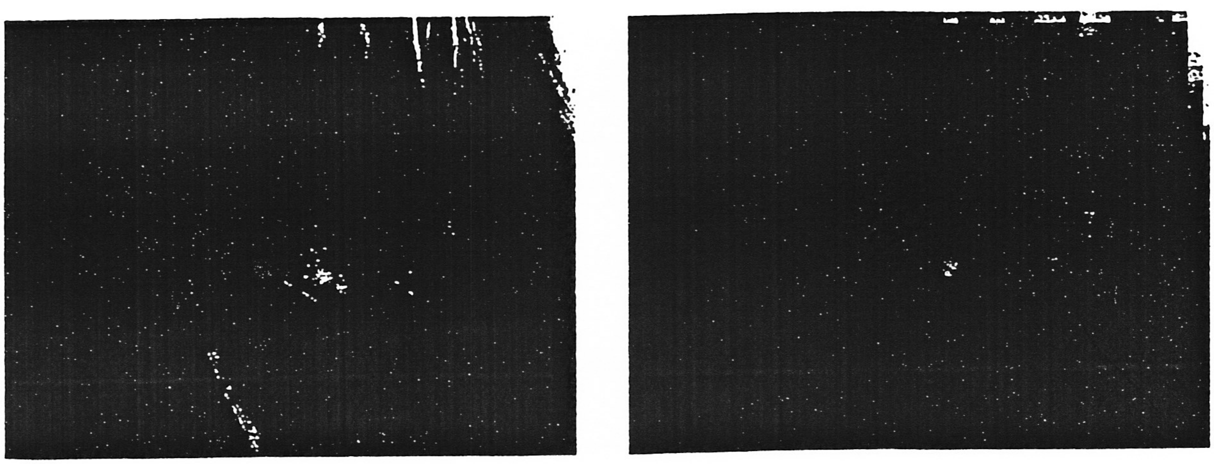

Figure 10: An example of a digitized photograph.

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