Visual Image Interpretation

Visual image interpretation is a first analysis approach to remote sensing imagery. Here, the size, shape, and position of objects as well as the contrast and colour saturation are analysed. The height of objects can be determined by indirect visual analysis. Visual perception, i.e. looking at the environment, is an everyday experience for most of us. This ability has to be used for remote sensing as well. Image objects and structures have to be recognised and interpreted. Different factors influence the eye of the beholder, e.g. size, shape and position of objects as well as contrast and colour saturation of an image and the previous knowledge of the perceiving person.

Elements of Visual Interpretation

As we noted in the previous section, analysis of remote sensing imagery involves the identification of various targets in an image, and those targets may be environmental or artificial features which consist of points, lines, or areas. Targets may be defined in terms of the way they reflect or emit radiation. This radiation is measured and recorded by a sensor, and ultimately is depicted as an image product such as an air photo or a satellite image.

What makes interpretation of imagery more difficult than the everyday visual interpretation of our surroundings? For one, we lose our sense of depth when viewing a two-dimensional image, unless we can view it stereoscopically so as to simulate the third dimension of height. Indeed, interpretation benefits

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greatly in many applications when images are viewed in stereo, as visualization (and therefore, recognition) of targets is enhanced dramatically. Viewing objects from directly above also provides a very different perspective than what we are familiar with. Combining an unfamiliar perspective with a very different scale and lack of recognizable detail can make even the most familiar object unrecognizable in an image. Finally, we are used to seeing only the visible wavelengths, and the imaging of wavelengths outside of this window is more difficult for us to comprehend.

Recognizing targets is the key to interpretation and information extraction. Observing the differences between targets and their backgrounds involves comparing different targets based on any, or all, of the visual elements of tone, shape, size, pattern, texture, shadow, and association. Visual interpretation using these elements is often a part of our daily lives, whether we are conscious of it or not. Examining satellite images on the weather report, or following high speed chases by views from a helicopter are all familiar examples of visual image interpretation. Identifying targets in remotely sensed images based on these visual elements allows us to further interpret and analyze. The nature of each of these interpretation elements is described below, along with an image example of each.

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Tone refers to the relative brightness or colour of objects in an image. Generally, tone is the fundamental element for distinguishing between different targets or features. Variations in tone also allows the elements of shape, texture, and pattern of objects to be distinguished.

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Shape refers to the general form, structure, or outline of individual objects. Shape can be a very distinctive clue for interpretation. Straight edge shapes typically represent urban or agricultural (field) targets, while natural features, such as forest edges, are generally more irregular in shape, except where man has created a road or clear cuts. Farm or crop land irrigated by rotating sprinkler systems would appear as circular shapes.

Size of objects in an image is a function of scale. It is important to assess the size of a target relative to other objects in a scene, as well as the absolute size, to aid in the interpretation of that target. A quick approximation of target size can direct interpretation to an appropriate result more quickly. For example, if an interpreter had to distinguish zones of land use, and had identified an area with a number of buildings in it, large buildings such as factories or warehouses would suggest commercial property, whereas small buildings would indicate residential use.

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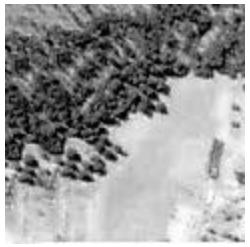
Pattern refers to the spatial arrangement of visibly discernible objects. Typically an orderly repetition of similar tones and textures will produce a distinctive and ultimately recognizable pattern. Orchards with evenly spaced trees, and urban streets with regularly spaced houses are good examples of pattern.



Texture refers to the arrangement and frequency of tonal variation in particular areas of an image. Rough textures would consist of a mottled tone where the grey levels change abruptly in a small area, whereas smooth textures would have very little tonal variation. Smooth textures are most often the result of uniform, even surfaces, such as fields, asphalt, or grasslands. A target with a rough surface and irregular structure, such as a forest canopy, results in a rough textured appearance. Texture is one of the most important elements for distinguishing features in radar imagery.

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Shadow is also helpful in interpretation as it may provide an idea of the profile and relative height of a target or targets which may make identification easier. However, shadows can also reduce or eliminate interpretation in their area of influence, since targets within shadows are much less (or not at all) discernible from their surroundings. Shadow is also useful for enhancing or identifying topography and landforms, particularly in radar imagery.

Association takes into account the relationship between other recognizable objects or features in proximity to the target of interest. The identification of features that one would expect to associate with other features may provide information to facilitate identification. In the example given above, commercial properties may be associated with proximity to major transportation routes, whereas residential areas would be associated with schools, playgrounds, and sports fields. In our example, a lake is associated with boats, a marina, and adjacent recreational land.

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Crescentic dune (Barchan)

The shape is formed by constant wind with unchanged wind direction. The smaller ends of the sand dune are moving faster than the main dune and thus the characteristic semilunar structure is formed.

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Longitudinal dune (Seif)
Constant unidirectional wind forms the longish shape of the dune. The side facing the wind is wider and higher than the other side. These dunes can be several kilometres long.

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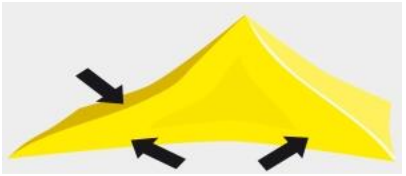
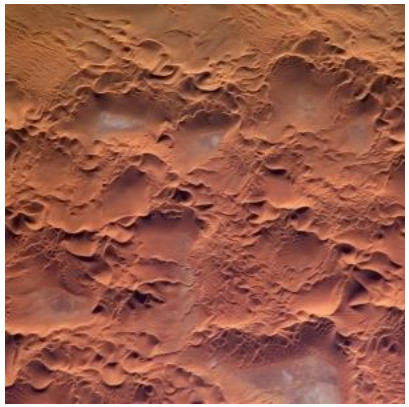


Star dune
Changing wind directions lead to huge sand forms. The sand is reallocated again and again leading to a new formation.



Different shapes of dunes, schematic illustration vs. satellite image. The arrows stand for the main wind direction.

The figure above shows the different shapes of dunes. Knowing the ideal-typical scheme, one can find out that the satellite image shown above depict dune formations. Which kind of dune is prevailing can be found out at a second glance. This information can be used to derive the main wind directions.

How do we structure visual image interpretation?

Visual image interpretation is best-structured if organized in three stages:

1. General areas (settlement / tree-covered / open space / water bodies)
2. Similar areas (fields / grassland / speciality crops / mixed)
3. Single objects (plant species / fallow land / vegetation density)

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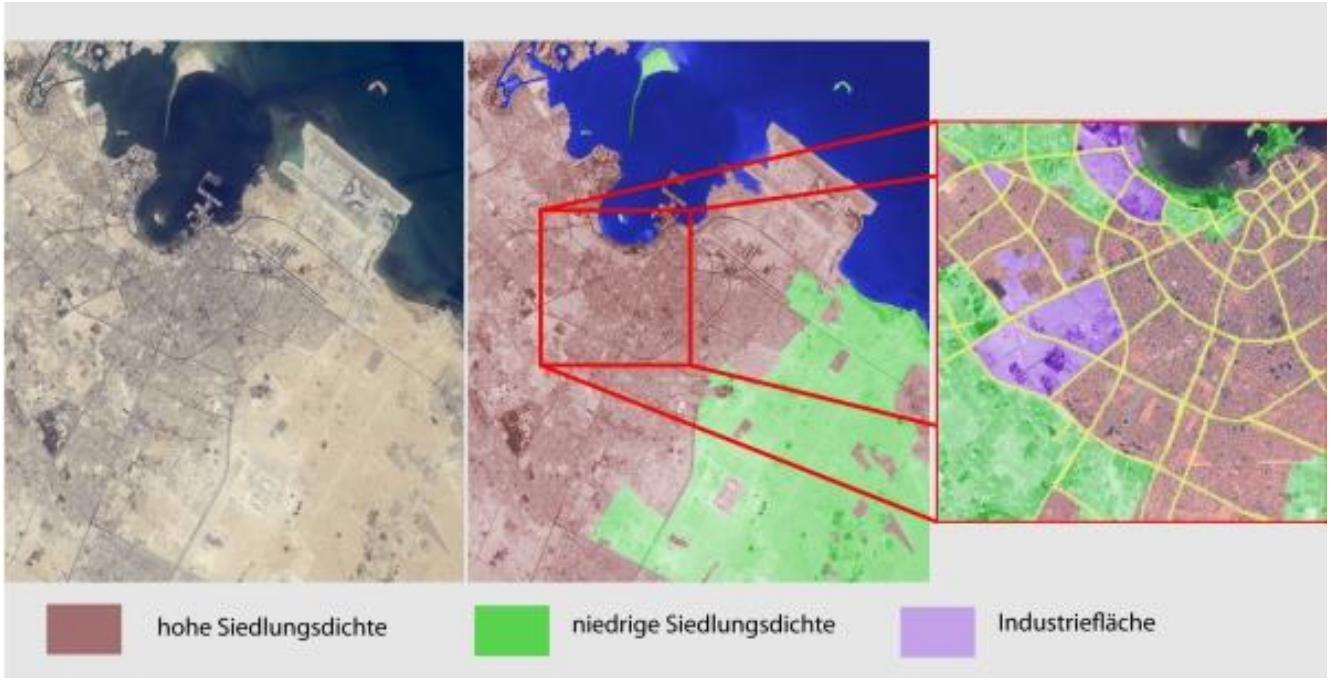

Schematic illustration of visual interpretation by the example of Doha, capital city of Qatar (input data: NASA).

The procedure of image interpretation is carried out as seen above: First of all, one has to search for boundaries between different kinds of areas or colours. We have highlighted them in the second image. Then, finer structures, i.e. smaller image sections, are focused upon. The third image shows streets (yellow) or industrial spaces (violet) as examples.

You can try to visually interpret the images below yourself:

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Left: Syr Darya, Kazakhstan, right: Minnesota, USA (© NASA)

How to obtain indirect information

The image below depicts the Cologne Cathedral (Kölner Dom) from a bird's eye view. At a first glance, we can collect information on shape, area and surroundings of the building. A second glance reveals the height of the object as well: The cast shadow of the object is used to calculate the height. It is apparent how the steeples and the nave vary in size; this would not be visible without the shadow.

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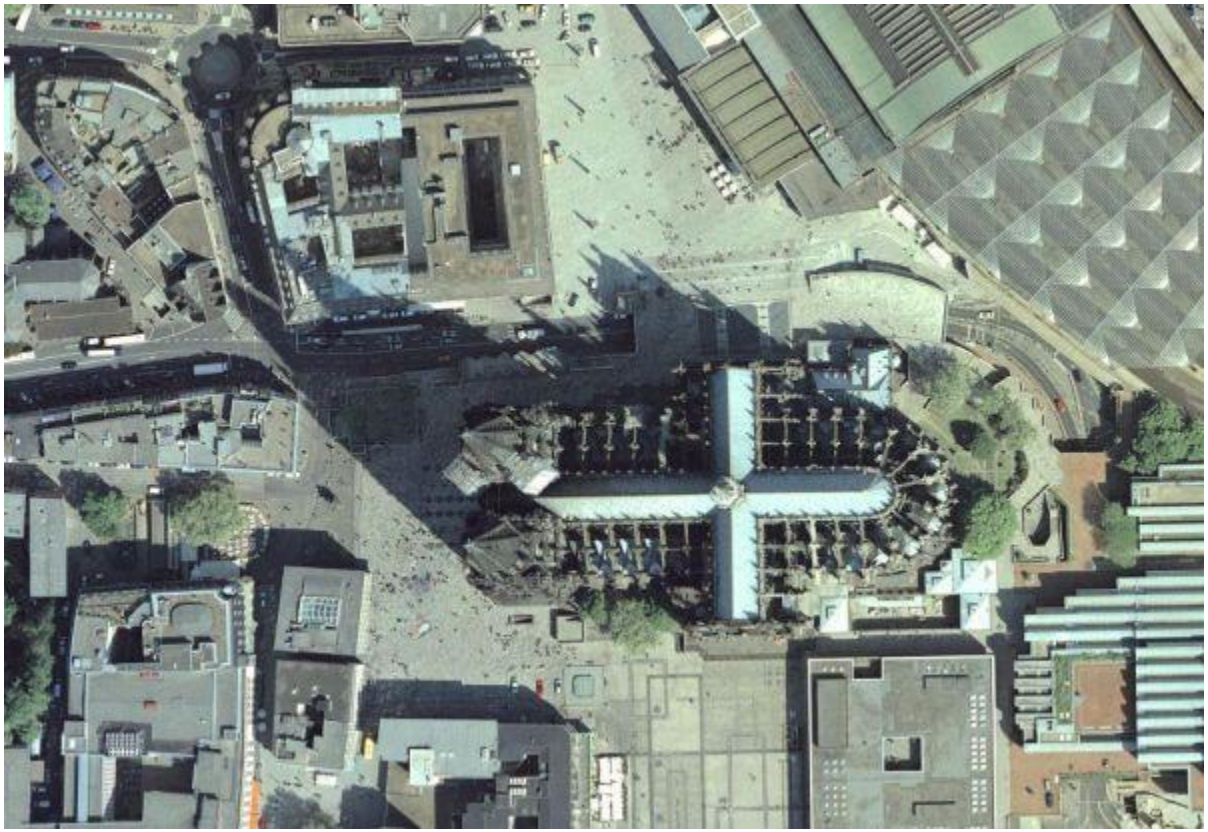
Study material for students of Department of Geography, B.P.Chaliha College



Aerial image of the Cologne Cathedral. The length of the shadow combined with the solar altitude can be used to determine the height of the cathedral indirectly. (© Google Earth).

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In order to determine the height correctly, the angle of incidence of the sun has to be known, or the height of a reference object (like a fountain) as well as the length of its shadow. Then the height can be calculated, by using either a trigonometric function or the theorem of intersecting lines. Thus, indirect image interpretation supports quantitative and qualitative statements about the depicted objects.

Conclusion:

Visual image interpretation is a first analysis approach to remote sensing imagery. Here, the size, shape, and position of objects as well as the contrast and colour saturation are analysed. The height of objects can be determined by indirect visual analysis.

References

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