EXAMPLE QUESTIONS OF SOME SUBJECTS WITHIN THE REMOTE SENSING COURSE

Subjects: digital filters, geometric corrections, vegetation indices, classification, radar

1.a) Explain the difference between a low pass filter operation and a median filter operation.

b) What will be the difference of the resulting image after applying the filters of a) when the original image shows some distinct spikes (extreme values)?

c) Why is a low pass filter not used for reducing the speckle in radar images?

2. There exists a difference between the concepts of "geometric rearrangement" (registration) and "resampling".

a) Why is the "master" (correct image or map) transformed to the "slave" (distorted image) and not vice versa?

b) What is the essential difference between a resampling using "Nearest neighbours" and a "Bilinear interpolation"?

3.a) The *spectral signature* of various kinds of objects is based on reflectance factors (or reflectances), plotted against wavelength. However, a sensor generally does not measure reflectance factors. What does the sensor measure actually, and how can one arrive at reflectance factors?

b) Why does the spectral signature of vegetation (in general) differ so much from that of (bare) soils?

Which wavelength bands yield information on biomass of plants and how does this become evident?

c) What is the difference between "ratio-based" vegetation indices and "orthogonal-based" vegetation indices? **Give some advantages and disadvantages of both types.**

4.

a) What is the main difference between the *minimum distance to means classification* (MDM) and the *maximum likelihood* (MLHD)?

b) Assume a crop type classification has been performed using the Landsat-TM satellite. Subsequently, the classification result is being evaluated by means of a field survey.

The result is as follows:

Of the 25,000 potato pixels, 15,000 were classified correctly as potatoes, 1,250 as wheat and 8,750 as sugarbeet.

Of the 50,000 wheat pixels, 40,000 were classified correctly as wheat, 5,000 as potatoes and 5,000 as sugarbeet.

Of the 25,000 sugarbeet pixels, 16,500 were classified correctly as sugarbeet, 6,000 were classified as potatoes and 2,500 as wheat.

Perform the following tasks/calculations:

- Make the confusion matrix.
- Calculate for each class the classification accuracy and reliability.
- Calculate the overall classification accuracy.

c) Which 2 classes are most difficult to separate? What could be a solution in order to improve the classification result?

5.a) Passive microwave remote sensors have a lower spatial resolution than comparable (i.e. same wavelength, same altitude/platform) active systems. Why?

b) What is the wavelength at which the Earth (with T = 300 K) emits the most power?

c) Why is microwave remote sensing better suited for monitoring tropical rain forests than optical remote sensing?

d) Explain the difference between the look angle and the incidence angle for a radar system, and in what situation are both the same?

Short answers

1a. With a low pass filter the average value is calculated within a window, which then is written at the position of the central pixel value in the output image. With the median filter the median (which is the middle in order of magnitude) value is taken.

1b. With the median filter isolated extreme pixel values are completely removed from the image, whereas with the low pass filter there is a smoothing effect, but extreme values do contribute to the output.

1c. A low pass filter also smooths field boundaries and linear line structures like roads. In removing speckle one needs special filters that reduce speckle within objects, but keep boundaries etc. as they are.

2a. The geometry after the registration of the distorted image (slave) is already known. This is the geometry of the master. We only have to fill the grid cells of the master with the pixel values of the slave. Therefore, we transform the master geometry to the geometry of the slave and perform the resampling (either nearest neighbour, bilinear interpolation or cubic convolution). The resampled values are then entered at the right grid cells of the original master geometry.

2b. With a nearest neighbour resampling the original pixel values are not changed. In case of a bilinear interpolation, some mathematical recalculation of the original pixel values is performed (smoothing is occurring). Therefore, the original values are lost. However, the latter method is geometrically more accurate than nearest neighbour.

3a. A sensor measures EM radiation (or photons). Through an AD-conversion the signal is stored as digital numbers. Through a radiometric calibration these DN-values can be converted to radiances measured at sensor. An atmospheric correction can convert these values into reflectances measured at the top of the canopy.

3b. Vegetation has a low reflectance in the VIS due to absorption by chlorophyll. Soils are lacking this chlorophyll and mostly have larger reflectances. Internal leaf structure and multiple reflectances within canopy layers cause a high reflectance in the NIR and soils lack this and have a lower reflectance. In the MIR water causes absorption effects in both vegetation and soils, and these can be less differentiated in the MIR (SWIR).
For biomass estimation the NIR is most suitable because of partial transparency of and multiple reflectances between leaf layers. The VIS can also help in biomass estimation (e.g., through vegetation indices). High biomass yields high NIR and low VIS reflectances.

3c. Ratio-based indices have isolines (of equal VI value) converging to the origin, whereas orthogonal indices have isolines running parallel (parallel to the soil line).
Ratio-based indices are simple, particularly suitable for estimating ground cover, correct for some disturbances like the irradiation, but are not suitable at high LAI, are influenced by soil background and can be severely influenced by leaf colour.
Orthogonal indices are more complex, a soil line has to be calculated, but they are independent of soil background and suitable for estimating LAI even at dense vegetation.

4a. The minimum distance to means classification uses Euclidean (geometrical) distances (non-parametric decision rule). The decision rule is based on the smallest Euclidean distance between a pixel and the centre of a given class. Maximum likelihood uses statistical distances (parametric decision rule). The decision rule is based on the highest statistical probability that a pixel belongs to a certain class, defined by the distance in terms of standard deviations to each class centre.

4b. Confusion matrix:

	Classification result				
Ground truth		potato	wheat	sugar beet	total
	potato	15 000	1 250	8 750	25 000
	wheat	5 000	40 000	5 000	50 000
	sugar beet	6 000	2 500	16 500	25 000
	total	26 000	43 750	30 250	100 000

	Accuracy = Producer's accuracy	Reliability = User's accuracy
Potato	60 %	57.7 %
Wheat	80 %	91.4 %
Sugat beet	66 %	54.5 %

Overall accuracy = 71.5 %

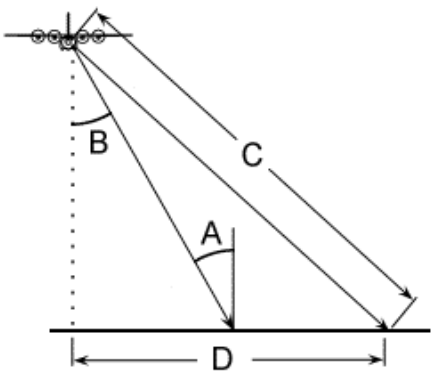
4c. Potato pixels that got a wrong label mainly got a label of sugar beet.
Wheat pixels got equally labels of potato and sugar beet.
Sugar beet pixels that got a wrong label mainly got a label of potato.
This means most mixture occurred between potato and sugar beet. In other words these are most difficult to separate. One might consider to merge them into one class.

5a. In the microwave window we deal with large wavelengths that have a very small irradiance from the sun and thus a very small amount of reflected energy. Also we deal with a very small amount of emitted energy from the Earth's surface in this spectral region. This means we have to integrate the signal over a large region (large pixel size) if we want to have a significant signal. If small pixels are required we need an active system sending a large amount of energy to the Earth's surface.

5b. $\lambda_{max} = 2898/300 \approx 9.6$ micrometer.

5c. Tropical rain forests are cloud covered most of the time and the cloud penetration of radar is much better than that of optical systems.

5d.



A = incidence angle, related to the object
B = look angle, related to the platform
Angles A and B will be the same if we deal with a flat, horizontal surface. With a curved surface are on slopes they will be different.