CASA0023 Weekly Diary

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Welcome

This is my weekly study notes for the CASA0023 course. My undergraduate major was Geographic Information Science, and my thesis focused on vegetation extraction from remote sensing imagery. Therefore, some of my personal reflections may be related to my undergraduate background.

1 Introduction

1.1 Summary

Remote sensing is a science that uses electromagnetic radiation as a medium to identify surface features and apply surface information to relevant fields (Navalgund, Jayaraman, and Roy 2007). Various sensors function like human eyes that can perceive a broader range of spectral bands, providing richer and more extensive ground information, thus laying the foundation for further analysis.

1.1.1 Active and Passive Remote Sensing

Figure 1.1 and Table 1.1 demonstate the differences between active and passive remote sensing in terms of working principles, advantages and applications.

Table 1.1: Comparison of Active and Passive Remote Sensing

Category	Active Remote Sensing	Passive Remote Sensing
Energy Source	Sensor-generated energy	Relies on surface radiation
Advantages	• Independent of surface radiation, unaffected by lighting conditions. • Can penetrate clouds, vegetation, etc.	• Can cover large areas simultaneously. • High revisit rate,capable of providing time-series data
Applications	Suitable for all-time, all-weather, and extreme environment measurements	Suitable for large-scale continuous observation

1.1.2 Interaction with Earth's Surface

As Figure 1.2 shows, solar radiation undergoes a series of interactions at the Earth's surface, such as cloud scattering, surface scattering, and atmospheric absorption. The energy ultimately received by the sensor is the result of these combined processes, representing rich information while also potentially introducing interference to the research. For example, atmospheric correction is required in the preprocessing of remote sensing images because the

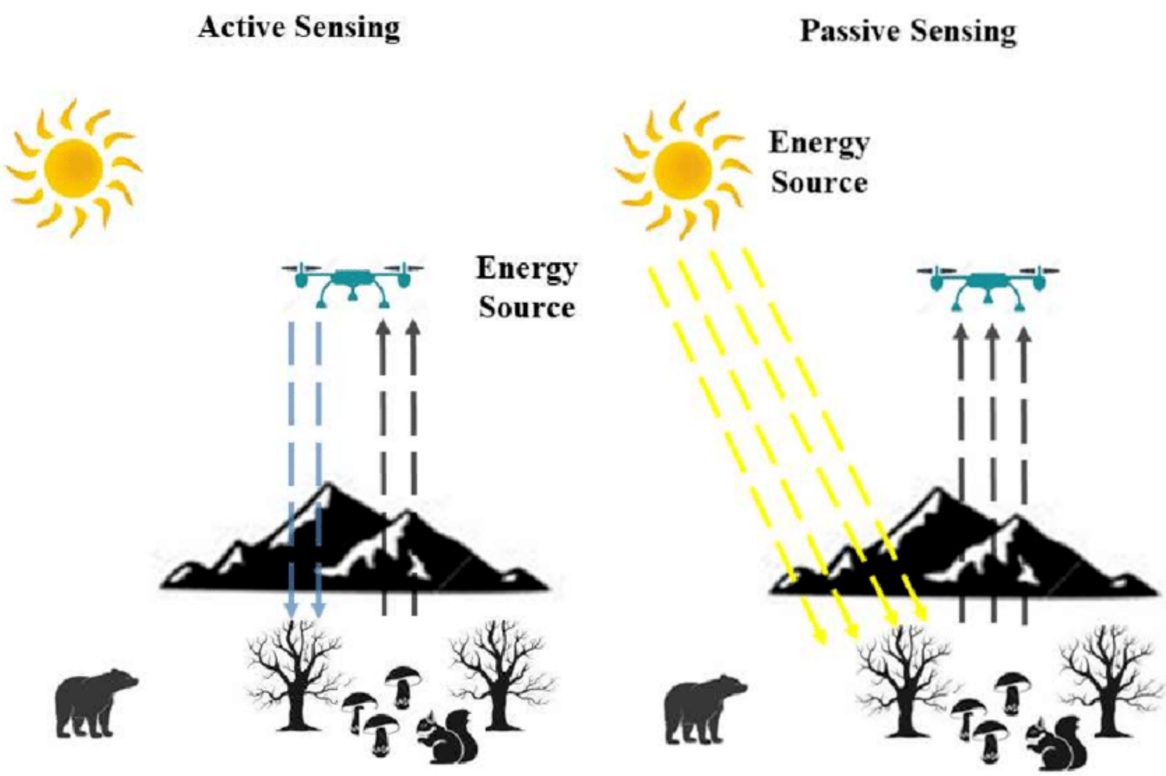

Figure 1.1: Principle Differences Between Active and Passive Remote Sensing

energy received by the sensor is affected by atmospheric scattering and absorption, leading to reduced image contrast.

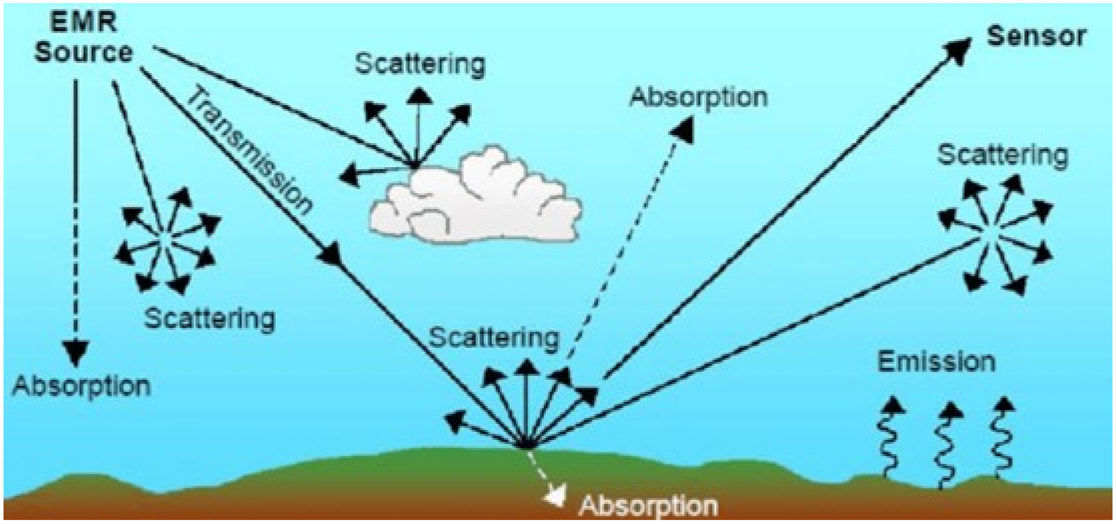

Figure 1.2: Interaction with Earth's Surface

1.1.3 Four Types of Resolution

Typically, the design of remote sensing sensors requires a trade-off between these four types of resolution based on their primary application areas. For example, high spatial resolution often comes at the cost of a smaller coverage area, which results in a longer revisit period, meaning lower temporal resolution. Additionally, due to technical constraints such as data transmission, spatial resolution and spectral resolution cannot be simultaneously maximized.

Table 1.2: Definitions of the Four Types of Resolution in Remote Sensing

Resolution Type	Definition
Spatial Resolution	The smallest ground unit distinguishable by the sensor, which corresponds to the size of a raster pixel.
Spectral Resolution	The number and width of spectral bands that the sensor can detect.
Temporal Resolution	The revisit cycle of the sensor.
Radiometric Resolution	The smallest detectable energy variation by the sensor.

1.2 Application

Remote sensing has been widely studied in various fields, including agricultural management, environmental monitoring, geological exploration, climate change research, land planning, and disaster emergency response. The applicability of active and passive remote sensing varies across different research areas. For example, in terrain mapping, passive remote sensing lacks strong penetration capability, making it difficult to acquire exposed terrain information. In contrast, active remote sensing techniques such as LiDAR and SAR can penetrate surface cover and directly measure elevation. Similarly, in vegetation analysis, the spectral characteristics of vegetation align well with solar radiation, allowing passive remote sensing to provide rich spectral information. This makes it easier to calculate vegetation indices and efficiently monitor vegetation changes.

In addition, different fields have varying requirements for image resolution. For instance, urban planning requires high spatial resolution to identify fine structures such as roads and buildings. Weather monitoring demands frequent data updates to capture rapidly changing atmospheric conditions. Vegetation analysis relies on abundant spectral information to detect subtle variations in vegetation health. Temperature monitoring requires sensors with high radiometric resolution to capture small temperature differences accurately.

Taking the application of remote sensing in agriculture as an example, the technology primarily utilized in this field is passive remote sensing, which aims to obtain information about plant growth and health conditions. Remote sensing in agriculture can be categorized into several aspects, including crop identification, growth monitoring, yield estimation, pest and disease control, and irrigation management, all of which help optimize agricultural operations and enhance production efficiency.

The advancement of remote sensing technology, particularly improvements in satellite image resolution, has significantly contributed to the development of precision agriculture. For instance, high spatial resolution data provides more detailed ground information, aiding in land cover identification and soil condition monitoring. Meanwhile, hyperspectral imagery captures finer spectral details, such as the quantification of solar-induced chlorophyll fluorescence, which helps estimate photosynthetic activity, reflecting crop nutritional status and stress response capabilities (Sishodia, Ray, and Singh 2020).

1.3 Reflection

1.3.1 Understanding Remote Sensing Sensors

I find it fascinating to compare the information received by the human eye with that received by remote sensing sensors. Despite experiencing the same Rayleigh scattering, observers at different locations may see different sky colors due to variations in the atmospheric path length of sunlight. Similarly, remote sensing satellites are highly susceptible to atmospheric effects, highlighting the importance of atmospheric correction. However, unlike the three types of cone cells in the human eye that perceive color and detail, remote sensing sensors are not limited to three spectral bands. For instance, the combination of the near-infrared and red bands can effectively distinguish vegetation, presenting a standard false-color representation that differs from true-color imagery.

1.3.2 Methods for Balancing the Four Resolutions

As mentioned earlier, it is challenging to simultaneously optimize all four types of resolution in a single task. Therefore, in practical applications, multi-source data fusion is often required. For example, to balance spatial and spectral resolution, high-spectral but low-spatial-resolution imagery can be fused with high-spatial-resolution imagery. Additionally, temporal interpolation can be used to integrate high-temporal, low-spatial-resolution data (e.g., MODIS) with low-temporal, high-spatial-resolution data (e.g., Sentinel-2) to generate imagery that balances both temporal and spatial resolution.

1.3.3 Future Prospects of Remote Sensing Technology

At present, remote sensing technology is evolving toward higher resolution, greater intelligence, and improved efficiency. Enhancing sensor performance while integrating artificial intelligence can significantly improve data processing efficiency and automation. Taking land cover classification as an example, the introduction of machine learning has enhanced classification accuracy and stability. In the future, the development of adaptive classification methods that reduce the need for manual labeling could further enhance the automation and efficiency of remote sensing classification.

2 Summary

In summary, this book has no content whatsoever.

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References

Navalgund, Ranganath R., V. Jayaraman, and P. S. Roy. 2007. "Remote Sensing Applications: An Overview." *Current Science* 93 (12): 1747–66. http://www.jstor.org/stable/24102069.

Sishodia, R. P., R. L. Ray, and S. K. Singh. 2020. "Applications of Remote Sensing in Precision Agriculture: A Review." *Remote Sensing* 12: 3136. https://doi.org/10.3390/rs12193136.