Chapter 1

Brief Overview of Remote Sensing

Dong, Pinliang; Chen, Qi.
LiDAR Remote Sensing and Applications
CRC Press

1.1 FROM AERIAL PHOTOGRAPHY TO REMOTE SENSING

- The term "remote sensing" was first coined by Evelyn Pruitt of the U.S. Office of Naval Research in the 1950s.

- The traditional aerial photography gradually evolved into remote sensing around 1960.

- Sabins (1987) defined remote sensing as methods that employ electromagnetic energy to detect, record, and measure the characteristics of a target, such as the Earth's surface.

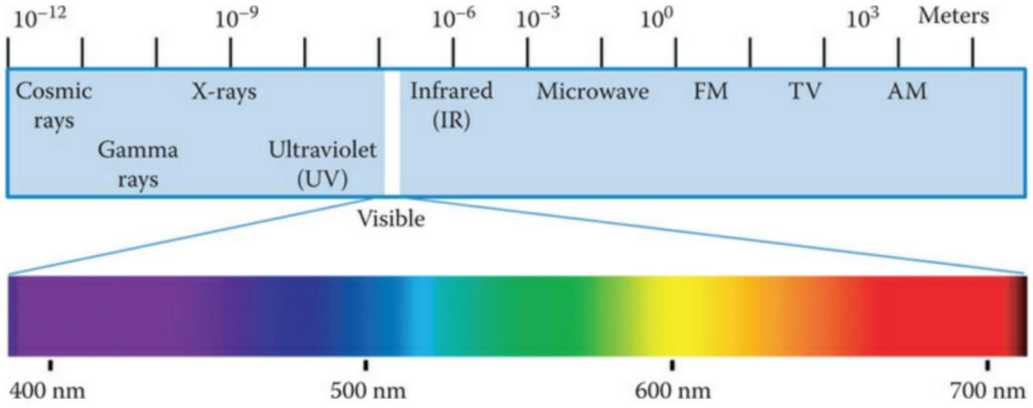

FIGURE 1.1 The electromagnetic spectrum.
The numbers show wavelengths of spectral regions.

1.1 FROM AERIAL PHOTOGRAPHY TO REMOTE SENSING

- There are two types of remote sensing systems: passive and active.

- Passive remote sensing systems measure reflected solar radiation in visible, near-infrared, and mid-infrared wavelengths, or absorbed and then reemitted solar radiation in thermal infrared wavelengths.

- Active remote sensing systems, on the other hand, emit radiation toward the target using their own energy source and detect the radiation reflected from that target.

- The following sections provide an overview of two passive remote sensing methods—multispectral remote sensing and hyperspectral remote sensing—and two active remote sensing methods—radar remote sensing and light detection and ranging (LiDAR) remote sensing.

1.1 FROM AERIAL PHOTOGRAPHY TO REMOTE SENSING

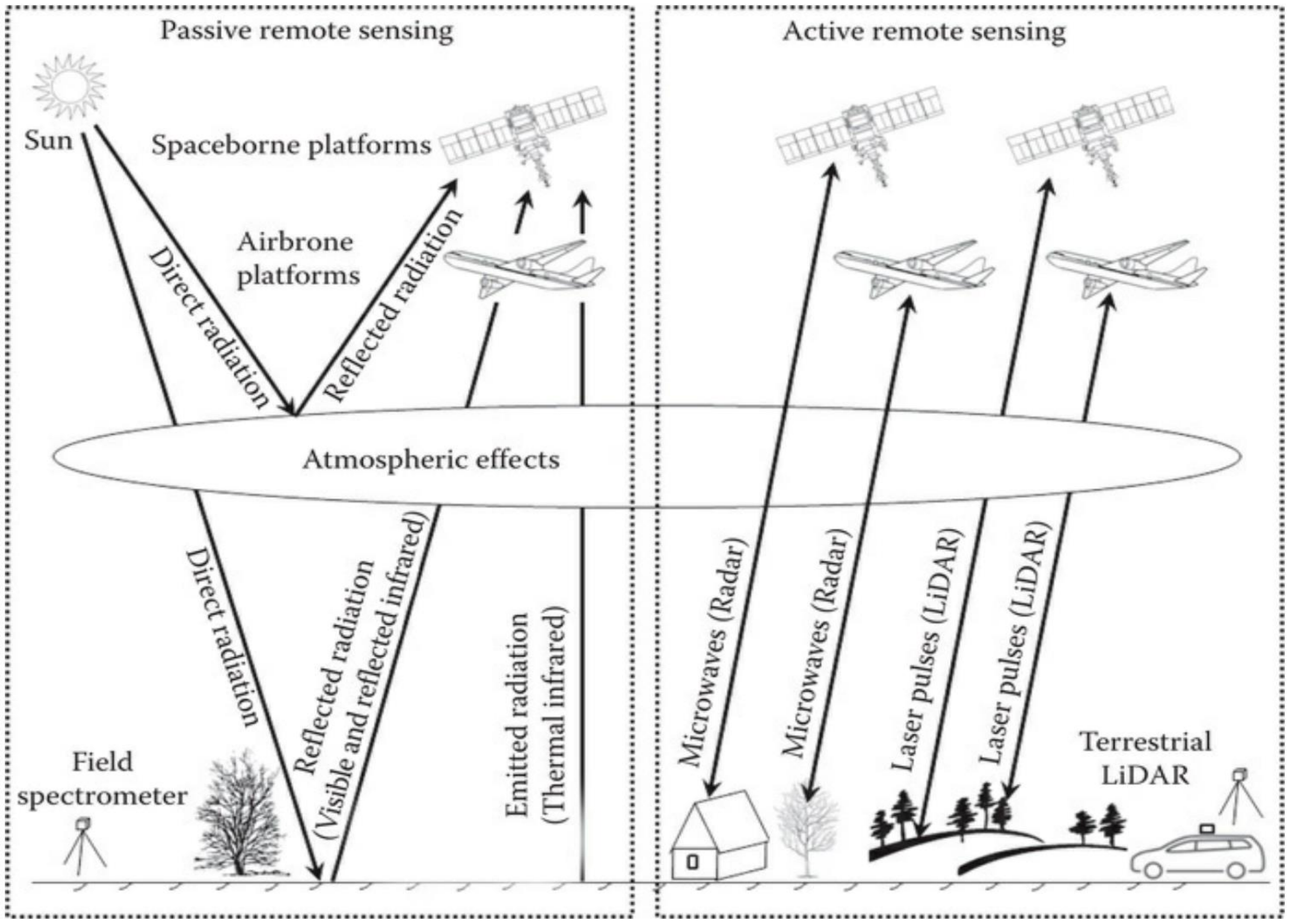

FIGURE 1.2 Passive and active remote sensing

- Compared with multispectral remote sensing that uses relatively broad spectral bands, hyperspectral remote sensing uses imaging spectrometers that measure near-laboratory-quality spectra in narrow spectral bands.
- It should be noted that there is no absolute threshold on the number of bands that distinguish between multispectral and hyperspectral remote sensing.

1.5 LiDAR REMOTE SENSING

- LiDAR standing for Light Detection and Ranging is a technology that measures distances (or ranges) based on the time between transmitting and receiving laser signals.

- Both pulsed and continuous wave lasers can be used: pulsed lasers transmit energy of very short duration and detect ranges based on amplitudes of the received signals; in contrast, continuous wave lasers detect ranges based on the phase difference between transmitted and received signals.

- Pulsed lasers are most often used in terrestrial applications and thus are the focus of this book.

- Since LiDAR can directly measure the geographic environment in three dimensions (3D), it does not have the problem of geometric distortion (e.g., relief displacement) associated with imaging that has to project the 3D world into a two-dimensional image space. In other words, a user does not have to worry about the issue of georeferencing, a nontrivial issue for image processing. This is one of the main advantages of LiDAR.

1.5 LiDAR REMOTE SENSING

- Another advantage of LiDAR is that data can be collected at daytime or nighttime, as long as there is no heavy fog, smoke, or high levels of moisture such as rain, snow, and clouds between the laser system and the object. For example, LiDAR data can be collected at night when the wind is calm

- The most useful characteristic of LiDAR might be that the laser energy can penetrate through canopy gaps and measure canopy structural and terrain elevation along the direction of laser rays. In an optical image, the value of each pixel (gray scale or color) is dominated by the reflectance of the object surface, and users cannot really see the terrain under dense canopy (Figure 1.9A). However, laser energy can reach terrain so that an analyst can use the ground laser returns to generate continuous Digital Terrain Models under canopy (Figure 1.9B).

1.5 LiDAR REMOTE SENSING

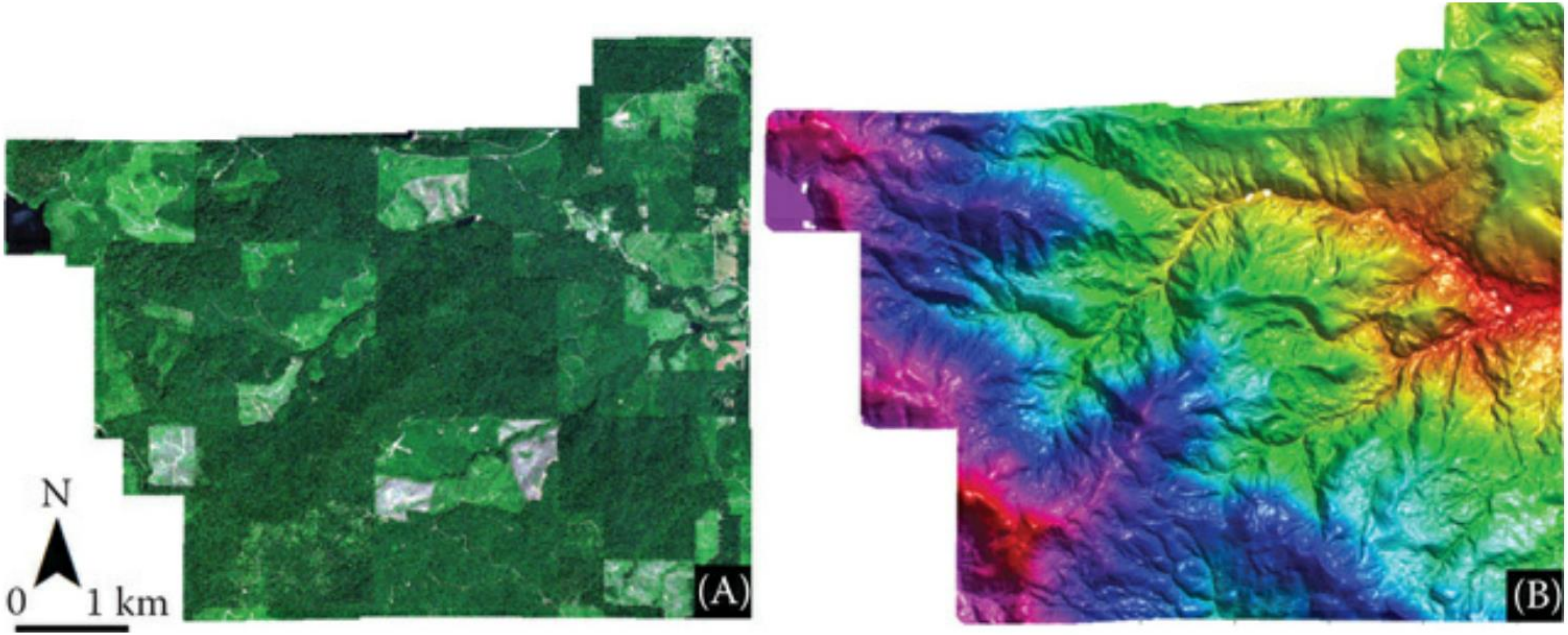

FIGURE 1.9 Different views of Panther Creek, Oregon, based on optical imagery and LiDAR data. (A) Geoeye imagery and (B) DTM derived from airborne LiDAR.