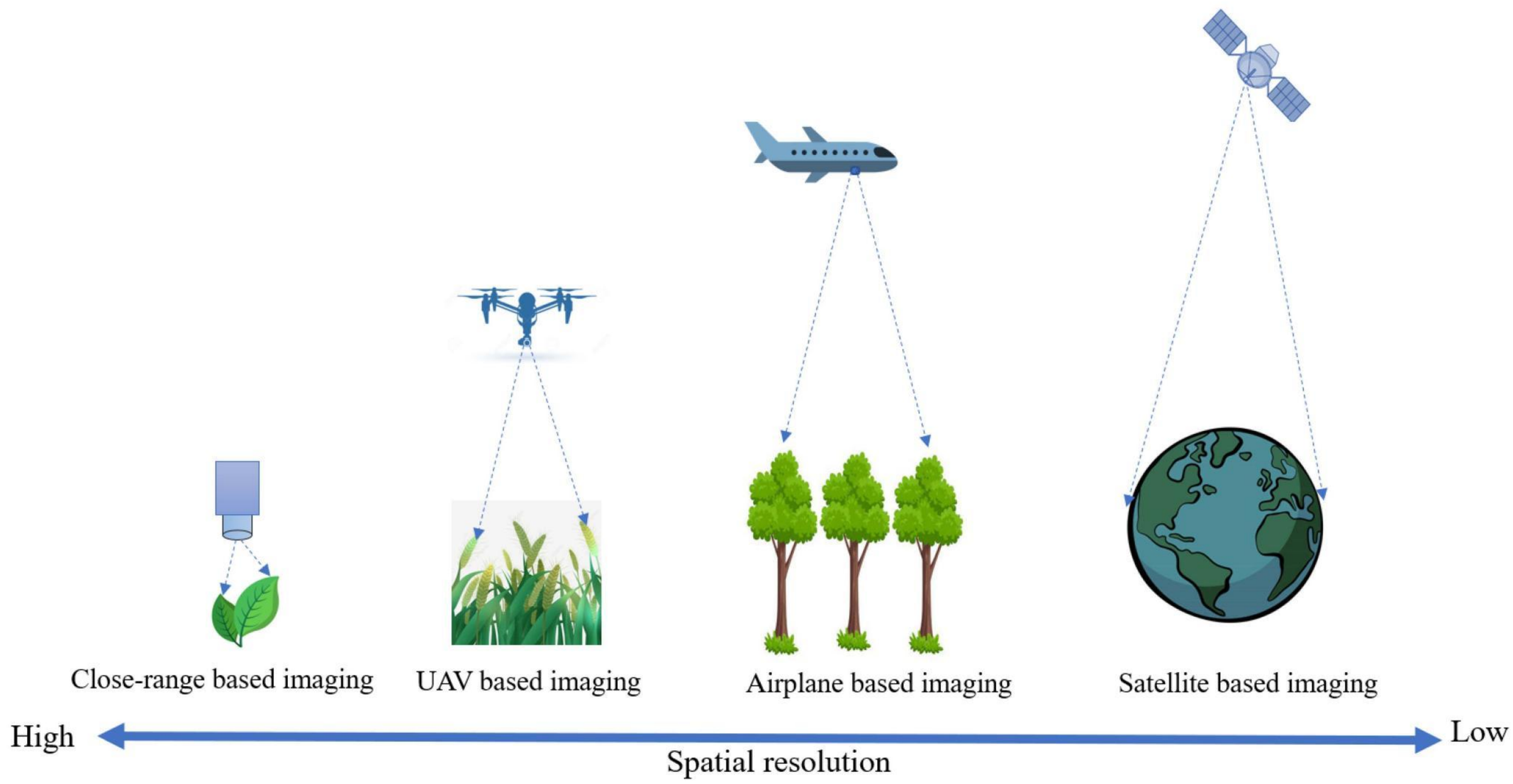

Fig. 3. Illustration of common hyperspectral imaging platforms. The illustration is inspired by [97].

permit a particular wavelength of light to pass, are swiftly changed, while images are obtained to retain hyperspectral image information. This type of sensor requires no movement of the sensor or the measured objects, primarily dependent upon the exposure time. Compared to the push and whisk broom sensors, filter-based sensors are fast for image acquisition and can be used to detect specific diseases (diseases that disrupt the chlorophyll content of leaves) [15], [36], [39]. However, the disadvantage of filter-based sensors is that the spectral resolution is often low as they can only obtain specific bands of the electromagnetic spectrum [15] On the other hand, snapshot sensors do not need to scan an object to form a hypercube. They are developed based on the principle operation of traditional RGB cameras (mosaic principle). The advantage of a snapshot camera is that it can provide a higher number of image recordings than the aforementioned ones. They are compact in size, require less time to obtain images, and can be used for moving objects [with unmanned aerial vehicles (UAVs)]. The obtained information from snapshot sensors exhibits characteristics of plant diseases, as the difference in light absorption and reflectance aids the plant disease detection and classification [40]. However, the spatial resolution for this type of sensor is very low compared to the traditional sensors [17]. Within the context of plant disease detection, push broom and whisk broom imaging sensors are suitable to be used in aerial and satellite-based studies as they have higher spectral resolution and can capture information from large areas/open fields. For targeted disease detection, and if the spectral profile of the disease is known, then filter sensors are the best choice to be used. Similar to push broom and whisk broom sensors, snapshot sensors can also be used for large areas/fields, as they can capture important information from the varying environmental conditions [17], [41]. In plant disease detection, future research opportunities for the aforementioned approaches can include integrating artificial intelligence tools, including machine learning and deep learning algorithms. The algorithms could be trained on diverse spectral profiles, which could yield earlier, more reliable, and precise disease detection compared to stand-alone methods. In addition to that, fusing data from multiple imaging techniques could further enhance the accuracy of detection results.

2) Hyperspectral Imaging Platforms: Hyperspectral image sensors are fitted on different types of platforms. UAVs, airplanes, satellites, and close-range platforms are the most commonly used platforms, which can acquire images at different temporal and spatial information [42]. Fig. 3 illustrates these platforms. A brief review of each of the platforms is presented in the following.

a) Close-range/laboratory-based hyperspectral imaging platforms: Close-range hyperspectral imaging platforms are also known as ground or laboratory-based hyperspectral imaging platforms [42]. They are capable of obtaining super-high-spatial resolution hyperspectral images. Hence, they are employed to analyze vegetation features such as leaf and canopy information, crop growth, early disease detection, nutrient deficiency, weeds, and so on. A linear stage, trucks, or scaffolds are used as the platform to mount the hyperspectral imaging sensors. The platforms are flexible and can be used in fields and greenhouses. For outdoors, the sun is considered the light source, while the images are captured, whereas halogen lamps are considered the light source for the indoors, such as greenhouse environment [42]. Besides, a hybrid version of light sources is used in greenhouses, which uses both halogen bulbs and natural sunlight to fall on the plants through roof glasses. Table I presents the specifications

Authorized licensed use limited to: FUDAN UNIVERSITY. Downloaded on August 28,2025 at 01:49:24 UTC from IEEE Xplore. Restrictions apply.