Point Cloud Characteristics

Livox LiDAR sensors are designed to detect and map their surrounding environments, providing users with detailed information to support applications in ADAS, autonomous driving, robotics, security surveillance, and much more.

The FOV Coverage

The field of view (FOV) of LiDAR sensors is the area in which target objects may be detected. However, not all target objects in the FOV can be detected. For example:
· If the reflected light is too weak to be detected, often as a result of the target distance being too far away from the sensor or the reflectivity of the target being too low.
· Within a limited period of time, only a fraction of the FOV can be illuminated by laser beams, which is related to the scanning pattern distribution. If the target object is not illuminated by the laser, it will not be detected.
By optimally designing the scanning method used for Livox LiDAR sensors, the fraction of FOV illuminated by laser beams can be increased. This reduces the probability of miss-detection that results from the scanning pattern distribution.
Hence, here we use the FOV coverage to characterize the performance of the scanning method, which is defined as the fraction of FOV illuminated by laser beams. Numerically, the FOV coverage (C) can be calculated with the following formula:

$$C = \frac{\text{Total area illuminated by laser beams}}{\text{Total area in FOV}} \times 100\%$$

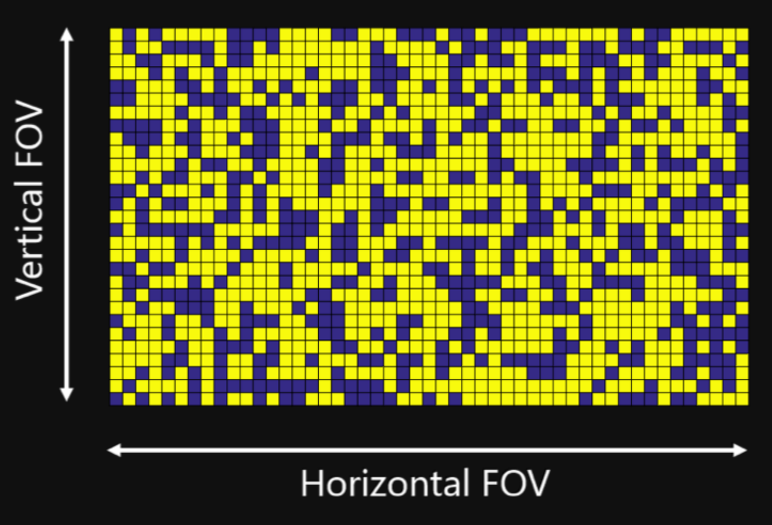
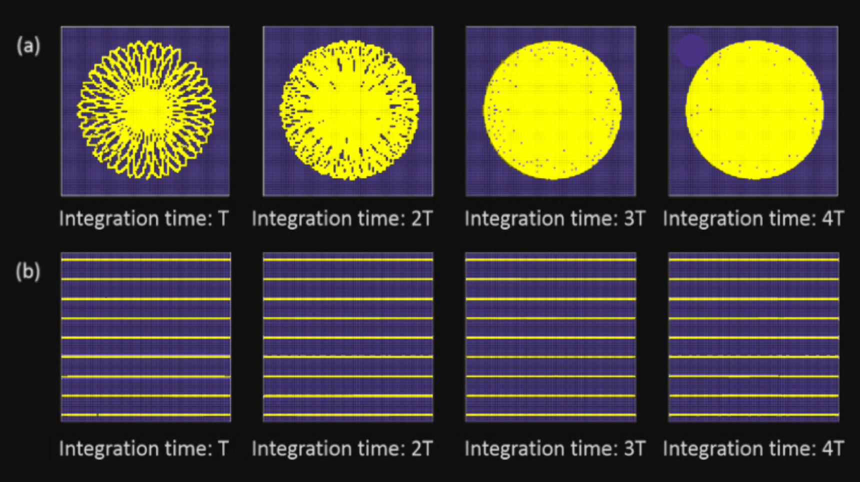


Fig. 1 An example showing the FOV and the illuminated and unilluminated areas in the FOV.

The unique scanning pattern of Livox LiDAR sensors and the benefits of non-repeating scanning patterns

The unique scanning trajectories and patterns of Livox LiDAR sensors are promising for many applications which require high FOV coverage. These scanning trajectories do not repeat themselves during use, thus we often use the term "non-repeating scanning patterns." Compared with the common mechanical scanning methods applied in most LiDAR sensors on the market, non-repeating scanning patterns offer an FOV coverage that significantly increases over time.
For example, in Fig. 2(a), due to non-repeating scanning patterns, the FOV coverage increases significantly over time. However, in Fig. 2(b), the FOV coverage is almost the same regardless of the integration time.

Fig. 2 Single frames and the related superimposed frames in non-repeating scanning regime (a) and repeat scanning regime (b).



Point Cloud Characteristics of Different LiDAR Sensors

The FOV coverage of Livox LiDAR sensors, including the Mid, Horizon and Tele-15 series are shown in Fig. 3. It's clear that as integration time increases, the FOV coverage increases significantly. After a certain period of time integration, the FOV coverage will approach 100%. This indicates that almost the entire FOV is illuminated by the laser beams and almost all targets within the FOV and detection range can be detected.
In Fig. 3 you can see the FOV coverage of other (non-Livox) LiDAR sensors that use common mechanical scanning methods. For these sensors, the number of laser lines and vertical FOV are 64-lines-27°, 32-lines-41°, and 16-lines-30°.

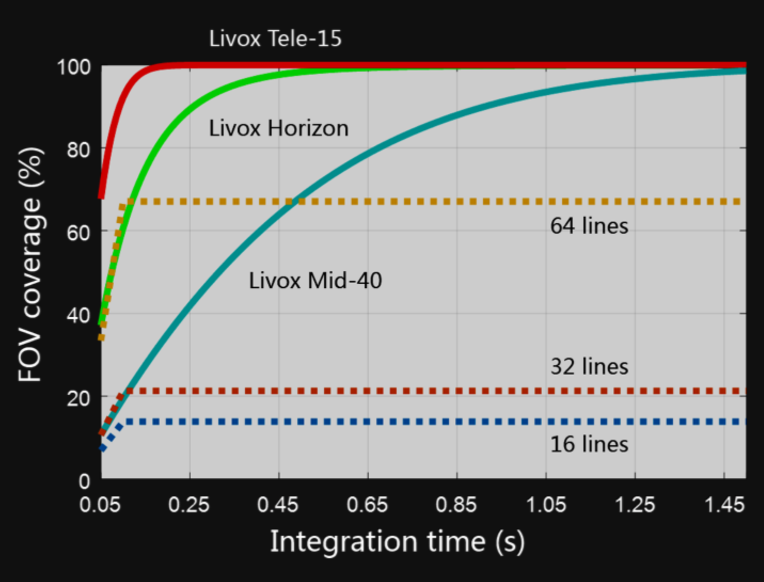


Fig.3 The FOV coverage of Livox LiDAR sensors, including Horizon, Tele-15, and Mid-40; compared with other (non-Livox) LiDAR sensors that used common mechanical scanning methods, with line-number and vertical FOV being 64 lines/27°, 32 lines/41°, 16 lines/30°. During calculation, the FOV is gridded with 5mrad*5mrad.

Compared with other LiDAR sensor units, the Mid-40, Horizon, and Tele-15 are outstanding with different integration times, and especially with long integration time.
· The Mid-40 is equivalent to the 32-line product when the integration time is 0.1s. With an integration time of 0.5s, the coverage performance is equivalent to the 64-line product.
· The Horizon has similar coverage to the 64-line product with an integration time of 0.1s, and when the integration time becomes longer, the coverage increases significantly.
· The Tele-15 has much denser FOV coverage than any other LiDAR sensor shown here. The FOV coverage approaches to 90% at an integration time of 0.1s.