ADOPTICUM

Livox HAP-TX

This document gives a brief overview of the Livox HAP-TX. It is based on evaluation of the sensor performed by Stiftelsen Adopticum in a project financed by Kempestiftelserna. For more information about the sensor, please feel free to contact Adopticum.

To describe the HAP-TX, Livox uses big words such as “the future of LiDAR technology”. Livox says that the ambition has been to develop a sensor for autonomous driving and to scale up into mass production.

The customers are automotive industry, and when this summary is written in October 2023 at least two Chinese automotive manufacturers uses the HAP in their products. To the best of our knowledge this makes the HAP the first Livox-sensor to be used in big scale and to accommodate the demand Livox has build a new production facility for the HAP-sensor.

With a price of Euro 1599 (Oct. -23) it´s a relatively cheap sensor when compared to what it delivers. As for many other sensors developed for the automotive industry, the areas of application outside the automotive world are many. The price is relatively low as the produced volume is high compared to niche sensors.

At a first look, the Livox HAP LiDAR gives a robust impression, and its compact form factor makes it versatile and easy to integrate into various setups. The build quality with a sturdy chassis feels capable of withstanding the rigors of real-world applications. The HAP is developed to meet major car producers’ standards and other industrial standards, such as ISO 16750.

If we start by looking at the data sheet, we find that this is a sensor that much like other Livox sensors are using a sweeping pattern to collect data. It´s got a more narrowly focused vertical view of 25°. The horizontal field of view is 120°. The detection range is reaching 150 meters with a point range of 452K points/s. Although HAP outputs up to 452,000 point clouds per second, they are not uniformly distributed across the FOV (120° horizontally, 25° vertically). The central zone of HAP’s FOV (40° horizontally, 12° vertically) is defined as the region of interest (ROI) with an angular resolution of up to 0.18° horizontally and 0.23° vertically.

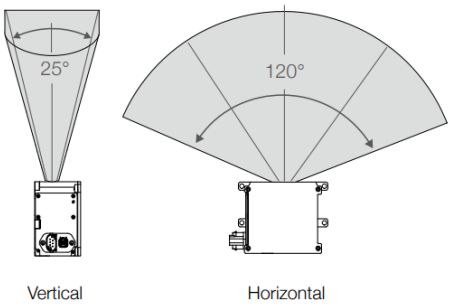


Figure 1 Field of view (FOV) HAP

Key specifications

Laser Wavelength	905 nm
Laser Safety	Class 1 (IEC 60825-1:2014) (Safe for eyes)
Detection Range (@100 klx)	150 m @ 10% reflectivity
Close Proximity Blind Zone	0.5 m
FOV	120° (horizontal) × 25° (vertical)
Distance Random Error (1σ)	< 2 cm @ 20 m (80% reflectivity)
Distance System Error	< ± 3 cm @ 20 m
Angular Random Error (1σ)	< 0.1°
Beam Divergence	0.03° (horizontal) × 0.28° (vertical)
Point Rate	452,000 points/s
Frame Rate	10 Hz
False Alarm Ratio (@ 100 klx)	0.01%

The Livox HAP also use the non-repetitive flower-pattern scanning strategy seen in its LiDAR predecessors, and due to that pattern the Livox sensors provide a very high resolution compared to most of its competitors.

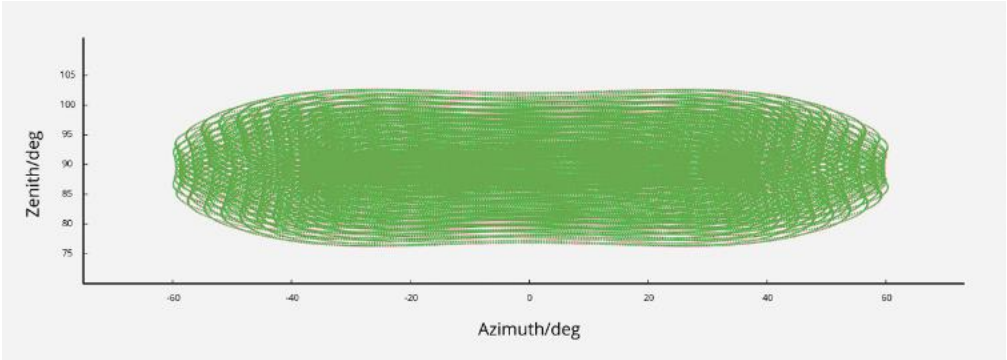


Figure 2 The scanner pattern for the HAP is relatively wide

The sensor uses an updated version 2 of the Livox communications protocol. The Livox SDK further simplifies the integration process, providing developers with the tools they need. The viewer is available for Windows and Ubuntu.

HAP can use two different scanning modes, Non-Repetitive and Repetitive. They have similar performance but, as the name suggests, they use a repetitive respective a non-repetitive scanning pattern. In the non-repetitive mode the area illuminated by the laser within the field of view expands over time, and the area covered by the field of view also expands significantly. The user can change between the two modes using either the SDK or Livox Viewer 2.

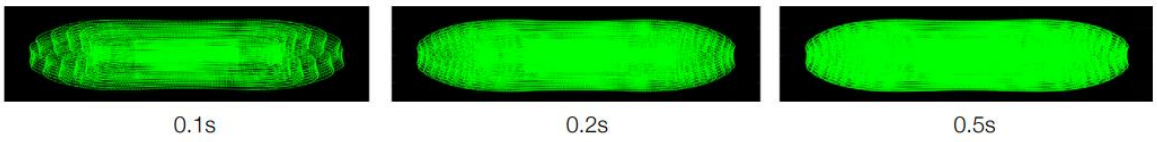
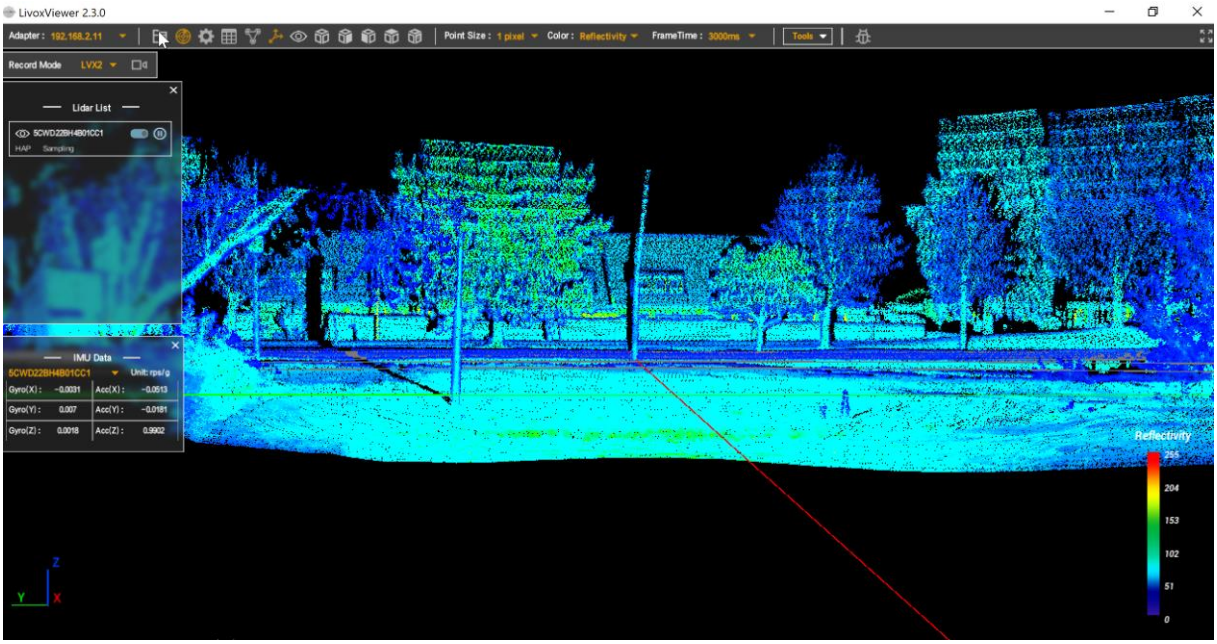


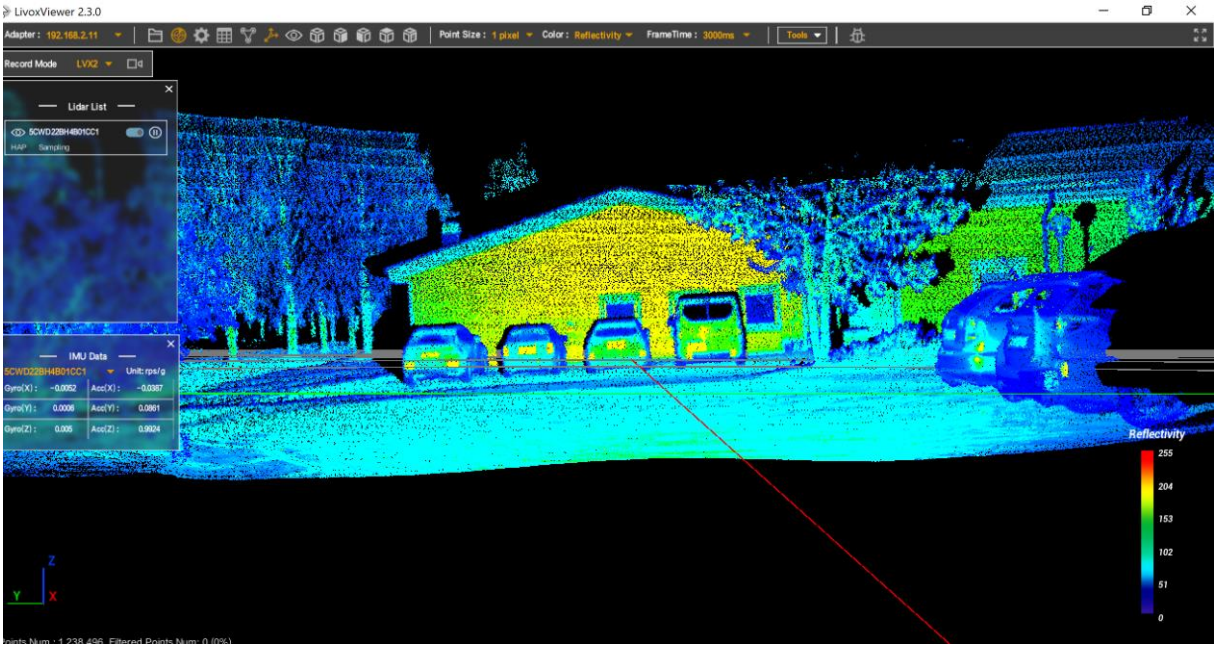
Figure 3 Image showing data collected for three different time intervals.

Our test shows that direct sunlight produces little noise to the data, as expected from a LiDAR sensor developed for the automotive industry.

The HAP has a window heating feature to keep the glass clear of snow, ice and fog. During our evaluation the weather did not allow for this to be thoroughly tested, but if this feature works well it brings an even higher value in outdoor applications. Adopticum has developed many solutions though out the years where keeping the sensor free from ice and fog have been solved by heated casings. This always add another component to integrate into the system. This feature is disabled by default and can be turned on via the SDK interface.

The maximum detection range of HAP is stated to 200 meters. but that is the maximum. The data sheet states that at 200 meters the object needs to be highly reflective and located in the center of the field of view. We´d say that using a max length to the object measured of 150 meters is a more suitable distance, similar to what is stated by Livox.





Kommentera bilderna

Use cases

We see that the HAP is an interesting sensor to use in a wide array of application. It could be used in different safety and security applications where controlling the environment is key.

- Large distances (1 - 150 m) to the scene to measure.

- Applications where wide field-of-view is a key factor

- Outdoor measuring applications (in colder climates, direct sunlight, etc.).

- Measuring big stationary objects.

- Measuring stationary objects from multiple angles to get a full map of bigger surroundings.

- When price is a factor

Summary

All in all, the Livox HAP is a pleasant sensor to work with. For this type of sensors, the price is relatively low at $1599 (October 2023). No calibration is necessary, so the sensor is a relatively easy and cost-effective way to get up and running for performing non-invasive measurements on many different scenes, not the least for scenes containing larger objects at a longer distance from the sensor.

The Livox viewer, here in a new release, simplifies getting the sensor started and getting measurement data from the sensor for analysis later. Works well for initial test measurements. As with any sensor, when a measurement application is required to work at all times, programming is necessary.

Compared to the other Livox products we have evaluated the temperature span on the HAP is far wider and Livox ensures working capability from -40℃ to 85℃ compared to −20℃ to +65℃ for the non-automotive grade lidars. At the time for evaluation this was hard to test as the utside temperature was -6℃. But we are looking into the possibility to team up with a company owning a temperature chamber to do some cold weather testing, for real. We have previously had some problems with the setup when using the MID40 and MID70 sensors outside in cold conditions, but these issues does not seem to come from the sensor itself but rather the external components. This is why a test in the climate chamber would be interesting.

This sensor is designed to be used in the automotive industry, but we see great possibilities in many types of applications outside the automotive world. Especially in the northern parts of Sweden where first and foremost the low temperatures during the winter season can be a challenge to many types of senors.