

LVX

Specifications v1.1

2020.05

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LVX Format v1.1

This document describes the specifications of LVX format v1.0. The LVX file is a point cloud file format developed by Livox Tech, based on the company's LiDAR sensors. This file format allows users to play the point cloud file at a base frequency of 20 Hz. At the same time, users can also acquire point data from a single device from this file for more complex algorithm development.

LVX Format Definition

The format contains binary data consisting of public header block, device info block, and point cloud data block.

| |
|----------------------|
| PUBLIC HEADER BLOCK |
| PRIVATE HEADER BLOCK |
| DEVICE INFO BLOCK |
| POINT DATA BLOCK |

All data are in little-endian format. The header block consists of file signature, version information, and a magic code. The length of the devices info block is variable, capable of accommodating any number of devices. The point cloud data block has point cloud data organized by package, and these packages are organized by frames in each file.

Data Types

The following data types are used in the LVX format.

- char (1 byte)
- unsigned char (1 byte)
- short (2 bytes)
- unsigned short (2 bytes)
- int (4 bytes)
- unsigned int (4 bytes)
- long long (8 bytes)
- unsigned long long (8 bytes)
- float (4 bytes IEEE floating point format)
- double (8 bytes IEEE floating point format)

Public Header Block

| Item | Format | Size |
|-------------------------------|--------------|----------|
| File Signature ("livox_tech") | char[16] | 16 bytes |
| Version-A | char | 1 bytes |
| Version-B | char | 1 bytes |
| Version-C | char | 1 bytes |
| Version-D | char | 1 bytes |
| Magic Code | unsigned int | 4 bytes |

File Signature: The file signature must contain "livox_tech" as it is required by the LVX specification. These characters can be checked by Livox Viewer as an initial determination of file type. Note that the first 10 bytes should be "livox_tech", and the last 6 bytes should be zero filled.

Version: Version a is 1, version b is 1, version c is 0, version d is 0.

Magic Code: This field should be a value of 0xAC0EA767. Livox Viewer will not identify a lvx file with an incorrect Magic Code.

Private Header Block

| Item | Format | Size |
|----------------|---------------|---------|
| Frame Duration | unsigned int | 4 bytes |
| Device Count | unsigned char | 1 byte |

Frame Duration: The duration of one frame. The unit of duration is millisecond(ms); Note: This field is only used to inform the user of the frame duration of the current file. In the 1.1.0.0 version of the Lvx file, this field is 50 and cannot be changed.

Device Count: The length of device info block is variable to suit several devices. This field should be a value of the count of devices;

Devices Info Block

| Item | Format | Size |
|---------------|--------|----------|
| Device Info 0 | struct | 59 bytes |
| | | |
| Device Info N | struct | 59 bytes |

Device Info: This is a field that provides information of each device. This field is defined as:

| Item | Format | Size | Description |
|------------------|---------------|----------|--|
| LiDAR SN Code | char[16] | 16 bytes | LiDAR broadcast code |
| Hub SN Code | char[16] | 16 bytes | Hub broadcast code. Note that an empty hub SN means there is no hub connecting this LiDAR. |
| Device Index | unsigned char | 1 byte | Index in device info list |
| Device Type | unsigned char | 1 byte | Device type: 0: LiDAR Hub 1: Mid 40/Mid-100 2: Tele-15 3: Horizon |
| Extrinsic Enable | unsigned char | 1 byte | 0: Extrinsic parameters disable, cloud points should be computed without extrinsic parameters; 1: Extrinsic parameters enable, cloud points should be computed with extrinsic parameters; |

| | | | |
|-------|-------|---------|--|
| Roll | float | 4 bytes | Extrinsic parameters: Roll Angle, Unit: degree |
| Pitch | float | 4 bytes | Extrinsic parameters: Pitch Angle, Unit: degree |
| Yaw | float | 4 bytes | Extrinsic parameters: Yaw Angle, Unit: degree |
| X | float | 4 bytes | Extrinsic parameters: X Translation, Unit: m |
| Y | float | 4 bytes | Extrinsic parameters: Y Translation, Unit: m |
| Z | float | 4 bytes | Extrinsic parameters: Z Translation, Unit: m |

Note that users can use Device Index to extract point cloud data of each device from a LVX file.

Point Cloud Data Block

Data from the Point Cloud Data Block are composed of frames, and each frame is composed of packages.

| Item | Format | Size |
|---------|--------|---------|
| Frame 0 | struct | N bytes |
| Frame 1 | struct | N bytes |
| | | |
| Frame N | struct | N bytes |

Frame is defined as:

| Item | Format | Size |
|--------------|--------|----------|
| Frame Header | struct | 24 bytes |
| Package 0 | struct | depends |
| Package 1 | struct | depends |
| | | |
| Package N | struct | depends |

Frame Header is defined as:

| Item | Format | Size | Description |
|----------------|-----------|---------|--|
| Current Offset | long long | 8 bytes | Absolute offset of the current frame in this file. |
| Next Offset | long long | 8 bytes | Absolute offset of next frame in this file. |
| Frame Index | long long | 8 bytes | Current Frame Index. |

Package is defined as SDK protocol new type normal Data

| Item | Format | Size | Description |
|----------------|-----------------|---------|--|
| Device Index | unsigned char | 1 byte | Refer to Device Info |
| Version | unsigned char | 1 byte | Package protocol version, 5 for the current version |
| Slot ID | unsigned char | 1 byte | ID of the Slot Connecting LiDAR Device: For more details, refer to Livox SDK Communication Protocol |
| LiDAR ID | unsigned char | 1 byte | LiDAR ID: 1: Mid-100 Left / Mid-40 / Tele-15 / Horizon 2: Mid-100 Middle 3: Mid-100 Right |
| Reserved | unsigned char | 1 byte | |
| Status Code | unsigned int | 4 bytes | LiDAR Status Indicator Information, refer to Livox SDK Communication Protocol for more details |
| Timestamp Type | unsigned char | 1 byte | Timestamp Type, refer to Livox SDK Communication Protocol for more details |
| Data Type | unsigned char | 1 byte | Point Cloud Coordinate Format: 0: Cartesian Coordinate System; Single Return; (Only for MID) 1: Spherical Coordinate System; Single Return; (Only for MID) 2: Cartesian Coordinate System; Single Return; 3: Spherical Coordinate System; Single Return; 4: Cartesian Coordinate System; Double Return; 5: Spherical Coordinate System; Double Return; 6: IMU Information |
| Timestamp | unsiged char[8] | 8 bytes | Nanosecond or UTC Format Timestamp, refer to Livox SDK Communication Protocol for more details |
| Point 0 | struct | depends | Point information, depends on Data Type |
| Point 1 | struct | depends | Point information, depends on Data Type |
| | | | |
| Point N | struct | depends | Point information, depends on Data Type |

Point is defined as following:

Data type 0 (100 points per package)

| Item | Format | Size | Description |
|--------------|---------------|---------|---------------------------|
| x | int | 4 bytes | X-axis position, unit: mm |
| y | int | 4 bytes | Y-axis position, unit: mm |
| z | int | 4 bytes | Z-axis position, unit: mm |
| reflectivity | unsigned char | 1 byte | Reflectivity |

Data type 1 (100 points per package)

| Item | Format | Size | Description |
|--------------|----------------|---------|---|
| depth | int | 4 bytes | Unit: mm |
| theta | unsigned short | 2 bytes | Zenith angle, unit: 0.01 degree, range [0,18000] |
| phi | unsigned short | 2 bytes | Azimuth angle, unit: 0.01 degree, range [0,36000] |
| reflectivity | unsigned char | 1 byte | Reflectivity |

Data type 2 (96points per package)

| Item | Format | Size | Description |
|--------------|---------------|---------|---|
| x | int | 4 bytes | X-axis position, unit: mm |
| y | int | 4 bytes | Y-axis position, unit: mm |
| z | int | 4 bytes | Z-axis position, unit: mm |
| reflectivity | unsigned char | 1 byte | Reflectivity |
| tag | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |

Data type 3 (96points per package)

| Item | Format | Size | Description |
|--------------|----------------|---------|---|
| depth | int | 4 bytes | Unit: mm |
| theta | unsigned short | 2 bytes | Zenith angle, unit: 0.01 degree, range [0,18000] |
| phi | unsigned short | 2 bytes | Azimuth angle, unit: 0.01 degree, range [0,36000] |
| reflectivity | unsigned char | 1 byte | Reflectivity |
| tag | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |

Data type 4 (48 points per package)

| Item | Format | Size | Description |
|---------------|---------------|---------|---|
| Item | Format | Size | Description |
| x1 | int | 4 bytes | X-axis position, unit: mm |
| y1 | int | 4 bytes | Y-axis position, unit: mm |
| z1 | int | 4 bytes | Z-axis position, unit: mm |
| reflectivity1 | unsigned char | 1 byte | Reflectivity |
| tag1 | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |
| x2 | int | 4 bytes | X-axis position, unit: mm |
| y2 | int | 4 bytes | Y-axis position, unit: mm |
| z2 | int | 4 bytes | Z-axis position, unit: mm |
| reflectivity2 | unsigned char | 1 byte | Reflectivity |
| tag2 | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |

Data type 5 (48 points per package)

| Item | Format | Size | Description |
|---------------|----------------|---------|---|
| theta | unsigned short | 2 bytes | Zenith angle, unit: 0.01 degree, range [0,18000] |
| phi | unsigned short | 2 bytes | Azimuth angle, unit: 0.01 degree, range [0,36000] |
| depth1 | int | 4 bytes | Unit: mm |
| reflectivity | unsigned char | 1 byte | Reflectivity |
| tag1 | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |
| depth2 | int | 4 bytes | Unit: mm |
| reflectivity2 | unsigned char | 1 byte | Reflectivity |
| tag2 | unsigned char | 1 byte | For more detail, please refer to SDK Protocol |

Data type 6 (1 point per package)

| Item | Format | Size | Description |
|--------|--------|---------|-------------|
| gyro_x | float | 4 bytes | Unit: rad/s |
| gyro_y | float | 4 bytes | Unit: rad/s |
| gyro_z | float | 4 bytes | Unit: rad/s |
| acc_x | float | 4 bytes | Unit: g |
| acc_y | float | 4 bytes | Unit: g |
| acc_z | float | 4 bytes | Unit: g |

