ZED 2i Stereo Camera

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Outline

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Introduction

Zed 2i is multi-sensors cameras that include stereo vision, motion, position and environmental sensors.
ZED 2i camera features:

- Wide-Angle 3D AI Camera: Long-range depth perception with AI to perceive environment in 3D with up to 120° wide-angle field of view.
- IP66-rated Enclosure: Resistant to dust, water and humidity designed for outdoor applications .
- Built-in IMU, Barometer and Magnetometer: 9-DoF sensors for spatial and positional awareness.
- Built-in polarizing filter: Filter helps reduce glare and reflections and increases color depth and quality as well.

Introduction

ZED 2i camera applications:

- STEREO CAPTURE: captures high-definition 3D video with a wide field of view and outputs two synchronized left and right video streams in side-by-side format.
- DEPTH PERCEPTION:
  - Depth Range 0.2m to 20m.
  - Frame rate as high as 100 FPS.
  - Works indoor as well as outdoor.
- POSITIONAL TRACKING:
  - Offers full 6 DOF positional tracking.
  - Can access 6 DOF motion tracking data through the ZED SDK
- SPATIAL MAPPING:
  - Captures digital model of a scene or an object in the physical world.
  - it is available either through the ZEDfu application or the ZED SDK.

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Zed SDK Overview

- ZED SDK is available for Windows, Linux and Nvidia Jetson platforms (Jetson Nano, Jetson Xavier and Jetson Orin).
- Contains all the libraries that power camera along with tools to test its features and settings.
- ZED SDK has specific OS and NVIDIA CUDA requirements.
- Installed ZED SDK for Jetson Orin:
  - Download SDK from: https://www.stereolabs.com/developers/release/
  - Follow installation steps: https://www.stereolabs.com/docs/installation/jetson/
  - Install ZED Python API: https://www.stereolabs.com/docs/app-development/python/install/

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Camera Controls

- Select different Video modes: 2.2K, 1080p, 720p, WVGA.
- Select different output view: Left view, Right view, Side-by-side view, Left or Right Unrectified, Left or Right Grayscale.
- Adjust Camera settings: Onboard ISP (Image Signal Processor) performs various image processing algorithms on raw images captured by the dual image sensors.

Camera Controls: Using the API

- First create and open a Camera object.
- Camera Configuration: Specify 'InitParameters' - camera resolution, FPS, depth sensing parameters and more.
- Image Capture: Specify 'RuntimeParameters' and call 'grab()' to grab a new frame and 'retrieveImage()' to retrieve the grabbed frame.

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Depth Sensing Overview

- DEPTH MAP:
  - ZED stores distance value (Z) for each pixel (X, Y).
  - Calculated from the back of the left eye of the camera to the scene object.
- 3-D POINT CLOUD:
  - Collection of 3D points (X,Y,Z) that represent the external surface of the scene and can contain color information.

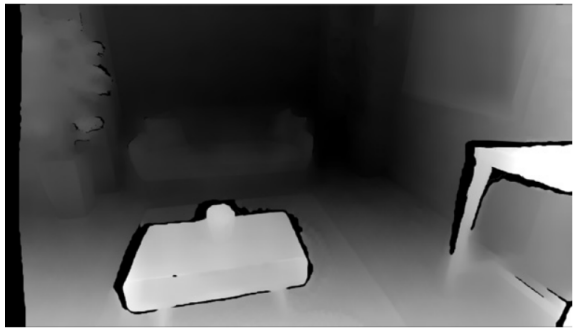

Figure: Depth Map

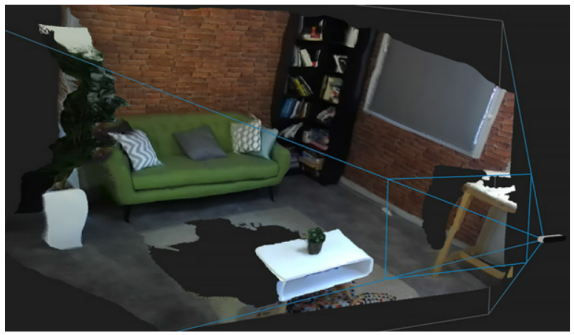

Figure: 3-D Point Cloud

Depth Sensing: Using the API

- Depth Sensing Configuration:
  - 'InitParameters' at initialization - depth mode (Ultra, Quality, Performance), metrics(m, cm, mm), memory (CPU or GPU).
  - 'RuntimeParameters' to change specific parameters during runtime.
- Getting Depth Data:
  - 'grab()' to grab a new image and 'retrieveMeasure()' to retrieve the depth aligned on the left image.
  - depth matrix stores 32-bit floating-point values which represent depth (Z) for each (X,Y). Access this through 'getValue()'.
  - 32-bit depth map can be displayed as a grayscale 8-bit image - 'retrieveImage(depth,VIEW DEPTH)'

Depth Sensing: Using the API

- Getting Point Cloud Data:
  - Point cloud stores its data on 4 channels using 32-bit float for each channel.
  - 3D point cloud with (X,Y,Z) coordinates and RGBA color can be retrieved - 'retrieveMeasure()'.
  - Access a specific pixel value - 'getValue()'
- Measuring Distance with Point Cloud:
  - To measure distance recommended to use 3D point cloud over depth map.
  - Euclidean distance formula allows to calculate the distance of an object relative to the left eye of the camera.

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Conclusion

- Explored Depth sensing through ZED SDK.
- Implemented Pedestrian detection and its distance estimation.
- Integrated the Pedestrian Distance into Navigation algorithm to make decisions.
- Need to explore other features of ZED SDK for autonomous navigation.

Thank you!