REAL3D.

GAIN THE UPPER HAND

Proposal for test of pmd performance on device level

“ToF Device Test”

pmdtechnologies – 2016-04-28

Overview

Requirements:

- ToF data accuracy and data quality should tested on the final device with the final processing software.
- The test execution must be fast, so that it can be done with every single device.

Proposal:

- Test box with a planar target surface.

Possible test points with planar target surface:

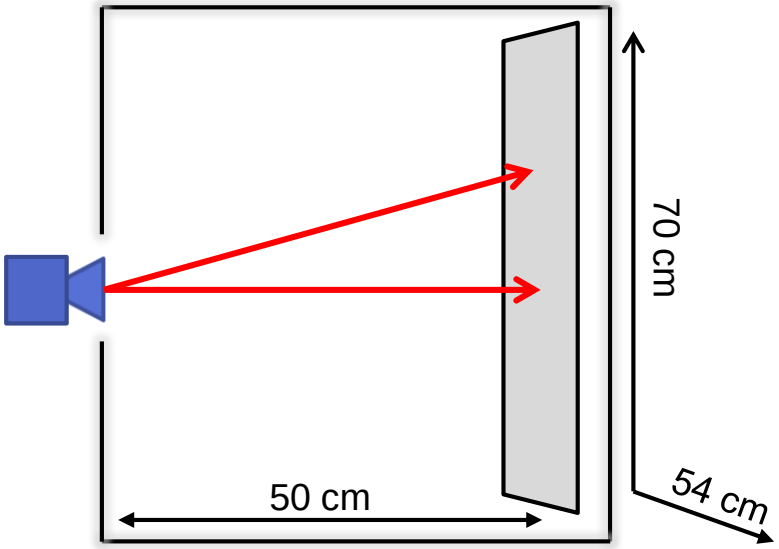
- general IRS functionality (e.g. power-up, frame rate)
- temperature sensor: reasonable temperature range (~20 to 40 °C)
- XYZ accuracy: plane fit, absolute distance, deviation of individual points from plane
- noise of XYZ data
- data stability (frame drops, data integrity)
- additional calibration verifications
  (e.g. amplitude wiggling, noise parameters)
- beam profile

Not possible with planar target surface:

- focus/MTF/sharpness of image data

Planar target specification (preliminary)

- Setup:
  - free field-of-view
  - homogenous, matte, diffuse reflective target plane (white or gray)
  - enclosure for highly reproducible measurement conditions, IR-light absorbent
  - fixture for the device for reproducible measurements
  - Arguments to consider for outer dimensions:
    - field-of-view (for example: 60° × 45°)
    - Distance during calibration of device is 40 cm. To verify the performance, it is unwise to evaluate at the exact same distance. 50 cm would be ideal for this device.
    - some safety margin between enclosure and target surface / field-of-view should be ensured to avoid reflections at target edge



black, matte, IR non-reflective enclosure

Target dimensions:
70 cm x 54 cm x 1 cm
(flat aluminum target plate)
Box outer dimension:
86 cm x 66 cm x 54 cm

Data source: camera HAL

- All data outputs of the Android camera HAL should be tested. The Android camera HAL provides three kind of output containers:

1. point cloud (XYZ data)
2. amplitude data (IR image)
3. depth data* (Z data image).

- The following slides show proposed, preliminary test points that can be made with a planar target test setup and these output containers.

* “depth” denotes the Z coordinate in Cartesian coordinates. A time-of-flight camera measures “distance” data, which is the radial distance from the camera in spherical coordinates. In order to retrieve “depth” from “distance”, the camera’s lens calibration is being applied.

Point cloud test point proposal (XYZ data)

Steps:

1) retrieve single XYZ point cloud from framework (1 frame)
2) evaluate valid pixel count
3) plane fit of valid pixels
4) evaluate fit accuracy, plane distance from camera
5) evaluate maximum pixel deviations from plane fit

Validates:

- FPPN
- temperature compensation
- phase wiggling
- lens parameters
- sensor performance

Does not validate:

- amplitude wiggling (MPI flag can be used, if available)
- noise parameters (access to calibration data required)
- beam profile

Required data: data from camera HAL

Amplitude test point proposal (IR image)

Steps:

1) retrieve amplitude image from framework (~20 frames)
2) evaluate: mean, min and max standard deviation of valid pixels

Validates:

- sensor performance
- beam profile homogeneity
- data stability

Required data: data from camera HAL

Depth data test point proposal (Depth data)

Steps:

1) retrieve depth image from framework (~20 frames)
2) evaluate: mean, min and max standard deviation of valid pixels

Validates:

- FPPN
- temperature compensation
- phase wiggling
- lens parameters
- sensor performance
- calibration accuracy
- data stability

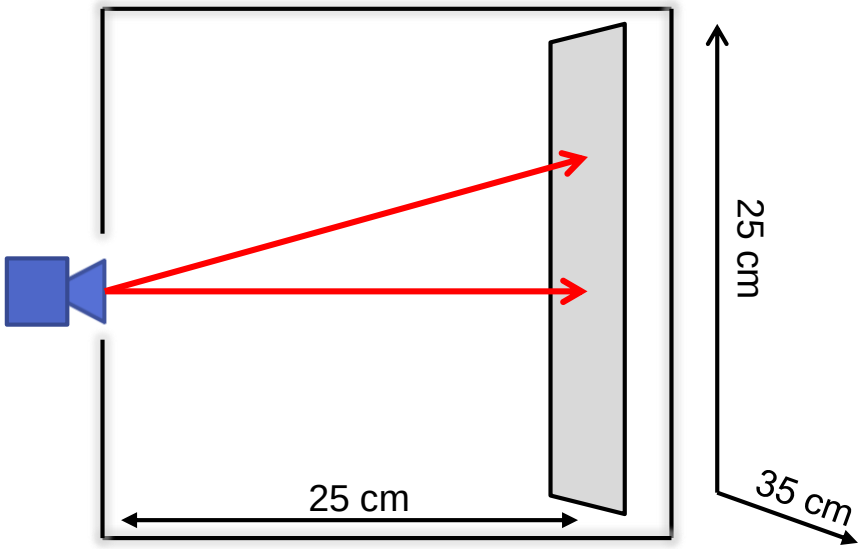
Required data: data from camera HAL

Appendix

Increased space constraints

Validation Box XS

- If only a functional device check is required for mass production, a smaller validation box may be used.
- Example: For a K6 lens with a FoV of 60° × 45°, 25 centimeter are feasible:



black, matte, IR non-reflective enclosure

- Target dimensions:
  25 cm x 35 cm x 1 cm (flat aluminum target plate)
- Box outer dimension (preliminary):
  41 cm x 31 cm x 32 cm (using 3 cm aluminum strut profiles)
- The identical test software/test procedure with adjusted test limits can be applied

- **Please note** that the absolute test accuracy in this test box is reduced. Regular sample tests larger test distances are recommended to ensure device data quality!
  (e.g. using a larger Validation Box or a linear translation stage)