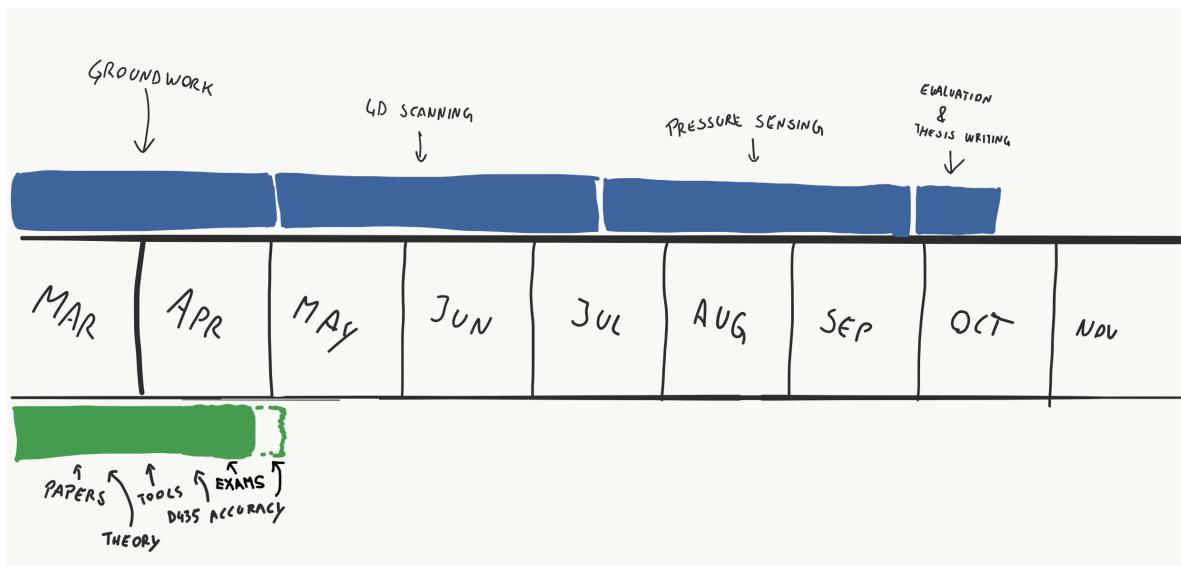


4DFS UPDATES @20.04

Roadmap



Progress report

In the last few weeks I mostly focused on exams, which went great (I passed both of them)!

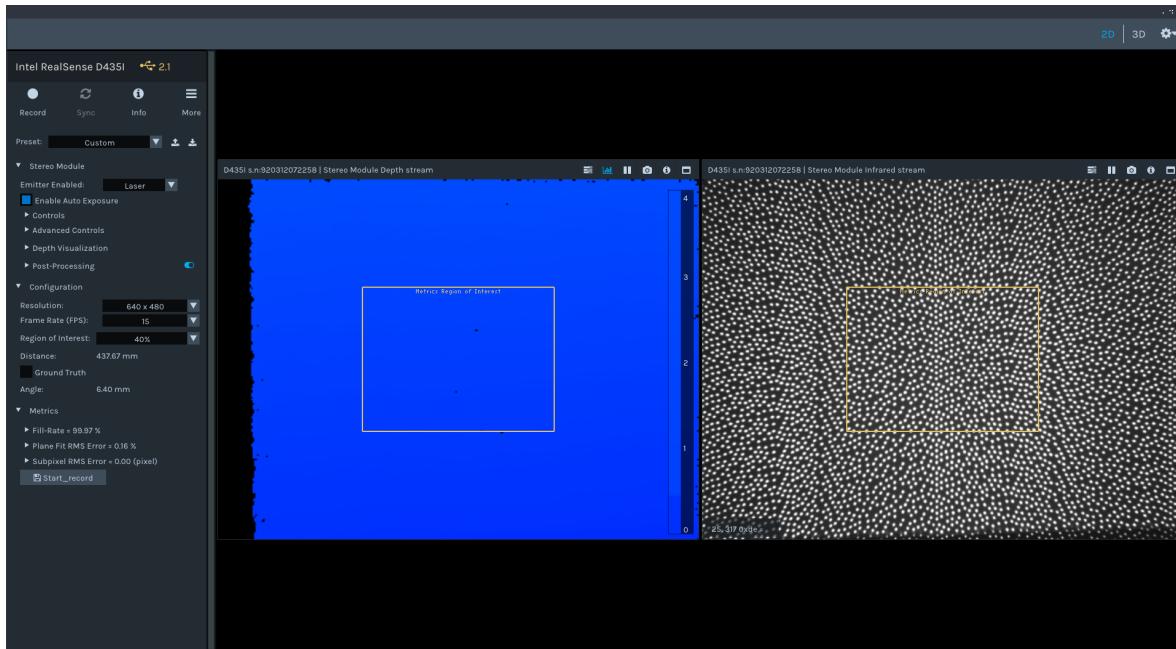
I conducted the **first accuracy measurement** test, using Intel RealSense Depth Quality tool. I used the following papers as guidelines:

- [Metrological and Critical Characterization of the Intel D415 Stereo Depth Camera](#)
- [Tuning depth cameras for best performance](#)

My goal was to measure **systematic planarity errors** at different distances from the sensor (in other words, if we measure a flat surface, how homogenous/flat is the obtained data). Image below shows my setup, which is a first attempt, serving mostly for educational purposes.



Setup of the experiment



RealSense Depth quality tool

Data was measured in range of 300 - 1100 mm with a pitch of 100mm. Metrics offered in Depth quality tool are: Fill-rate [%], Plane-fit RMS error [%], Subpixel RMS error [%].

Due to circumstances and lack of appropriate tools (and experience :)) I consider this test very inaccurate, but I learned a lot from it. Results are shown below

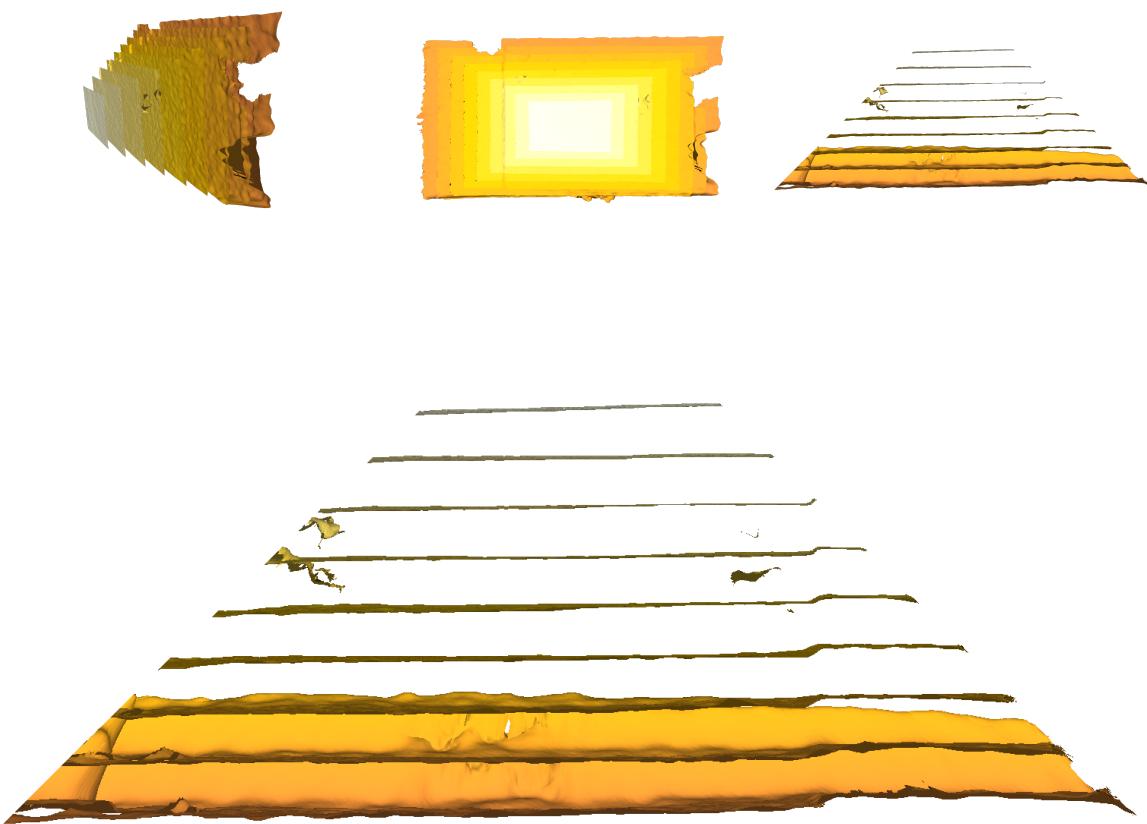
Default preset, auto-exposure (setpoint at 1536). Laser power (default) 150mW. Resolution 848 x 480 px, 40 FPS, 40% ROI.

distance	fill-rate	plane-fit RMS	subpixel RMS
30	99.99	0.16	0.05
40	100	0.17	0.04
50	100	0.20	0.04
60	100	0.15	0.02
70	100	0.28	0.04
80	100	0.17	0.02
90	100	0.32	0.03
100	100	0.19	0.02
110	100	0.36	0.03

*at 110 reaching the edge of the doors (wall area too small for larger distances)

High accuracy preset, other settings are the same

distance	fill-rate	plane-fit RMS	subpixel RMS
30	100	0.19	0.05
40	100	0.17	0.03
50	100	0.20	0.04
60	100	0.30	0.05
70	100	0.24	0.03
80	100	0.17	0.02
90	100	0.39	0.04
100	100	0.18	0.02
110	100	0.41	0.03



Visualization of captured planes at different distances (using MeshLab)

There are several things that could be improved or I want to ask about:

- I know **lighting** is relatively bad. Is there anything I could do better?
 - **autoexposure yes/no?** If yes, should I keep it constant across measurements, or adapt at every new distance?
 - I was measuring data only in the **ROI** of 40% (default setting of DepthQuality tool). I am guessing that it makes sense to measure accuracy across whole frame.
 - Camera **perpendicularity** against the wall. Not consistent across measurements, is this a problem?
-

Apart from that, I also tried **programming** my own "depth quality tool", to learn how to work with pointclouds, python and relevant libraries.

These the steps I managed to achieve with small python programs:

- obtain and display depthmap, colormap, infraredmaps + export `.ply` files
- create UI which shows camera stream (RGB) and captures depth image on button press
- visualize pointclouds (using Open3D library)



Pointcloud rendered with custom script (using Open3D library)

What's next?

Next step on my TODO list is **calculating best-fit plane**. Surprisingly I could not find a straightforward and simple solution in any of the libraries (OpenCV, Open3D) - am I missing something obvious?

Realsense implementation of Depth Quality tool uses [this method](#). Other potential methods:

- PCA ([article](#) explaining difference between PCA and Ordinary Least Squares)
- Total least-squares, SVD
- RANSAC
- Hough transform

I am now working towards understanding the mathematics and implementing one of those methods.