Calibration Rig for pmd ToF Modules

Project	ToF Calibration Rig		
Subject	Specification of the ToF Calibration Rig		
Version	**01.00**		
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Contents

List of Figures

1. Introduction

For the calibration and the characterization of pmd ToF modules in small or medium series, a calibration rig with an automated linear translation stage and a reference target can be used. This calibration rig can be supplied to a large extent by Image Engineering, however, especially the software performing the actual depth data calibration is supplied by pmd.

In this document, the technical requirements for such a calibration rig are described, and the roles and responsibilities are clarified.

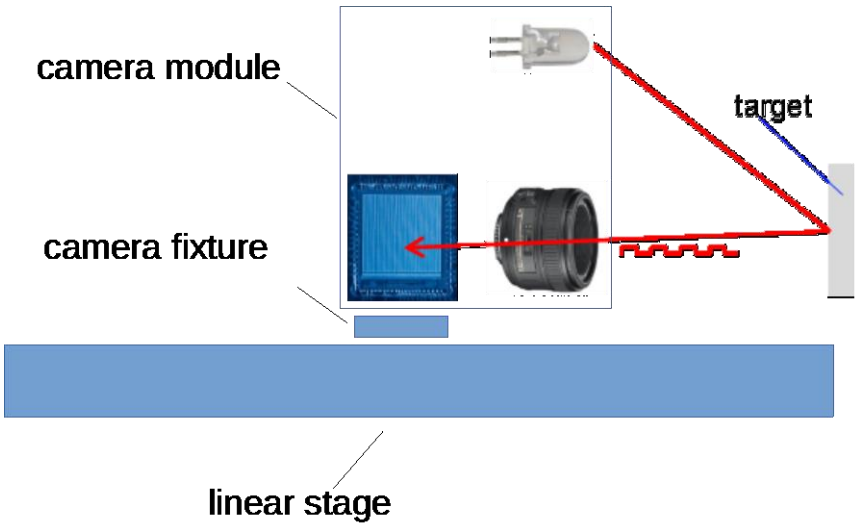

Figure 1: Calibration rig (schematic)

Pmd will supply a C2 camera module with a USB MIPI adaptor board in order to show the functionality of the calibration scripts.

2. Technical Requirements

The following table lists the technical requirements regarding the calibration rig.

Linear Stage
•Repeated and absolute precision: <±1mm •set-up does not oscillate after movement stops •movement speed >0.2m/s •standard interface to PC (e.g. USB) •USB3 data cable in the cable carrier (for the communication with the camera module) •Range: 0..3m (optional 0..5m). At the zero position, the distance to the target amounts to 0.2 .. 0.4m.
Target
•Diffuse, homogeneous, matte, plane foil / paper with defined reflectivity •The stage will be aligned in a way that the camera looks normal to the wall through the whole movement range. That can be shown e.g. by mounting a laser pointer to the stage - the projected spot must only show minimal movements.
Environment / Housing
•All strut profiles and other (especially metallic) parts within the FoV of the camera must be covered by EPMD to avoid specular reflections. •Optional, a housing can be offered to keep away ambient light.
Mounting
•An aluminum plate with raster drills (M5) is available to which the camera module can be mounted to.
Software
•API to automate the movements available (Windows 7 64bit) •A PC is not part of the offer.

Figure 2: Technical Requirements regarding the calibration rig

If not mentioned otherwise, one can assume a ToF camera module with a field of view of 60° x 45°.

3. Roles and Responsibilities

The following table shows the roles when supplying the stage to a customer.

Subject	Image Engineering (IE)	pmd
Hardware	• Linear stage, controller, setup, target • USB-3.0 data cable in the data carrier	• Reference module C2 with CX3 adaptor board
Setup	• Alignment to the wall in a way that the camera module looks normal to the target	
Training	• Usage and maintenance of the stage • Introduction to the API	• Introduction to calibration scripts
Software	• API	• Calibration scripts (Matlab) and wrapper between Matlab and the API from IE

Figure 3: Roles

For a first idea of the costs, the following two tables give a tentative overview:

Subject	Image Engineering (IE)	Costs
Hardware	• Linear stage, controller, setup, target • USB-3.0 data cable in the data carrier	• ca. 20k€ (stage, Controller, setup) • ca. 5k€ (Target)
Setup	• Alignment to the wall in a way that the camera module looks normal to the target	• Ca. 3k€ (incl. travel costs and shipment)
Training	• Usage and maintenance of the stage • Introduction to the API	• Ca. 1k€ (incl. travel costs)
Software	• API	• ca. 1k€

Table 1: Costs on behalf of IE (tentative)

Subject	pmd	Costs
Hardware	• Reference module C2 with USB MIPI adaptor board	• Tbd
Training	• Introduction to calibration scripts	• Tbd
Software	• Calibration scripts (Matlab) and wrapper between Matlab and the API from IE	• Tbd (NDA required!!!)

Table 2: Costs on behalf of pmd (tentative)