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Calibration of a 3D TOF Camera and Image Processing

ABSTRACT - Masterthesis

The 3D Time of Flight (ToF) is an emerging imaging technology which adds a new dimension to the imaging world. The cameras equipped with this technology capture the lateral as well as the depth information of an imaging 3D scenario. The camera works on the principle of Time of Flight wherein the distance towards any imaging point in 3D space is calculated according to the travel time of the rays hitting the sensor pixel. This technology provides an easy and fast way of capturing 3D information which is of prior interest among the new generation image and video processing systems.

Since the response of the camera varies with the integration time, background color, distance to the object, lens, reflectivity of the surface and various other factors, perfect reconstruction of the 3D scene is always a challenging task. An efficient calibration technique is always a basic necessity for reconstructing the imaged 3D scenes accurately.

The aim of this thesis is to develop an efficient calibration technique for the PMD Camcube 2.0 ToF camera. Parametric and non parametric methods are implemented for the calibration procedure according to the nature of the calibration problem. Imaging models, correlation model and correction models are proposed for model based calibration. Calibration results are presented which demonstrates exceptional performance in par with the proposed calibration models.

The contribution of this thesis also includes reflectivity based correction, Integration time offset correction and optimal Integration time selection for the PMD Camcube 2.0 camera. The thesis also outlines various well known depth denoising techniques and practical denoising examples by which the remaining stochastic noise after the calibration procedure are filtered.

The outcome of this thesis is an efficient step by step procedure for calibrating a PMD Camcube 2.0 camera. The reconstructed depth images can be used readily for post processing tasks such as object recognition, object tracking etc.