Method Development for the Evaluation of a 3D Imaging System for Human Motion Applications

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Medical technology
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Researchers at BFH aim to develop a non-ionizing imaging method based on 3D camera systems for monitoring scoliosis patients. For this a suitable HW solution must be found to reliably detect structural features on the human back. In order to perform a subsequent clinical study, various systems are tested for dynamic behavior. In this work, a method for quantitative comparison of different systems for capturing a scene with moving patients is developed.

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Introduction

Monitoring of scoliosis patients is still performed with radiology which is known to be harmful in the long term [Luan, FJ. et al.]. A joint project from BFH and ETH aims to reduce exposure to X-ray with a non-ionizing imaging process. In a later clinical study to confirm the systems functionality, patients are in motion during image acquisition, e.g., lateral bending. Due to latencies of 3D imaging systems, motion artifacts can occur in the resulting 3D point cloud representation. The causes for these artefacts are depending on the system, thus must be examined regarding the specific application.

Method Development

A dataset of motion speeds was defined with which the 3D imaging systems were evaluated. This dataset was established on measurements performed on healthy volunteers doing movements that are performed in the clinical study. A developed and 3D printed staircase model was moved from front to back on the image axis and horizontal from left to right on the image plane. At every speed in the previously defined range, point clouds were generated. Defined regions in the point cloud were parametrically analyzed as a statistical distribution in the image axis in Z (Fig1). The median of two distributions of adjacent stair steps was determined and by calculating their difference the represented step height was inferred. A comparison to the same value in a static captured point cloud resulted in a parameter which conveys the relative accuracy. The difference of a distributions' span, compared to the same value in the static point cloud, was evaluated as a parameter for the precision.

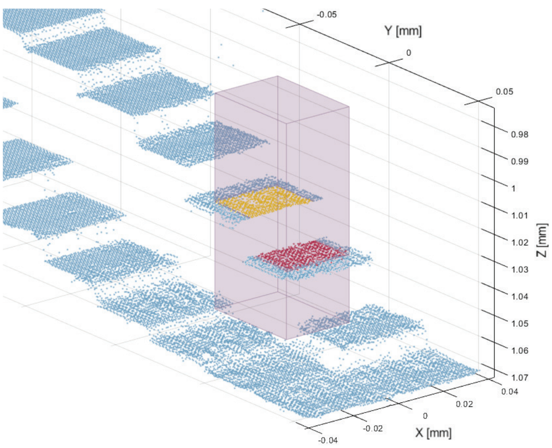

Fig1: Example of a region of interest (in magenta) and distributions (orange and red) on a point cloud

Evaluation Results

The expectations were met since a drop in relative accuracy and precision is observed with increased speed. The same behavior is noticed in a qualitative analysis on some samples as more and more artifacts are visible. An example of the decrease in relative accuracy with respect to increased speed is seen in the evaluation (Fig2).

Conclusion / Outlook

The developed method and corresponding evaluation pipeline can be used to analyze different 3D camera systems for their relative accuracy and precision depending on the speed of different applications. The proposed method for the staircase model can also be extended to other analytical approaches for distributions on the X- or Y-axis for further quantitative statements.

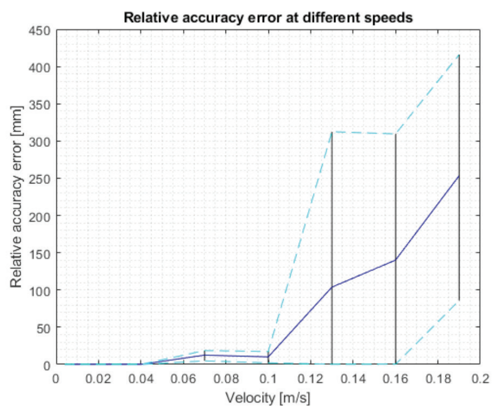

Fig2: Relative accuracy results of the Photoneo MotionCam-3D in Scanner mode using the proposed evaluation method