Calibration Procedure for Laser Triangulation Systems

Student

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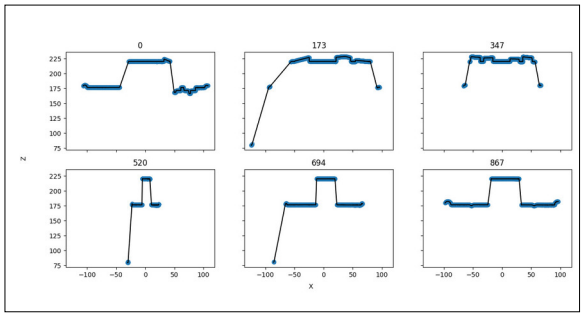
Introduction: This research extends the functionality of a measuring system with a 2D profile sensor and a turntable. The measuring system is thought to be implemented in the OST smart factory; an automatic injection molding cell focused on digitalized production. The measurement setup can be calibrated by compensating for shifts or turns in the sensor's position. A function is needed to determine the profile sensor's position in the turntable's coordinate system to calculate the needed shifts and turns.

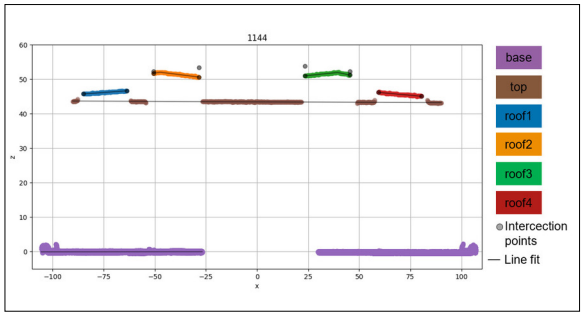
Approach: Given was the geometry of a calibration body with roof-like features on top. By scanning and processing a 3d-print of the calibration body, various points should be determined, so the position of the laserplane can be estimated by a best fit method. The laser plane's origin relative to the body frame can be calculated with the laser plane estimated.
By calculating the origin of the sensor relative to the body frame on various turning positions around the turntable, a set of origin points can be gathered. The set should have an ellipse-like pattern with the direction of the turn-axis as its normal vector and the center points as the position vector.
Combined with the measured base surface, the rotation point, and the rotation axis, the origin of the turntable is defined.

Result: The result of this thesis is an algorithm that can isolate essential sections of the measurements, analyze them, and fit the geometry of the calibration body into the result. With this result, the program does a best fit and determines the origin of the sensor in the body frame.
The output created with the evaluation data has an unexpected pattern and is not ellipse-like. It was analyzed that it has to be a result of errors adding up, and instability of the fit was assumed based on the cross-like pattern. Therefore it was clear that an ellipse fit would not give a satisfactory result.
By analyzing the data, a correlation was found between the clusters and the intersection position of the laser plane with the calibration body. That correlation showed that the assumption of the instability was correct because the clusters are spread in a swinging motion around the intersection lines.
With the primary sources of error found, recommendations are formulated to improve the calibration body.

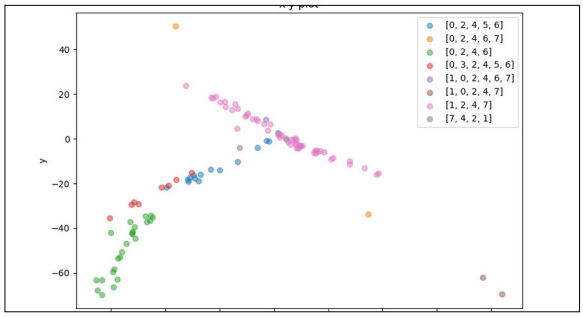
Samples of the measurement with the rotating turntable entitled with dataset number
Own presentment



A plot of example dataset 1144, colored by cluster with the fitted intersection lines and calculated intersection points
Own presentment



X-Y plot of the origins of the seonsor frame in the body frame categorized by the corresponding plane cut order
Own presentment



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Subject Area
Computer Science, Sensor, Actuator and Communication Systems, Mechatronics and Automation, Software and Systems