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Position and orientation calibration of a 2D laser line sensor using closed form least-squares solution

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Laser line sensors are used for inspection, positioning and scanning of 3D objects. They are often mounted on the flange of an industrial robot. The laser line sensor provides 2D measurement values in the x and z direction with respect to the sensor coordinate frame. In order to transform the measured values into the robot coordinate frame and therefore expand the 2D measured values into 3D coordinates, the position and orientation of the sensor coordinate frame with respect to the flange coordinate system must be determined by solving a kinematic equation in terms of transformation matrices. This article provides a complete solution for solving this problem. A unique solution is derived based on the separable closed-form solution after two movements of the robot flange under satisfying constraints. Robotic applications are usually implemented with the presence of noise. Therefore, a least squares solution is determined after performing several measurements. Finally the calibrated laser line sensor is integrated in combination with a process tool into a semi-automated assembly process in aircraft production. In the assembly of the aft section of the aircraft the pressure bulk head must be mounted through a riveting process to the section barrel. Using skills of humans and robots the riveting process can be performed precisely in human robot collaboration.

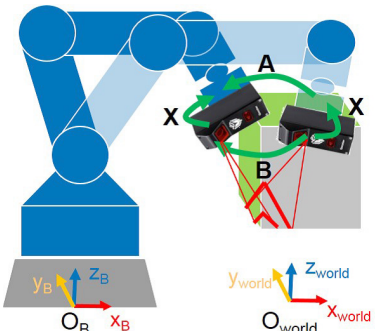

Figure: *A laser line sensor Gocator 2330 from the company LMI Technologies [3] mounted on a serial robot measuring the base of a cube that is defined as a calibration target at the initial robot position and after moving the robot*

Recent Publications

1. Shiu Y C and Ahmad S (1989) Calibration of wrist-mounted robotic sensors by solving homogeneous transform equations of the form AX=XB. IEEE Transactions on Robotics and Automation 5(1):16–29.
2. Park F C and B J (1994) Martin robot sensor calibration: solving AX=XB on the Euclidean group. IEEE Transactions on Robotics and Automation 10(5):717–721.
3. Müller R, Vette M and Kanso (2018) Comparison of practically applicable mathematical descriptions of orientation and rotation in the three-dimensional Euclidean space. Kongresses Montage Handhabung Industrieroboter DOI: 10.1007/978-3-662-56714-2_14.

Biography

Ali Kanso is a Scientific Researcher at ZeMA. His activities cover different fields in the frame of automation and handling devices. These are analysis and optimization of handling device, calibration of the robot kinematic chain and deployment of sensitive robots in the production.

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