Popular Science Summary

High Precision Robotic Manipulator for Bluelining at MAX IV

Master's thesis in Automatic Control

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Bluelining at MAX IV

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Substantial progress in the field of particle accelerators has made it feasible to make discoveries in the field of physics, medicine, chemistry and so on. For effective operation, all particle accelerators need exact positioning of numerous components. In particle accelerators, survey and alignment operations involve precisely locating multiple components within micro-metric tolerances across the workspace in relation to a reference point set by beam physicists in any plane.

Before installation of components along a beam-path, the CAD model of the setup is projected on the workspace and positional data of all equipment is generated to meet the requirement of relative alignment along the horizontal plane. This provides the measurement team with the coordinates of the footprints of all the components on the floor. The team then uses a laser tracker to aid the marking of these points on the floor. The initial step of equipment installation is Bluelining.

However, the process of locating and marking points on the floor is an extremely tedious and time-consuming task. The measurement team spends a lot of time and energy in marking these points which could rather be spend in other activities. Automating this task would ease the work of the measurement team using robotic solutions and free up some time and resources for them. Not to mention the reduced back pain.

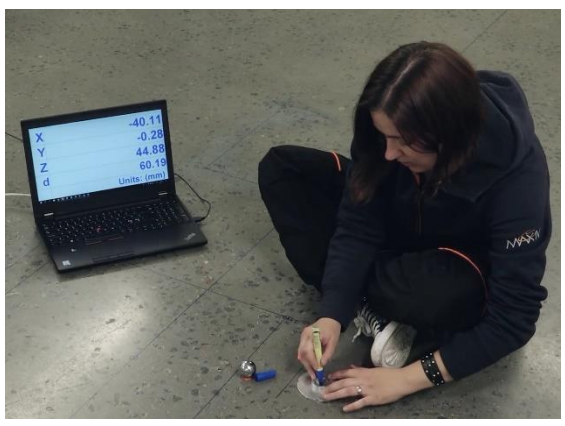

Figure 1 Research Engineer at MAX IV performing Bluelining

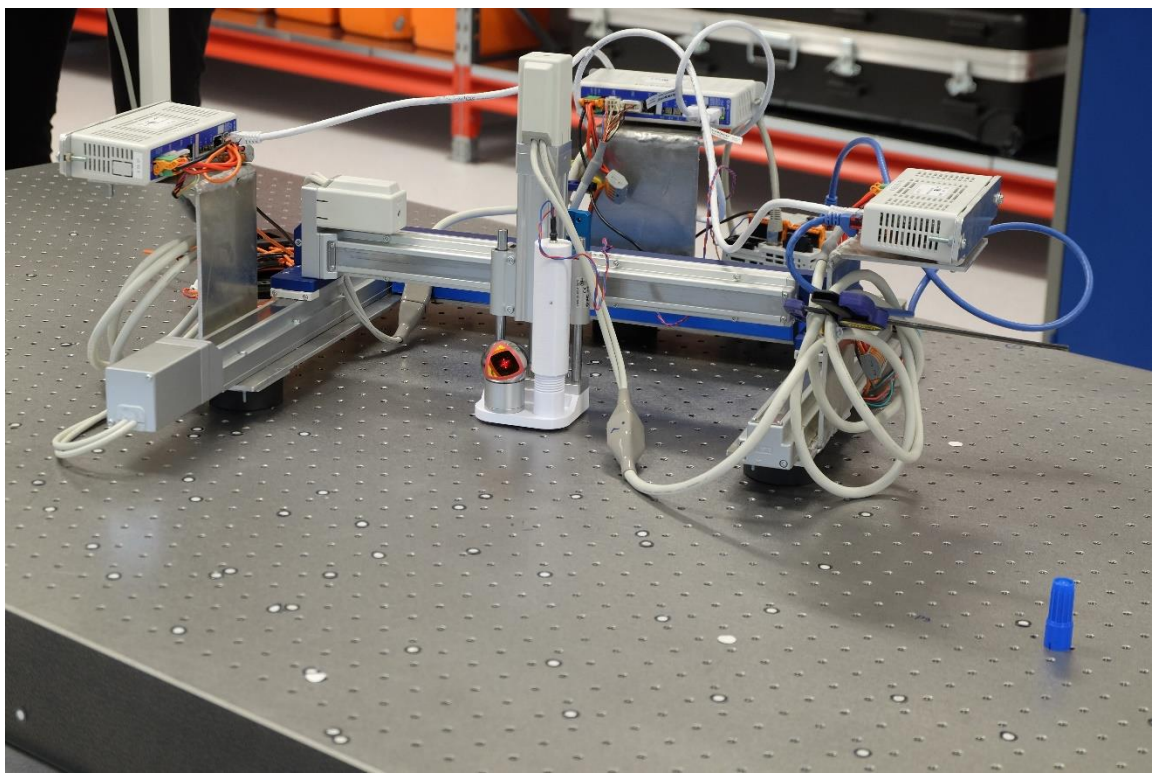

Figure 2 A Robotic manipulator marking points on the surface. The robot is equipped with 3 SMC actuators along the 3 axes (X, Y, Z) which can perform motions repeatable upto ± 0.02 mm.

A solution that could help the measurement team in Bluelining.

A High Precision Bluelining Robot

Solutions presented as part of the master's thesis

An important aspect when doing high precision positioning lies in the robot hardware, the control algorithm and the sequence and logic that control the robot. The goal of this thesis (Patil, 2022) is to use the feedback from the Leica laser tracker previously used for bluelining and to control the robot to position its end effector as close as possible to the desired position. This project is an extension of previously completed master's thesis at the Automatic Control department by Lisa Klinghav (Klinghav, 2021). The robot used in the project was designed as part of the Applied Mechatronics and Mechatronics and Industrial Product design courses at LTH (Shahin, et al., 2021). However, the software to control the robot is designed as part of this master's thesis project.

The Bluelining robot can position and mark the points on the floor with high degree of precision. To perform bluelining, the robot follows a set of sequences i.e., finding its position in the workspace, finding its orientation in the workspace, perform positioning of the robot closest to the target point and then finally, marking the point using the pen.

The robot's range of motion, due to its construction is limited to a 300x300 mm square. In future, a 3-DOF omnidirectional mobile robot will be added to the robot as a base to enable the robot to operate with a larger workspace.

References

Klinghav, Lisa. 2021. *Mobile Floor-Marking Robot, utilizing Feedback from Laser.* Lund : Department of Automatic Control, Lund University, 2021. Master's thesis report, TFRT-6123, http://lup.lub.lu.se/student-papers/record/9041939.

Patil, Vinay Venkanagoud. 2022. *High Precision Robotic Manipulator for Bluelining at MAX IV.* Lund : Dept. of Automatic Control, Lund University, 2022. Master's thesis report, TFRT-6173.

Shahin, Abdullah, et al. 2021. *Concept development to product production of a Cartesian Robot for high precision Bluelining.* Lund : Dept. of IEA, Lund University, 2021. Student Report.