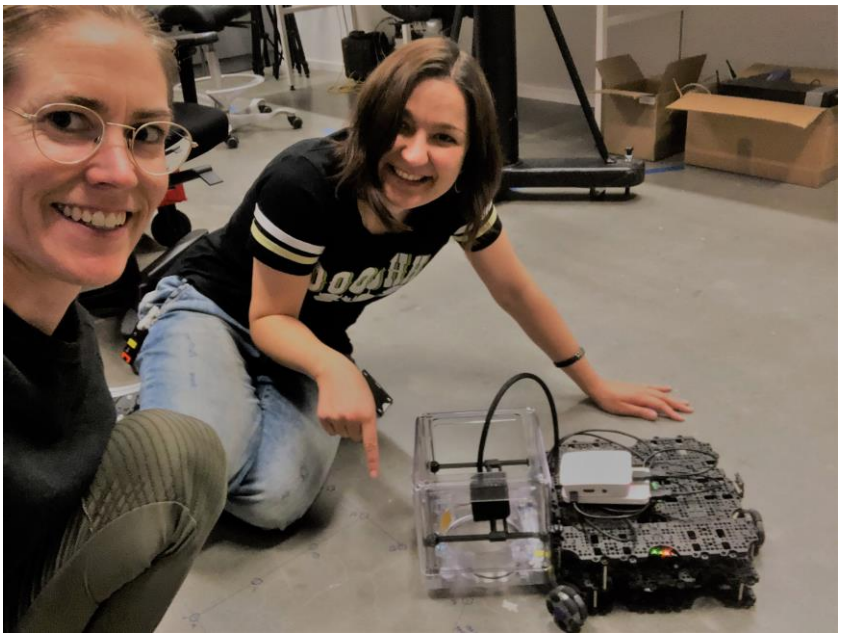
Mobile floor-marking robot unburdens employees during installation at MAX IV

Popular science summary, master's thesis *Mobile Floor-Marking Robot, utilizing Feedback from Laser Tracker* (Klinghav, 2021)

It is 13:15 on a Friday and measurement engineer Alina Andersson just realized something is not right. Equipment installation at MAX IV is done on a tight schedule, and drilling of the floor is planned for Monday. The bluelining task, showing where to position equipment, has taken most of the week to perform and Alina's body is aching from sitting on the floor, doing tedious work. A few phone calls later her fear is confirmed; The job must be redone, and Monday's task be postponed.
– If only the robot was ready, she says.

It is not the first time a situation like this arises, and probably not the last. In fact, Alina has already initiated a project to automate the uncomfortable and repetitive task of bluelining the floor. A master's thesis is started, with the intention to perform the task with a mobile robot. The idea is to transport a 3D-printer, with a regular pen mounted on it, to a position close to the target by a modified mobile robot. Then letting the printer fine tune the pen position and drawing a mark on the floor. Intended and actual position of the marks are monitored by a high accuracy laser tracking system, already utilized at the facility. The overall logic is to be handled by a Python program run on a Raspberry Pi and operated from a regular laptop. Lisa Klinghav, studying Mechanical Engineering at Lund University Faculty of Engineering, chose to take on this challenge as her degree project. According to her, there is potential to expand the use of the bluelining robot at many other construction sites,



Cheerful moment at the lab. Alina is pointing out the first bluelining performed by the robot.

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Equipment installation at MAX IV, a state-of-the-art particle accelerator in Sweden, requires final accuracy and precision in the range of micrometers. To achieve this, bluelining must be done with millimeter accuracy. The measurement technology used is laser tracking, including a stationary laser source and a movable reflector. Data describing the real-time position of the reflector is handled in a software called SpatialAnalyzer, managing it within the point cloud of statistically secured reference nodes, located all around the facility. The laser tracker is operated via a PC, whereas adjustment of the position of the reflector-equipped inventory is a manual, sometimes trying exercise, performed by measurement engineers (Robotics @ Lund University, 2020). If this task were to be automated, it would free up time and resources, as well as improve the working condition for the employees.

The system developed in the master's thesis *Mobile Floor-Marking Robot, utilizing Feedback from Laser Tracker* (Klinghav, 2021), consists of a modified M3D micro+ 3D-printer linked to a TurtleBot3 mobile robot, equipped with omni wheels (Digitalt på LTH, Lunds Tekniska Högskola, 2020). It is controlled via a main program that runs on a Raspberry Pi and it is powered via rechargeable batteries. Performance was evaluated in case studies, and the average deviation from target achieved was, at best, six millimeters. As the testing was brief, it is recommended to perform further activities to define accuracy, precision, and repeatability. However, the indications are that it is possible to perform automatic bluelining with modified off-the-shelf products, receiving positional coordinates from a laser tracker system. The result could be further improved with a custom-made robot, preventing compromises in its automation and design.

Alina Andersson will continue working to automate bluelining, applying the lessons learned in this project, as well as mentoring the students who will take on the challenge of prototyping a custom-fit robot.

Lisa Klinghav 2021-02-20

References

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