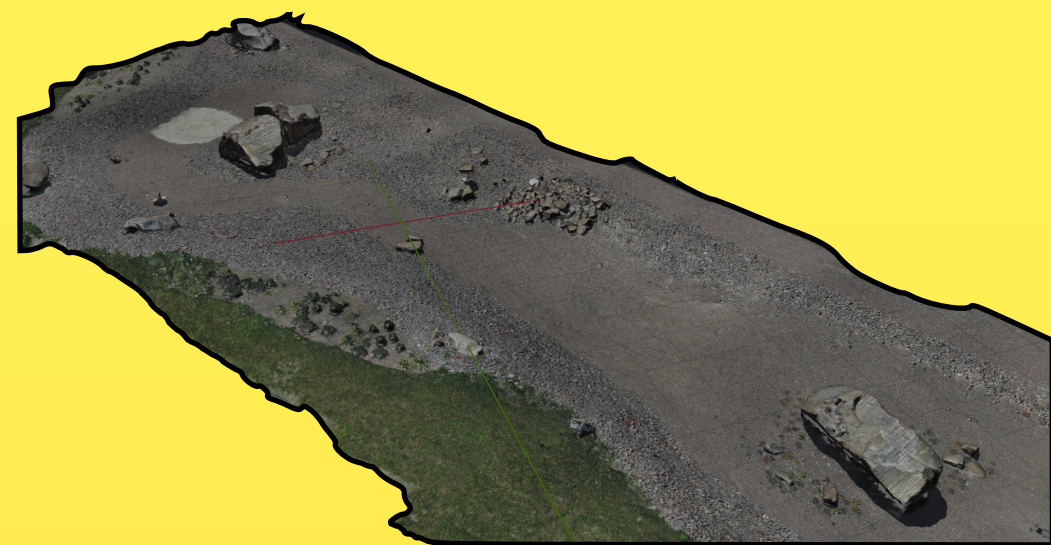


Mars Rover Navigation

The goal of this project is to improve the **autonomous navigation system** for the **FHNW Mars Rover** to compete at the **European Rover Challenge 2025**.

The navigation system is used for the navigation task, where a given set of waypoints needs to be visited by the rover as autonomously as possible.

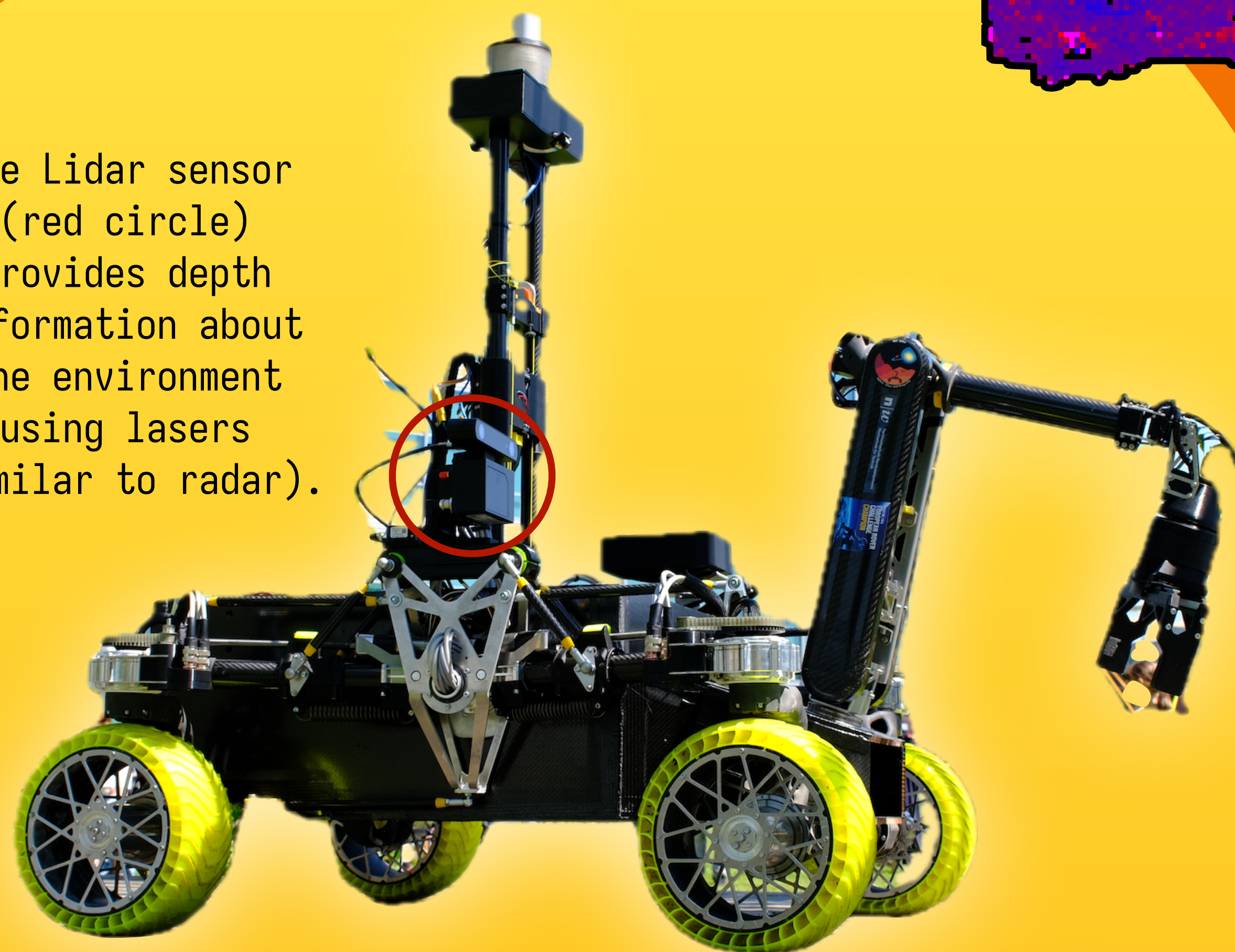


① A 3D model (left) of the environment is used to create a **height map** (below) once. That's an image storing elevation data in each pixel.



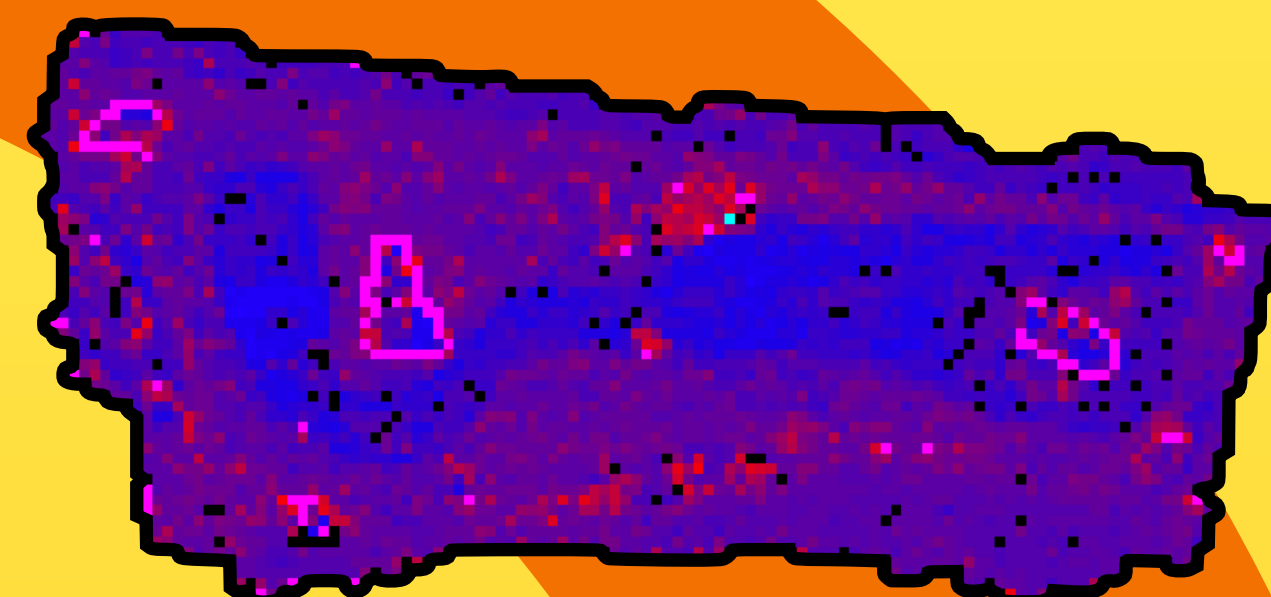
⑥ The data from the Lidar (in form of a point cloud) is used to **update the height map** with the new elevation data. This triggers the entire process again and allows the rover to avoid obstacles.

The Lidar sensor (red circle) provides depth information about the environment using lasers (similar to radar).



The wheels are able to turn 360°. This allows the rover to perform advanced maneuvers.

② The height map is used to create a **cost map**. The cost map assigns a difficulty to each area based on the **slope** and the newly added **roughness** of the terrain. Blue areas are safer, red and pink ones are more difficult. Previously, only the slope was used.



③ The cost map is used to calculate the “best” (short and safe) **path** visiting all waypoints. The sharp path of straight lines (blue dashes) is now converted to a path of **arcs** (black line). This allows the rover to drive smooth curves.

⑤ When the rover moves, the Lidar scans the new environment. The localization system updates the current estimated position. The blue blob (above) represents an obstacle detected by the Lidar.



④ The path is used together with the current (estimated) location to calculate the **drive command**. This step was updated to handle the new arcs. The rover needs to be oriented in the right direction before it can follow an arc.



Studiengang, Semester: Informatik, 25fs
Projekttitel: Mars Rover Navigation
Diplomand: Miro Albrecht
Auftraggeber: FHNW Rover Team
Experte: Markus Bracher
Dozenten: Prof. Dr. Christoph Stamm, Sandro Covo