Using reinforcement learning for path planning of an autonomous robot

About Lely

At Lely we want to create a sustainable, profitable and enjoyable future for farmers. To achieve this, we develop robotic solutions to automate repetitive tasks at the dairy farm. The challenge is to make sure that our solutions work 24/7. Our robots should also be affordable for the farmer and friendly towards the animals. The most well-known example is the autonomous milking robot, of which thousands are sold each year in more than forty countries worldwide. But at Lely we also manufacture other robots to help dairy farmers with their daily work. One of those robots is the Discovery Collector.

About the Discovery Collector

The Discovery Collector is an autonomous robot from Lely that vacuums manure at dairy farms. It drives in between the cows to clean their habitat of up to 600 square meters about every 2 hours, in order to improve hygiene as well as to reduce emissions. The impact on daily operations is big if the robot fails, so it must be reliable. Improving reliability is a huge challenge for several reasons. First of all, it drives a dynamic and uncontrolled environment, where cows are always moving around. It is also a dirty environment with manure and dust that create though conditions for the sensors and algorithms on the robot. And lastly, there are lots of variations at the farm. The weight of the robot changes significantly as it cleans. Fences may be open on certain days and closed on others. There are uneven floors, slopes, changing weather conditions. All of this makes it challenging to design optimal cleaning behavior that works all around the world.

The assignment

To automatically create optimal cleaning behavior, we investigate if we can benefit from using reinforcement learning for path planning. Essentially, we have to solve a coverage problem. The robot should clean the larger areas as well as narrow corners equally well throughout the whole day. However, there are several constraints that need to be taken into account. First of all, the capacity of the manure tank is limited so it has to empty itself at a designated location before it is full. The capacity of the battery is also limited so it needs enough charging time during the day. Both the amount of manure the robot vacuums and the energy it consumes may vary throughout the year and throughout the day due to for example weather conditions. The robot is also limited in its sensing capabilities due to the environment it operates in. It has to do perception-aware path planning, which means it should plan the routes such that it can also localize correctly. This imposes additional constraints. For example, it should drive close enough to walls and optimize traction to avoid slip.