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GRASSROBOTICS – ROBOTIZATION OF FORAGE PRODUCTION

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Forage production from grassland and ruminant livestock production make the base of Norwegian agriculture (Steinshamn et al. 2016). The growth season in Norway will start earlier and last longer as the winter becomes milder. More extreme precipitation events, as well as increased overall precipitation are expected. (Hanssen-Bauer 2015, IPCC 2013).

When relying on heavy agricultural equipment to harvest grass, the equipment may cause soil compaction. This means that several consecutive days without precipitation are needed in order to avoid excessive soil compaction. The number of days with moist soil and wet conditions will increase with a wetter climate in the future. With increased soil moisture, the maximum permissible ground pressure of agricultural vehicles to get satisfactory crop yield decreases (Medvedev and Cybulko 1995). Use of lighter agricultural equipment is one possible adaptation to the increased precipitation.

One aim of the GrassRobotics project is to develop a less vulnerable harvesting regime for forage production that is more independent of weather conditions. In the grasslands, this will be achieved by equipping a lightweight robot with tools for mowing, collecting and transporting forage. There is currently no agricultural robot developed for this purpose. However, the robot used in this project, Thorvald, (Grimstad and From, 2017) can easily be rebuilt into such a system.

The first task to be addressed was the mowing of grass. For this purpose, Thorvald has been equipped with a 1.70 m wide cutter bar in front. As this is a relatively lightweight, battery driven system, the energy consumption of the cutter bar is of interest, as well as the system's ability to mow grass.

A small field test has been conducted. About 1,000 m^2 of grass was to be mowed by the robotic system. The weather was fair, with moist soil and wet grass after a rainfall the day before. A new GPS based path planner algorithm was tested, as well as a LIDAR based safety system that stops the robot if it senses a foreign object in its path.

The key findings of the field test was the following:
Mean power drawn of the knife bar was approximated with use of a voltage data logger, at three different velocities, 0.5 m/s, 1 m/s and 1,5 m/s. There was a quite moderate difference in power drawn dependent of velocity. The values varied from 1.2 kW at 0.5 m/s to 1.4 kW at 1.5 m/s. This indicates that higher velocities will result in lower energy consumption per area mowed. The robot is currently equipped with around 7 kWh of batteries, which should be enough to power the cutting bar for several hours. Note that these values do not include the energy drawn by the robot, only by the cutting bar alone. The bar is, however, assumed to draw considerably more power than propulsion.

The grass did for the most part get thoroughly mowed. A few exceptions were when chunks of cut grass got stuck on the cutting bar's gearbox, thereby pushing the grass in front of the robot down against the ground, making the knives miss. This happened a few times, usually at higher velocities.

The robot did not make substantial marks in the ground, despite the soil being moist. It was by visual inspection hard to determine where the tire tracks were.

The path planner made a path based on four coordinates that made up the corners of the test area. The path consisted of parallel, straight driving lines, with 180 degree turns just outside opposite sides of the mowing area.

The safety system was tested by standing in the robot's path. The robot consistently stopped when it saw an object about 2 meters in front of it. Each time the person moved out of the robot's path, the robot continued to go at given speed.

To summarize:
Grass mowing equipment has been fitted to the Thorvald platform. The system does cut grass, and battery power seems to be sufficient to drive the system for several hours.

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