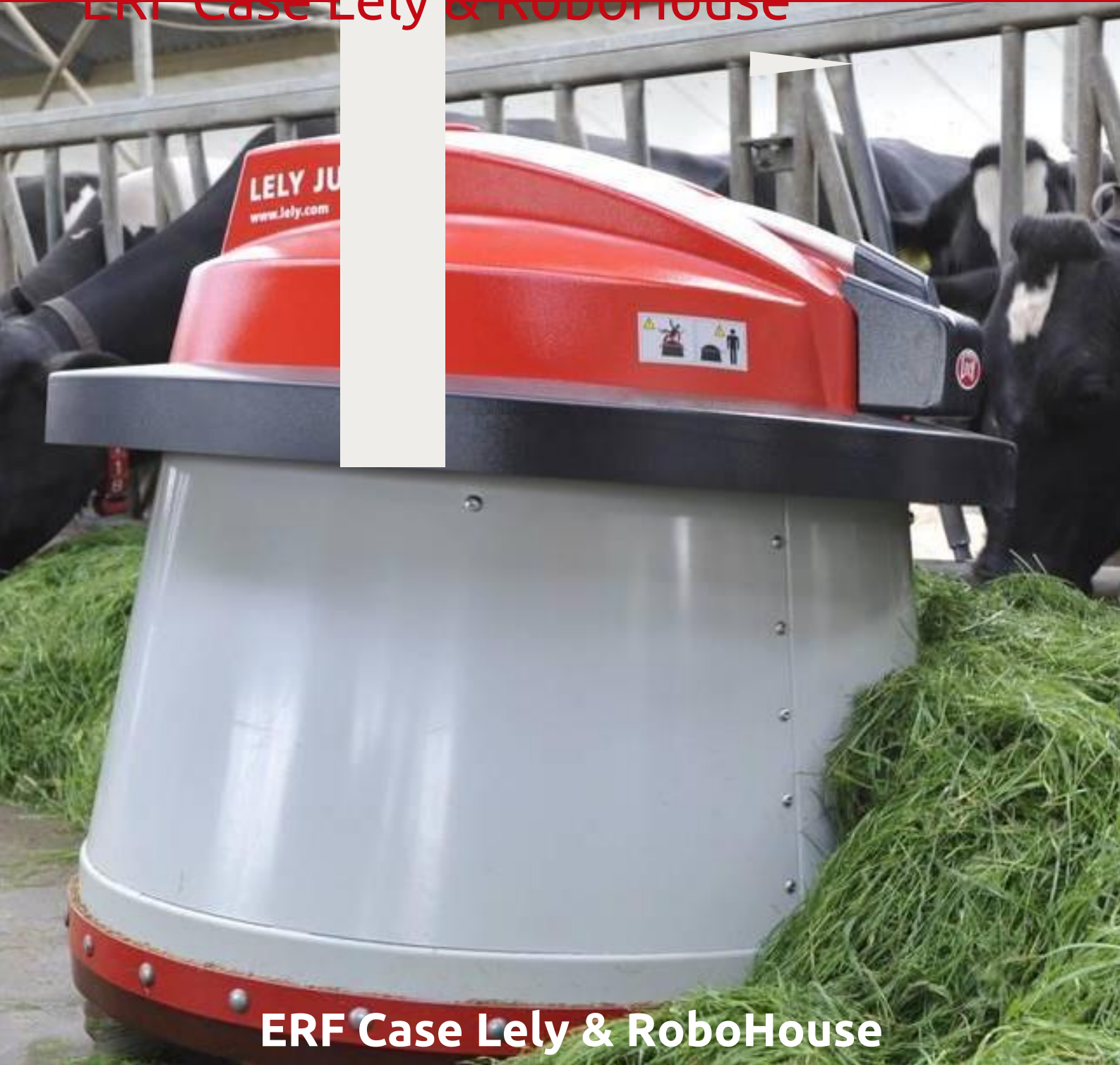# EUROPEAN
ROBOTICS FORUM

ERF Case Lely & RoboHouse

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Title
Autonomous multi robot navigation in a barn.

Case
Two (Juno) feed pushing robots need to push the feed in a predefined area. Your goal is to prevent them from colliding while performing different challenges and providing information to/communication with the farmer.

Company introduction Lely
As an international family business in the agricultural sector, we spend every day making farmers' lives easier with innovative solutions and tailored services. We offer solutions for almost all activities in the cowshed: from milking to cleaning. We provide advice on how to organize a dairy farm smartly with the use of management systems. Our vision and the needs and demand of our clients are the things that drive and inspire us.

Something we have done since 1948: in this year brothers Cornelis and Arij van der Lely introduced the finger wheel rake to the market: one of our first inventions that made a substantial change in the traditional way of working on the farm. There were many more innovations with only one purpose: making agrarian life easier and working together for a sustainable, profitable, and enjoyable future in the agricultural sector.

Company introduction RoboHouse
The RoboHouse team and its network of robotics experts and industry partners believe that we need a new research and development practice to answer one of the most current questions in cognitive robotics and society: 'How do we make work healthy and empowering?'

We have created an industrial environment on the TU Delft Campus designed to encourage practical and inclusive collaboration, where innovative organizations, SMEs and talented individuals can develop and test their robotics applications in a variety of settings and contexts. This can be done in one of the working labs, such as a mini supermarket. All to accompany the future of work.

Problem introduction
In a barn, one way the cows are being fed is by laying feeds, such as grasses, near a so-called feeding fence. When the cows reach through the fence for the feed, they slowly push away the feed away from fence. At some point the cows are unable to reach the feed anymore. Therefore, the feed must be pushed back against the fence, so that cows have enough feed and that the feed is used efficiently. This can be a cumbersome and time-consuming task for the farmer to do, which is why Lely has created the Juno. The Juno is a feed pushing robot that can push the feed towards the feeding fence autonomously.
for some nice movies of a Juno in action, see "https://www.lely.com/solutions/feeding/juno/"
Working in a barn is tricky for robots, such as the Juno, because the barn can be dirty, each barn has a different layout, people can walk around, and there are cows that have their head stuck through the feeding fence. On top of that there can be other robots around as well. Being able to sense what is happening around the robot, and communication with the farmer and other robots are therefore key for creating a safe environment.

Problem statement

- Two (Juno) feed pushing robots need to push the feed in a barn environment. An example of a barn environment is shown on the next page. In this barn environment, the Junos must drive certain routes. The barn environment shown on the next page is an example, the actual environment can slightly deviate day to day. but all maps will have a narrow passage where only one Juno can pass at a time. During their route, they are not allowed to collide with each other. While driving around, one can score points by completing challenges and minimizing the total time needed to complete the route. Each task is also judged on how the team is providing information to farmer/developer, human robot interaction and data management strategy. These tasks will be judged during the demo with the Junos on the 3rd day of the Hackathon.

- The total budget per group for the sensor-suite of the Junos is not limited, however for every Euro spent you will get less points (see grading).

- The Juno platform with motors is provided by Lely. There are only two Junos available. Therefore, the teams can only test with them for 3 hours each day. In the weeks before the event the teams can gain some experience with the sensors by using the Mirte robot platform provided by RoboHouse. The sensors (see sensor list on the last page of this document) and the Mirte robot (https://mirte.org/docs/index.html) will arrive two weeks before the start date of the Hackathon. The actual demo must be performed with the Junos.

Example Barn environment
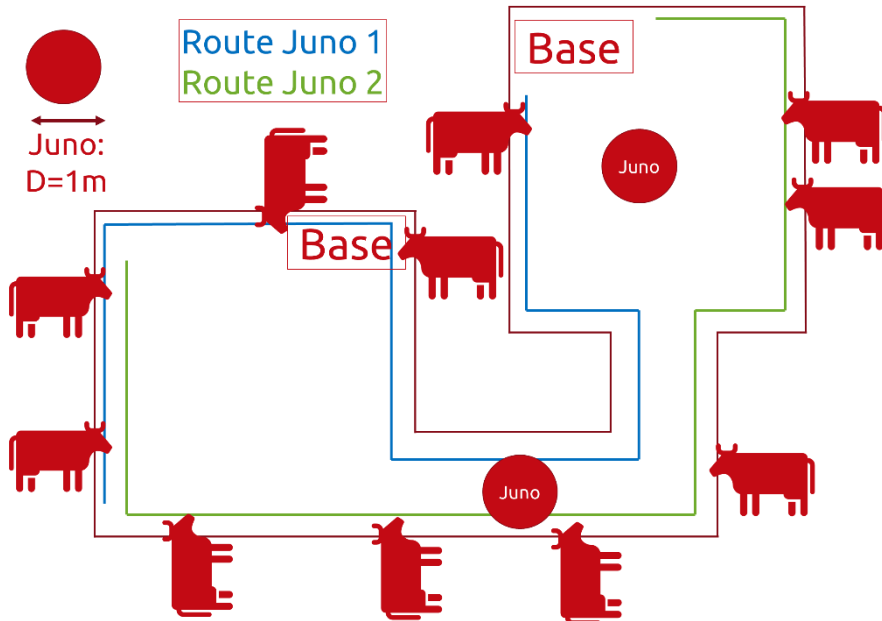
Example of a barn environment. The actual environment can slightly deviate
day to day during the Hackathon.

Challenges

1. The Juno needs to (autonomously) inform the farmer that it is in the narrow passage where only one Juno can pass.
100 points

2. Pass through a plastic strip curtain. The curtain will be set up in an unknown location in the barn environment when the teams decide to tackle this challenge. **400 points**

3. Be able to cope with parts of the feeding fence having been removed. **300 points**
    a. A farmer could cross the road at the section without the feeding fence. **+200 points**
    b. Communicate to the farmer that he can cross. **+200 points**

4. Leave from/return to 'home' base (touch traffic cone) in the middle of the arena instead of a corner. **100 points**

5. Leave from/return to 'home' base (touch traffic cone) at a random location in the arena instead of a corner or exactly the middle of the arena. **400 points**

6. Drive around obstacle(s) (for example, mini wheelbarrows). **400 points**

7. Count (our inflatable 'hot') cows and inform the farmer. The heat will be provided by infrared heating lamps in a protective cage. The approximate temperature will be 75 - 100 °C. **500 points**

8. Deal with failing network during route (communication). The robot should still be able to perform his tasks without the connection to the cloud or second Juno. **500 points**

9. Turn lights on if there is a Juno in the neighborhood. **200 points**

Grading challenges

Each challenge will be scored based on these points:

1) To make sure all the "virtual" feed is properly pushed towards the fence, a Juno first needs to pass at a distance of 0.6m +/- 0.1m followed by a pass at a distance of 0.2m +/- 0.1m. 300 points if all fences are pushed once, 600 points if all fences are pushed twice (first 0.6, then 0.2)

2) Total time to complete labyrinth relative to the other teams: 1st **600 points**, 2nd **300 points**, 3rd **150 points**, 4th **75 points**

3) Providing information, e.g. dashboards, and providing warnings to the farmers. **up to 600 points**

4) Human Robot Interaction. **up to 600 points**

5) Information for developers (documentation of achieved challenges and status related). **up to 600 points**

6) Data management strategy (cloud, storage, interaction, informing). **up to 600 points**

7) Bonus points: extraordinary solutions (overall awesomeness). **up to 600 points**

8) The total budget for all the hardware is €678. This is the total budget for both Junos together, not per Juno. For every Euro which is not spent you will get double the points in the final budget grading. For example, if you have spent €300, then your points for the budget will be 756 points.

About the Hackathon Juno's

The Juno's available for the Hackathon are a stripped down version of the commercially available robot. They still weigh close to 600Kg. Have two actuated wheels (diff-drive) and a passive swivel wheel in front.
Both Juno's have a height off approx. 1 meter, but only one has the red top fitted. The other has a more Hackathon friendly bracket as top replacement. See picture.
Each Juno can be controlled from your own laptop which needs to be placed on top of the Juno. This laptop must be connected to one of our Access Points (AP). The laptops can only communicate over the connection of the AP. Each Juno needs one laptop on top, this laptop should be used as "the brains" of the Juno. This laptop is connected to the Juno through USB to provide the commands to move the Juno.
The Junos run on ROS1 Melodic.

Other information

- On the first day of the Hackathon, the teams need to provide a list of all the sensors chosen. All hardware provided needs to be returned to Lely and RoboHouse.

- Two 3D printers will be provided for printing equipment to attach the sensors to the Juno. Note: you have to share them with the other teams. Therefore, **if you're sure of what you will need, bring it ready from home!**

- Two Q&A sessions will take place during the 2 weeks preparation. One general meeting with all the teams and one meeting with each team separately. Please send your questions two days in advance for the separate team meeting. General meeting: **16th of June 4 PM.** Q&A Sessions: **20th of June 2 PM, 22nd of June 10 AM, 23rd of June 12 PM, 24th of June 11 AM.**

- For communication we use a Lely MS Teams channel. Here, you can ask questions to us and each other. We will add you to this team as soon as possible.

- The final presentation and demo must be completed within 15 minutes.

Sensor	Sensor details	Max amount	Cost
360 deg lidar 1 plane	RPLIDAR A1M8-R6 360° Laser Range Scanner - 12m range	1	€160
Ultrasonic sensors	HC-SR04	4	€4
Webcam	Logitech C930e Business	1	€200
IMU	MPU-6050 Accelerometer en Gyroscope 3-Axis Module 3.3V-5V	2	€100
ToF	VL53L0X Time-of-Flight ToF Afstandssensor	4	€20
Magnetometer	HMC5883L 3-Axis Kompas Magnetometer Sensor Module 3V-5V V2	2	€10
Infrared sensor	Amg8833 Ir Thermische Camera Breakout 8X8 Infrarood Thermografiek	2	€10
Weight Sensor + load cells	Load Cell Versterker – HX711 & LOADCELL1KG (tiny tronics)	2	€4
Light sensor	Adafruit BH1750 Light Sensor - STEMMA QT / Qwiic	4	€10
Sound sensor	KY-037 Microfoon geluids detectie module	3	€10
Arduino kit	Arduino Starter Kit (robotshop)	2	€50
Compute stick	Intel Neural Compute Stick 1	1	€100

Cloud environment

Each team will receive access to a Microsoft Azure cloud environment in which you are free to create resources to aid you during the challenges. Each team will have a total of **300, - Euros** to spend in this environment during the preparation phase and the Hackathon at ERF itself. Exceeding this budget might prevent teams from using the cloud environment any further. As cloud costs are often opaque up front, we recommend teams to use the Microsoft Pricing Calculator to get a cost estimate for their solutions to prevent unexpected costs: https://azure.microsoft.com/en-us/pricing/calculator/

In addition, there you can find a stand-alone docker image that you can use to interface with the Juno and all the software installed.

Details on how to access this environment will follow.