The University of Western Australia
Dept. of Electrical, Electronic & Computer Engineering
Professor Thomas Bräunl

Mobile Robots
AUTO4508

Group Project	**Autonomous Navigation**	**weeks 7-12**

GROUPS: Form groups of 4 students

EQUIPMENT: Pioneer 3-AT Outdoor Mobile Robot Platform
Industrial Linux PC with touch screen display
GPS: built-in
IMU: Phidget Spatial 3/3/3
Camera: Stereo Camera OAK-D V2
Lidar: TBA
Software: ARIA

Each group will be assigned a Pioneer mobile robot manipulator to use for this project.

Tasks to complete

1. Drive the robot along a path, specified through a number of given GPS way-points. The robot has to visit each waypoint before returning to its starting position.
2. Each waypoint is marked by an orange traffic cone. Whenever a waypoint has been reached (within reasonable accuracy), the robot must take a photo of the marker object and then head towards the next waypoint.
   Always leave this marker to the robot's **right** side.
3. At each waypoint, an additional object (a colored bucket) will be in the vicinity, but at an unspecified distance. Identify the object, record a photo of it, and calculate its distance from the waypoint marker.
4. Upon completion of the waypoint course, print all marker photos, object photos and object distance measurements on the screen.

5. Record the robot's driving path and display it graphically on the robot's display with all detected markers, objects and any obstacles.
6. Implement a user interface with graphics and text on the robot's display that always displays the robot's internal state and its intended actions.
7. At all times, avoid collisions with markers, objects and any other stationary or moving obstacles, such as walls, vehicles, people, bikes, etc.
8. For safety reasons, implement a Bluetooth link between the robot's on-board PC and a gamepad controller:
    a. Button 'A' enable **a**utomated mode.
    In automated mode, use the back pedals as a dead-man switch.
    If released, the robot has to stop.
    b. Button 'B' enable manual mode (disable automated mode).
    In manual mode, the steering controls can be used to manually drive the robot forward/backward and left/right.

Getting started

You can program the robots either using the ARIA framework. Make use of the software libraries for Phidget (IMU) and OAK-D (stereo camera), as well as OpenCV (image processing) and possibly TensorFlow (deep learning).
Note that the robots are designed to **only drive outside** on grass or sand.
For **indoor testing**, you need to wrap all tires with gladwrap to allow the rigid wheels to slip – otherwise the robot's motors will burn out (this already happened in the past)!

Resources

Pioneer:

- ARIA Library: https://github.com/cinvesrob/Aria

Phidget IMU:

- User Guide: https://www.phidgets.com/?tier=3&catid=10&pcid=8&prodid=1204
- Code Samples https://www.phidgets.com/?tier=3&catid=10&pcid=8&prodid=1204

OAK-D Camera:

- DepthAI API: https://docs.luxonis.com/projects/sdk/en/latest/
- Code Samples: https://docs.luxonis.com/projects/api/en/latest/tutorials/code_samples/

SICK Lidar:

- TBA

DEMONSTRATION

On the scheduled presentation day at the end of the semester, all groups will give a practical demonstration of their projects and answer the project supervisors' questions re. their implementation.

VIDEO PRESENTATION

Put together a 5 min. (max) video presentation of your project. In this video explain all major components of your solution and show the robot in action. This video is due and will be presented at the first lecture slot in week 12.

SUBMISSION

Submit a hardcopy and softcopy with official coversheet incl. declarations of all team members:

1. Project design report (*pdf*), which includes
    - Report on which team member did what
    - Software design description
    - Diagrams, photos, screenshots, plots, etc.
    - Include page numbers
    - Max 10 pages plus 1 Title page

      Do NOT include:
    - Program code
    - Table of contents, etc.
    - Half-empty pages
2. User Manual (*pdf*)
    - Max 5 pages, **no** Title page
    - As if it was sold to a customer
3. Source code *(email to project supervisor only, no hardcopy)*, clearly marking any imported code with referencing the source.

MARKING

60% Functional Performance, Design, Complexity, Innovation
20% Project Design Report
10% User Manual
10% Video Presentation (max 5 min.)