



# Projects

## Challenge levels and grades

Projects can be completed at three *Challenge levels*. The *Challenge level* determines the **best** grade that can be received to the project!

Challenge level	Best grade
Basic	3
Advanced	4
Epic	5

### Tip

The projects are defined in a way that it is recommended to start with the **Basic** level, and then gradually work

towards **Epic**.

The projects are graded based on the following aspects:


- Proved to be the student's own work
- Running results valid output
- Usage of versioning, usage of GitHub/GitLab/other repository
- Launch files
- Completeness of the solution
- Proper ROS communication
- Proper structure of the program
- Quality of implementation
- Documentation quality

## Schedule

Week	Date	Event
8.	April 18	Project lab I.
13.	May 23	Project lab II.
14.	May 30	Project presentations.

## Grading

To pass the course, Tests and the Project must be passed (grade 2). One of the Test can be taken again.

 Grade
$\backslash(\text{Grade} = (\text{Test1} + \text{Test2} + 2 \times \text{Project}) / 4)$

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## Project topics

### 1. TurtleBot3

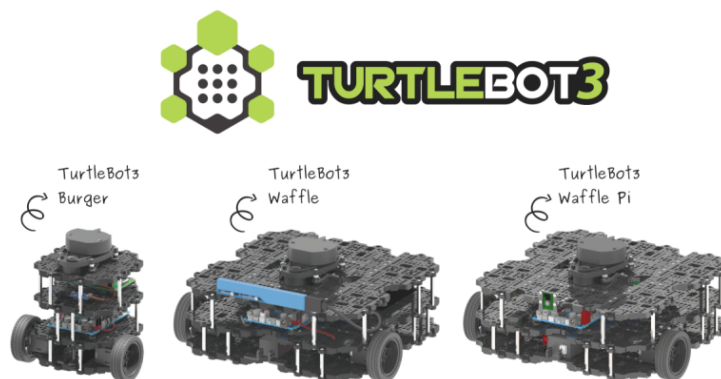
[TurtleBot3 ROS tutorial](#)

### 1.1. TurtleBot obstacle avoidance



- **Basic:** Simulator animation, SLAM testing. Implement ROS node/nodes to read sensor data and move the robot.
- **Advanced:** Implement ROS system to detect obstacle and plan and implement obstacle avoidance trajectory in simulated environment using any sensor.
- **Epic:** Impress me!

### 1.2. TurtleBot path following



- **Basic:** Simulator animation, SLAM testing. Implement ROS node/nodes to read sensor data and move the robot.
- **Advanced:** Implement ROS system for tracking in a simulated environment using any sensor (e.g. passing a wall at a given distance using LIDAR).
- **Epic:** Impress me!

Image source: <https://robots.ros.org/turtlebot3/>

### 1.3. TurtleBot object tracking/visual servoing

- **Basic:** Simulator animation, SLAM testing. Implement ROS node/nodes to read sensor data and move the robot.
- **Advanced:** Implement ROS system to find/recognize object and track/move it in simulated environment using any sensor (e.g. visual servoing).
- **Epic:** Impress me!

### 1.4. TurtleBot action library

- **Basic:** Simulator animation, SLAM testing. Implement ROS node/nodes to read sensor data and move the robot.
- **Advanced:** Implement a ROS action-based library of simple operations and a system to execute them (e.g. push object, move to object, turn around).
- **Epic:** Impress me!

## 2. YouBot



[YouBot controller GitHub](#)

### 2.1. YouBot ROS integration

- **Basic:** YouBot repo build, getting to know it
- **Advanced:** Moving a simulated robot in an articulated ROS environment
- **Epic:** Testing on real robot and/or impress me!

## 3. AMBF

[AMBF GitHub](#)

## Building AMBF

Fork AMBF, then clone our fork:

```
cd ~/ros2_ws/src
git clone <MY_AMBF_FORK.git>
```

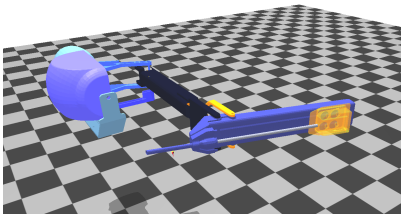
Don't use make as suggested in the AMBF documentation, use colcon:

```
cd ~/ros2_ws
colcon build --symlink-install
```

Launch the simulator:

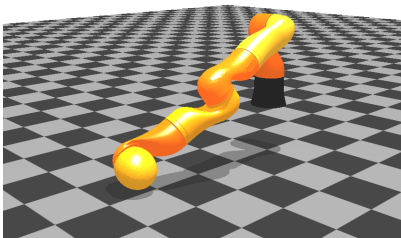
```
cd ~/ros2_ws/src/ambf/bin/linux64
./ambf_simulator -l 4
```

### 3.1. AMBF da Vinci ROS integration



- **Basic:** Simulator animation, robot control in joint space and task space (IK already implemented in AMBF) from ROS via CRTK topics
- **Advanced:** Object detection in *\*Peg transfer puzzle*
- **Epic:** Autonomous manipulation in *Peg transfer* and/or impress me!

### 3.2. AMBF KUKA arm ROS integration



- **Basic:** Simulator animation, robot control in joint space from ROS
- **Advanced:** Generate trajectories in joint space

- **Epic:** Implement inverse kinematics and/or impress me!

### 3.3. AMBF PR2 humanoid ROS integration



- **Basic:** Simulator animation, robot control in joint space from ROS
- **Advanced:** Robot control in task space, IK?
- **Epic:** Trajectory planning/Navigation/Manipulation and/or impress me!

## X. Own topic

By discussion.

## Useful links

- [TurtleBot3 Simulation](#)
- [TurtleBot3 Tutorial](#)
- [AMBF](#)
- [My fork of AMBF](#)
- [CRTK topics](#)
- [Navigation stack](#)
- [Paper on LiDAR SLAM](#)
- [Paper on vSLAM](#)
- [Paper on Visual Servoing Mobile Robot](#)