

Lab 8

*School of Architecture, Civil and
Environmental Engineering*

EPFL, WS 2023-2024

https://disal.epfl.ch/teaching/signals_instruments_systems/

Lab 8 outline

- Contents
 - Positioning Systems and Frames
 - 1D Odometry with accelerometer
 - 2D Odometry with wheel encoders
 - Tools
 - Webots 2023a
 - C compiler
 - MATLAB R2021b
- } Noise-free Sensors

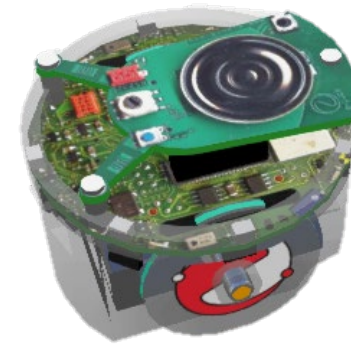
Getting Started

- Installation
 - Go to moodle and download:
Lab08 (.zip) and the assignment
- Starting with Webots
 - Launch Webots (from terminal)
 - Open World file *odometry.wbt*
 - Clean + Build robot controller

Robot Pose

- In 2D : Ground Robot
 - Needs 3 variables
(e.g. 2 positions + heading)

$$p_{2D} = [x, y, \theta]^T$$



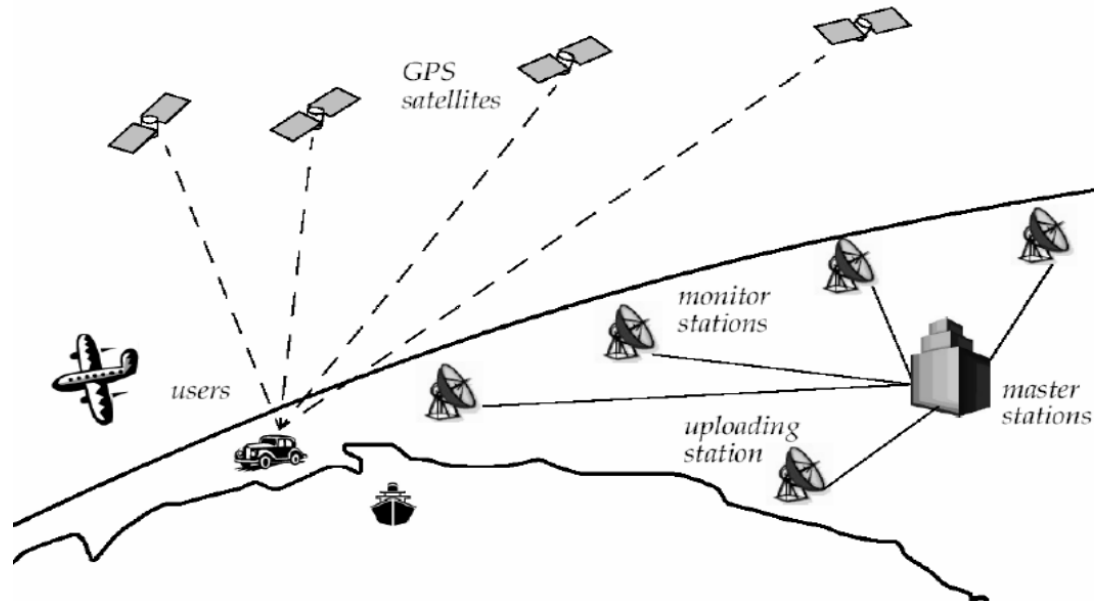
- In 3D : Aerial robots
 - Needs 6 variables
(e.g. 3 positions + 3 angles)

$$p_{3D} = [x, y, z, \phi, \theta, \psi]^T$$



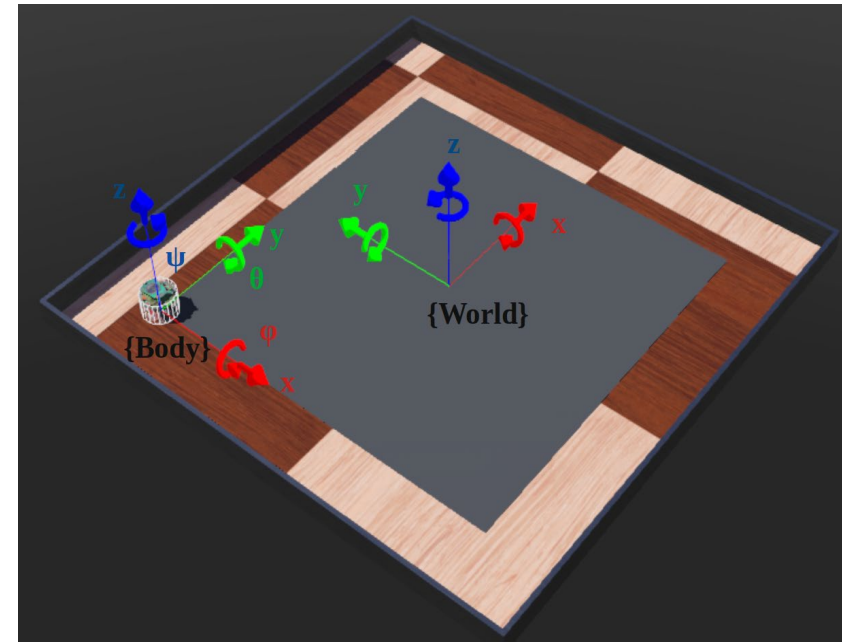
Positioning Systems

- Example : GNSS, MCS, IR-UWB
- Goals : Get positions + orientation (sometimes)



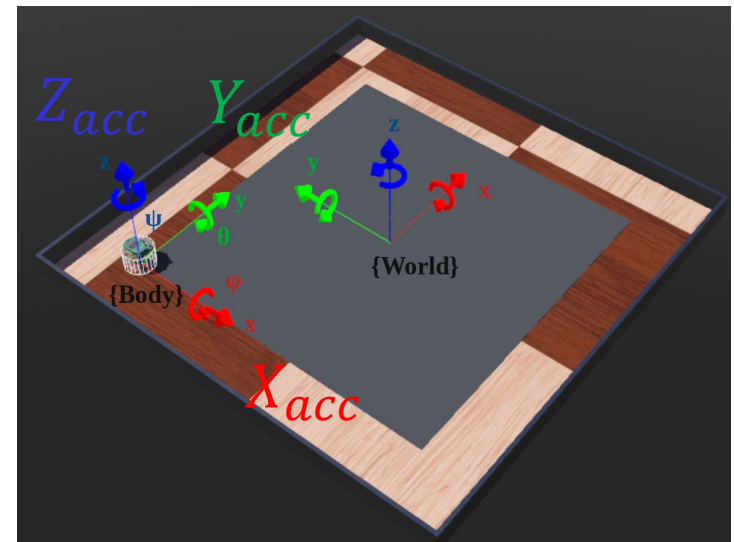
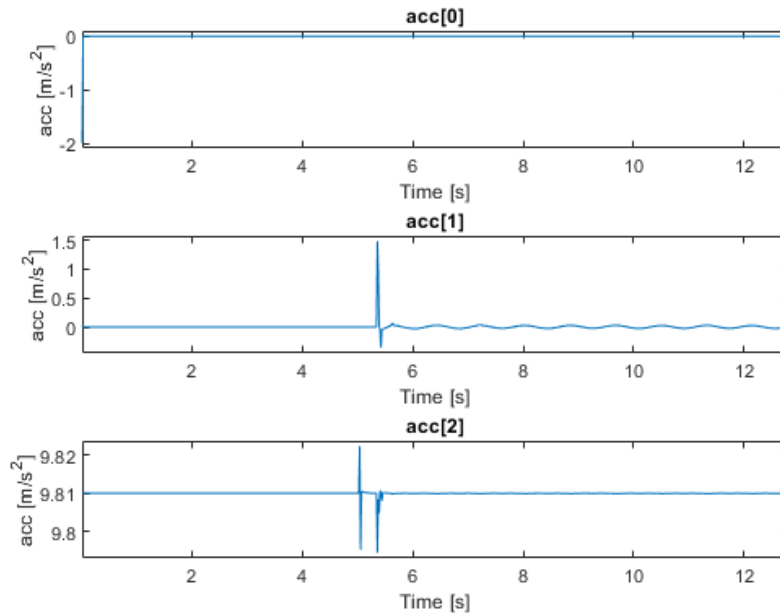
Positioning Systems (Webots)

- Example : GNSS
 - GPS (USA)
 - Galileo (EU)
- Frames :
 - World frame (inertial)
 - Body frame (not inertial)
 - A frame (inertial)



Check and test your frame conversion !

Odometry 1D



- **Goals :**

- Understand the accelerometer values
- Derive motion model based on accelerometer
- Implement + Test your equations against GPS

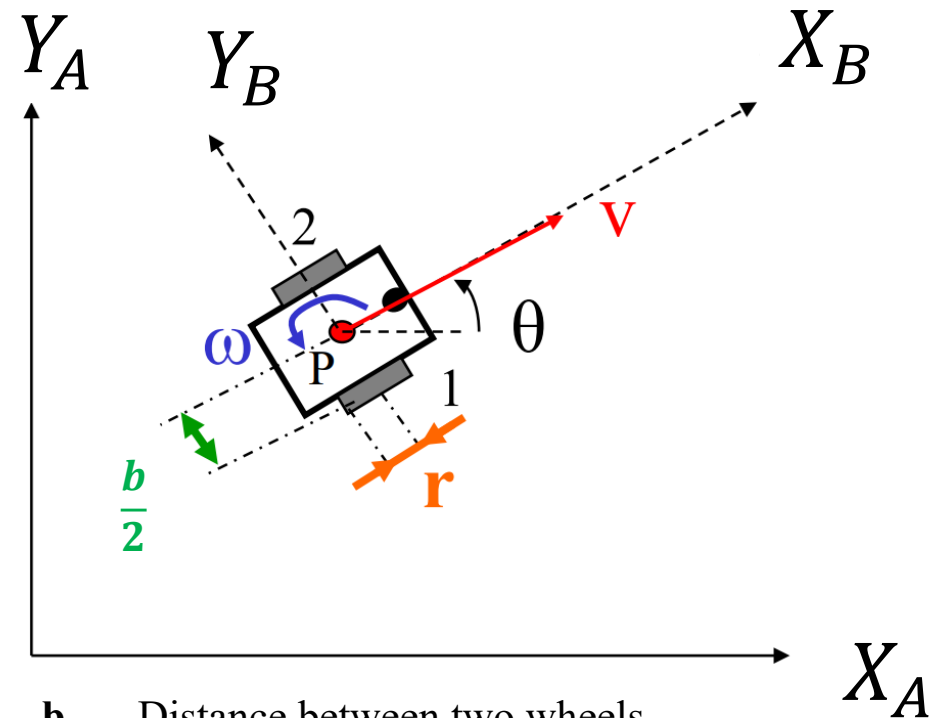
Check and test your frame conversion !

Odometry 2D : Recipe

- 1) Compute Delta wheel encoders
- 2) Compute forward (v) and rotational (ω) speed in body frame $\{B\}$.
- 3) Transform v and ω to frame $\{A\}$
- 4) Derive the continuous time equations for the motion model
- 5) Discretization (integration) of your equations
- 6) Implement, test and improve your odometry

Useful slides :

Odometry lecture notes



b Distance between two wheels

r Wheel radius

$\{A\}$ Frame A , static in time

$\{B\}$ Frame B (Body), move with the robot

Real example: Smart watches



Start
Logging



Navigate



Backtrace
with
odometry

Code complements

```
(void *)memset(void *str, int c, size_t n)
```

1) Set array double acc[3] to 0 :

```
memset(arr, 0 , sizeof(arr));
```

2) Set structure pose_t _pose to 0 :

```
memset(&_pose, 0 , sizeof(pose_t));
```

```
(void *)memcpy(void *dest, const void * src, size_t n)
```

1) Copy array double* gps_position to array double _meas.gps[3]:

```
memcpy(_meas.gps, gps_position, sizeof(_meas.gps));
```

2) Copy structure pose_t odo_pose_enc to struct pose_t odo :

```
memcpy(odo, &_odo_pose_enc, sizeof(pose_t));
```

General Information

- Code :
 - Use the same controller + world for all the parts
 - Control the robot with your keyboard

Table 2: Keyboard keys and corresponding actions

Keyboard key	Simulation actions
R	The robot start to move
S	The robot stop
U	Increase the speed
D	Decrease the speed
Up Arrow	The robot move forward
Down Arrow	The robot move backward
Left Arrow	The robot turn left
Right Arrow	The robot turn right

Click on the world window and then use the keyboard!

Feedback for Lab 8

Please help us improve the labs by giving us feedback.

Thank you and enjoy the lab!