Lab 3

Distributed Intelligent Systems,

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Getting Started

- Installation
  - Go to moodle and download :
    Lab03 (tar.gz or zip) and the assignment (pdf)
- You will need
  - Webots
  - Matlab
- Webots:
  - Clean and build the controller

General Information

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

Keyboard	Simulation actions
R	Start moving
S	Stop moving
U	Increase speed
D	Decreases speed
↑↓	Move forward/backward
← →	Turn right/left

Click on the world window and then use the keyboard!

Robot Pose

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

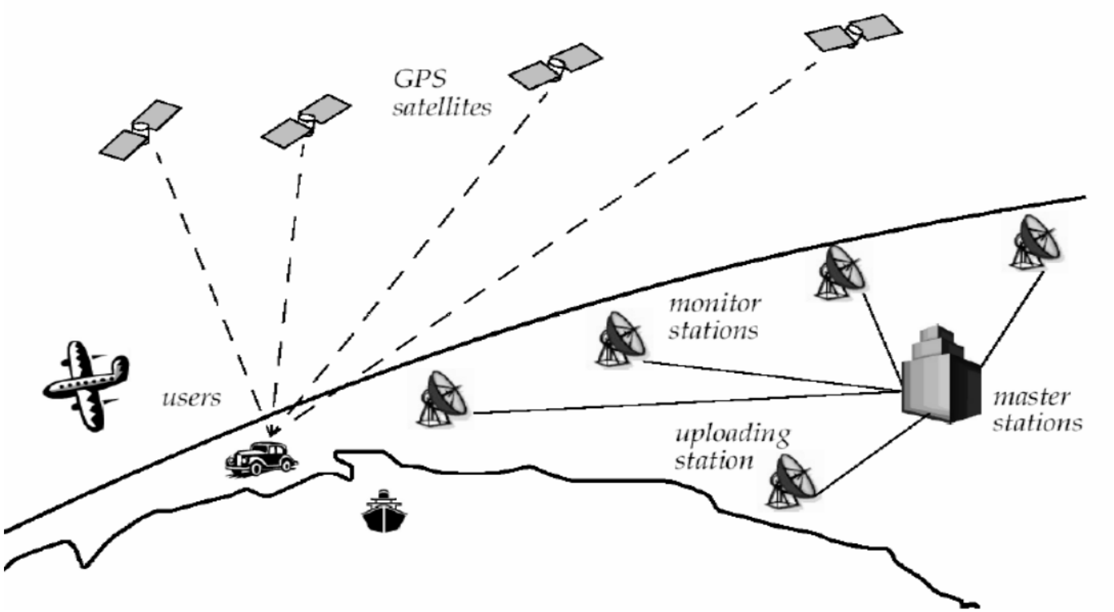
  $p_{2D} = [x, y, \theta]^T$

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

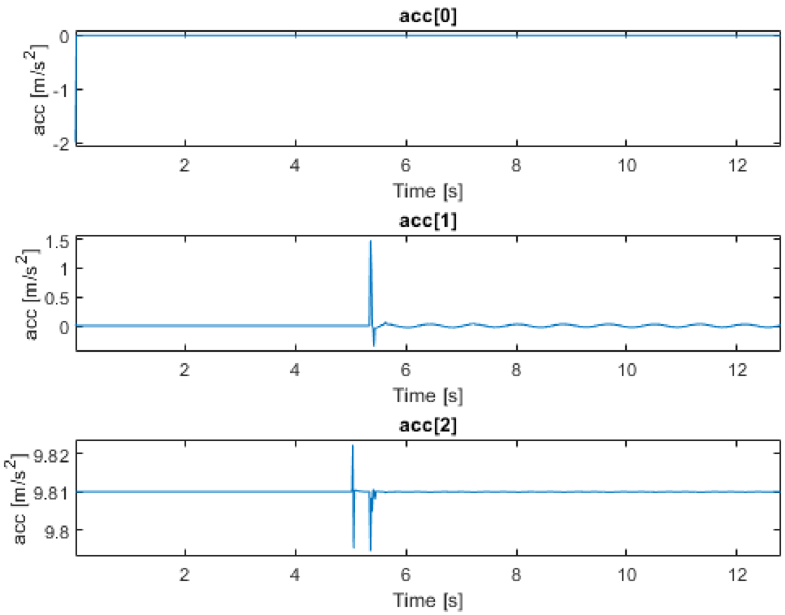
  $p_{3D} = [x, y, z, \phi, \theta, \psi]^T$

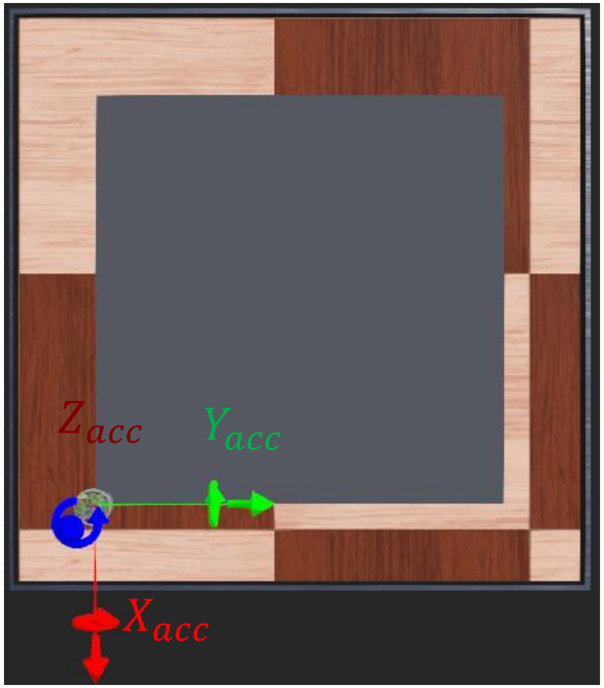
Positioning Systems

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



Odometry (accelerometer)





- Simplified, 1D :

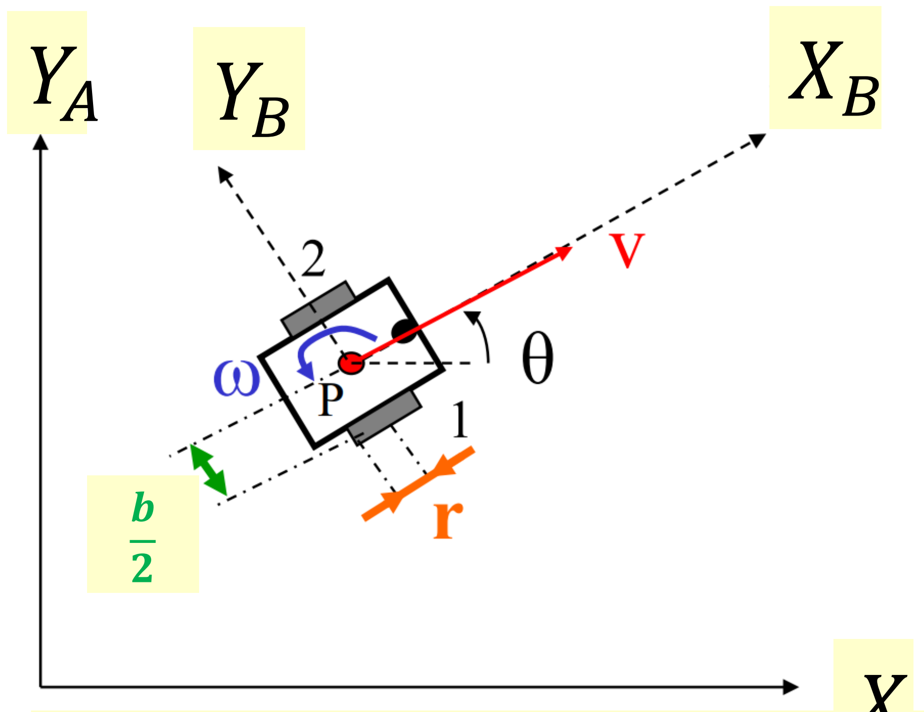
Check and test your frame conversion !

  – Understand the accelerometer values
  – Derive motion of robot based on accelerometer
  – Implement + Test your equations against GPS

Odometry (wheel movement)

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 :
23-35 from lecture notes (Week9)



b	Distance between two wheels
r	Wheel radius
{A}	Frame A , static in time
{B}	Frame B (Body), move with the robot

Kalman Filter

- Combine information from odometry and multiple sensors => Sensor Fusion
- Two step process
  1. Predict new state (using odometry, control, etc)
  2. Update state (using sensor measurements)

  Repeat

Kalman Filter

Algorithm **Kalman_filter**($\mu_{t-1}, \Sigma_{t-1}, u_t, z_t$)

1. Prediction:
2. $\bar{\mu}_t = A_t \mu_{t-1} + B_t u_t$
3. $\bar{\Sigma}_t = A_t \Sigma_{t-1} A_t^T + R_t$
4. Correction or update:
5. $K_t = \bar{\Sigma}_t C_t^T (C_t \bar{\Sigma}_t C_t^T + Q_t)^{-1}$
6. $\mu_t = \bar{\mu}_t + K_t (z_t - C_t \bar{\mu}_t)$
7. $\Sigma_t = (I - K_t C_t) \bar{\Sigma}_t$
8. Return μ_t, Σ_t

You will use accelerometer as a process input u in this exercise

[Adapted from Thrun et al., 2005]

Continue next week

- You will have more time in the next week's lab session to finish this exercise.