Multi-robot navigation and control for acoustic inspection of metal plate structures

Semaine 1

Lectures

- Learning the propagation properties of rectangular metal plates for Lamb wave-based mapping:
  - recover the geometry of a metal plate using UGWs acquired by a mobile unit without using a predetermined propagation model.
  - Uses beamforming for localisation of boundaries;
- A FastSLAM Approach Integrating Beamforming Maps for Ultrasound-based Robotic Inspection of Metal Structures
  - localization and mapping on metal plates using UGWs.
  - Uses a wave propagation models and beamforming
- Combined Grid and Feature-based Mapping of Metal Structures with Ultrasonic Guided Waves
  - mapping using UGWs and beamforming

Lectures

- Experimental Investigation of Impact Localization in Composite Plate using newly Developed Imaging Method
  - compression molding process to create a composite plate
  - piezoelectric sensors used
  - wavelet transform based method to get TOF of waves of each cluster of sensors
  - specific algorithm to determine localisation thanks to TOF
- High Resolution Guided Wave Tomography
  - HARBUT, the Hybrid Algorithm for Robust Breast Ultrasound Tomography
  - Beamforming algorithm
  - velocities of waves vary with the product of frequency and thickness
- A Magnetic Crawler System for Autonomous Long-Range Inspection and Maintenance on Large Structures
  - Uses particle filter for position estimation
  - Ultrasonic mapping with beamforming, only when robot stops, not simulated on large structure

1. Get initial estimate of sound speed (typically set everything to a constant background value)

Lectures

- MinPos : a Novel Frontier Allocation Algorithm for Multi-robot Exploration
  - Approches classiques: nearest frontier, greedy assignment (he robot-frontier pair with lowest cost is selected, the robot is assigned to the frontier, and both are removed from their respective list), utility-based
  - Centralized / decentralized
  - synchronous: The centralizer wait for all robots to arrive at their frontier to assign the new set of frontiers / asynchronous: whenever a robot reaches its frontier
  - Each robot performs repeatedly the following steps: 1. Frontiers identification and clustering 2. Computation of the distances to frontiers 3. Assignment to a frontier 4. Navigation towards the assigned frontiers for a fixed time period
  - The map representation used is an Occupancy Grid
  - Minimum Position: approach that consists in assigning to a robot a frontier for which it is in best position, i.e. the frontier having the less robots closer than itself.
  - Wavefront propagation stopping and Parallel computation of wavefronts are used to reduce computation complexity

Simulation

- Blender to create corroded metal plate
- Gazebo
- drone_simulator: