MARS
Mobile Agricultural Robot Swarms

Deliverable D3: OptiVisor (Due Date: 31.04.2016)

Dissemination Level: RESTRICTED

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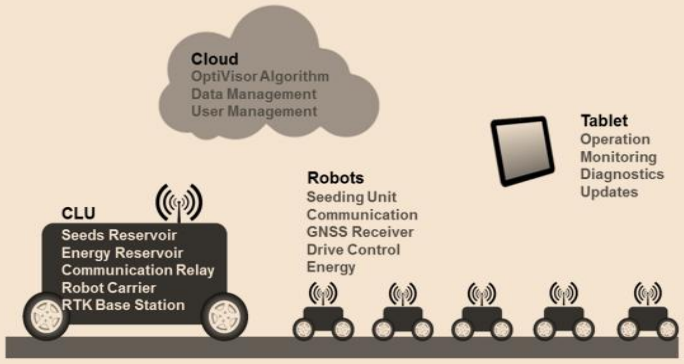


OptiVisor - Overview

- **Consists of two main components:**
  - OptiVisor Planning
    - Offline Part (Initial Planning)

      Determines initial execution plan
    - Online Part (Replanning)

      Provides modified plan in case of robot failures

      Provides path back to CLU
  - OptiVisor Control

Further Details:

Timo Blender, Thiemo Buchner, Benjamin Fernandez, Benno Pichlmaier and Christian Schlegel. Managing a mobile agricultural robot swarm for a seeding task. In 42nd Annual Conference of the IEEE Industrial Electronics Society (IECON), Florence, October 2016

(submitted, under review)

OptiVisor Planning – Initial Planning (Offline)

- **Field Partitioning**
  Partitioning into seeding area, headland area, Gate/CLU
- **Lane Coverage**
  Place lanes through seeding area until whole field is covered

Lane Coverage	Type:	Seeding Accuracy		Field Shapes		
	Property:	Pattern	Density	Convex	Concave	Inner Obstacles
	Consideration:	✓	✓	✓	✓	✓

Available Result:

Optimization: Lane determination into direction of the longest edge of the field contour (reduction of number of turnings to next lane) ✓

Possible Future Work:

Adapt direction for different subregions of complex field shapes

OptiVisor Planning - Initial Planning (Offline)

- **Workload Distribution**
  Initial work assignment to robots
  Available Result:
  Same share of coverage lanes for each robot ✓
  Possible Future Work:
  - Work assignment such that all robots complete their work at the same time (less coverage lanes in case of longer distance to CLU)
  - Specific aspect for complex field shapes: Finding a suitable assignment and coverage order of different subregions when workload of one robot expands to more than one subregion

OptiVisor Planning - Initial Planning (Offline)

- **Reload Planning**
  Finding appropriate locations to drive back to CLU for reloading
  Consideration: Energy (when to recharge ?) / corn tank (when to reload ?)
  Available Result:
  Optimization: Regarding to a defined target function (e.g. minimize non-productive path lengths) ✓
  Possible Future Work:
  Enhancement of target function(s)

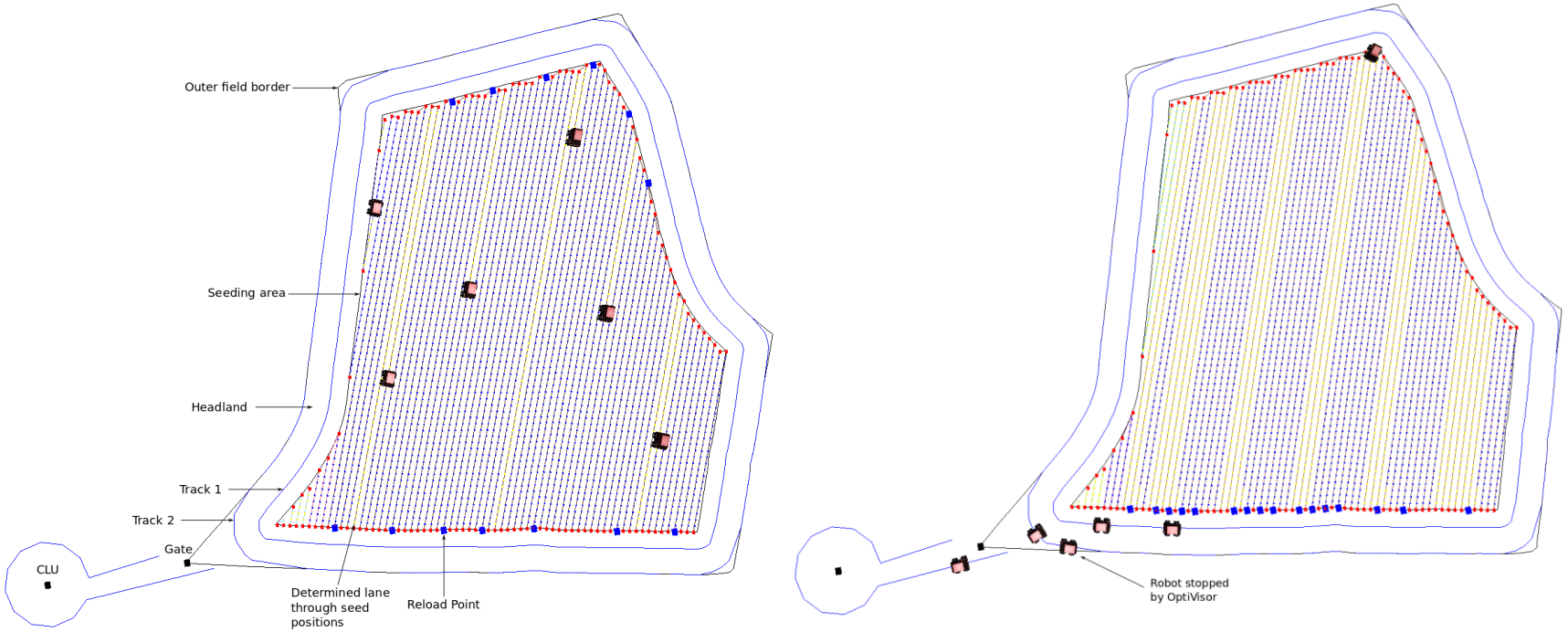
OptiVisor Planning – Replanning (Online)

- Reassign remaining work of failed robot to working robots
  Available Result:
  Optimization: Based on reassignment strategy
  At the moment: Reassign work to the predecessor robot of the failed one.
  Predecessor robot of a failed robot is the robot whose (work-)path ends where the (work-)path of the failed one has started. ✓
  Possible Future Work:
  Enhancement of reassignment strategy

OptiVisor - Control

- **Communication with each robot ✓**
- **Communication with cloud ✓**
  - Create and send status reports continuously ✓
  - Receive user instructions (tablet) ✓
- **Robot Control + Supervision ✓**
  - Send path segments to robot ✓
  - Apply user instructions (start / stop / to CLU) ✓
  - Receive position, recorded path and status information ✓
  - Collision avoidance between robots (stop robots) ✓
  - Failure handling (request modified plan) ✓

Impressions from Simulation



Two scenes of the working mode of a seeding task, planned and controlled by OptiVisor

Video

- **Interplay of all components (Tablet ↔ Cloud ↔ OptiVisor ↔ Simulated Robots)**

  (see attached video)