

# Artificial Perception Framework for Scene Understanding in Forestry Robotics

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## Motivation

- During the last 30 years, 40% of all wildfires in the Mediterranean have occurred in Portuguese forests.
- Prevention → Forest Maintenance [1].
- Fully autonomous robotic solutions for precision forestry is still at an early stage.
  - Limited perception capabilities [2].

## Objectives

- Real time implementation of a precise multi-modal semantic segmentation system for forestry landscaping.
- A robust depth completion system.
- A solution for probabilistic projection of semantic information onto a metric map to perform 3D metric-semantic mapping.

## Expected Outcome

Semantic map for final decision-making regarding forestry landscaping tasks, e.g. mulching flammable material (Red).

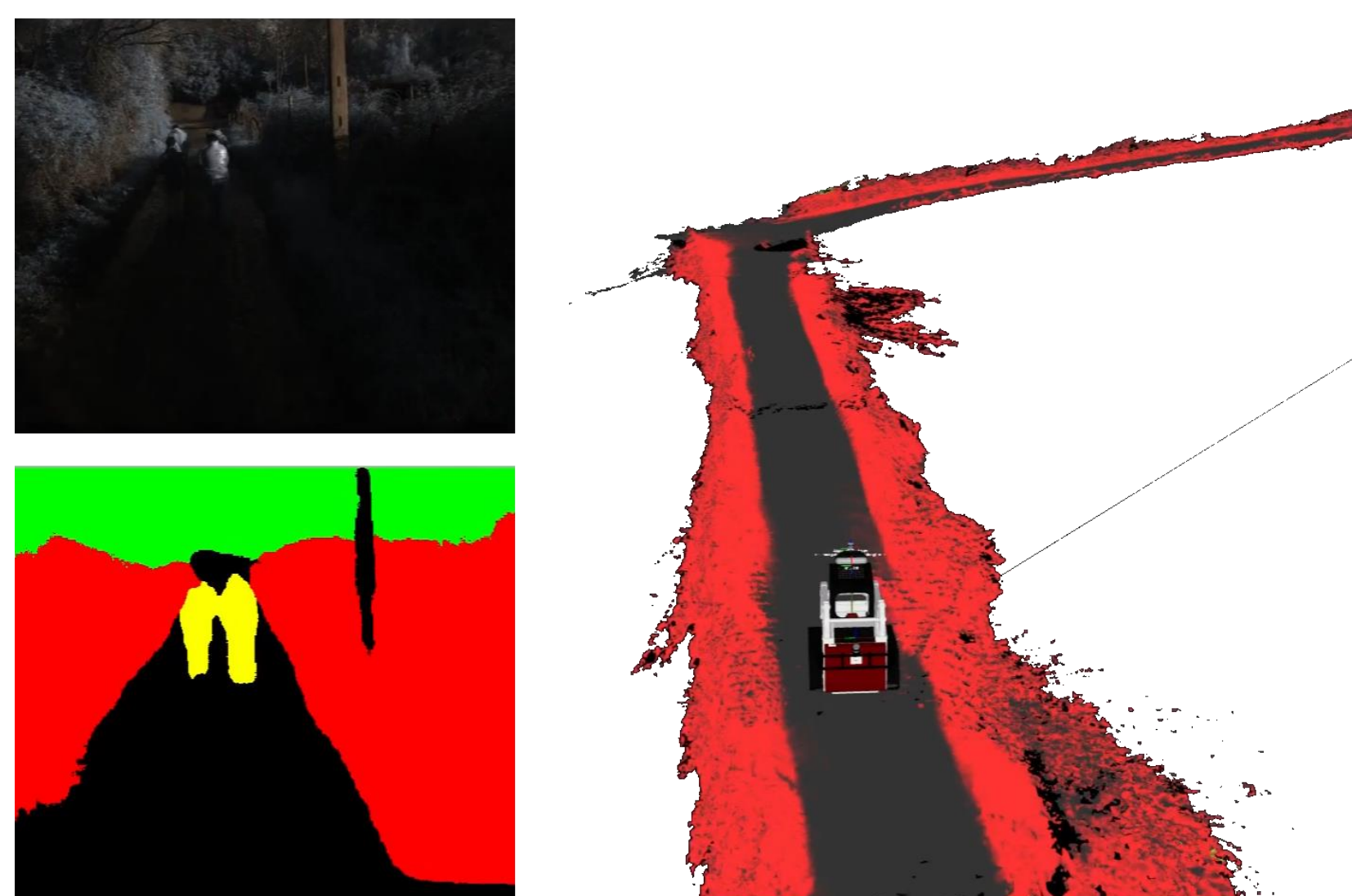
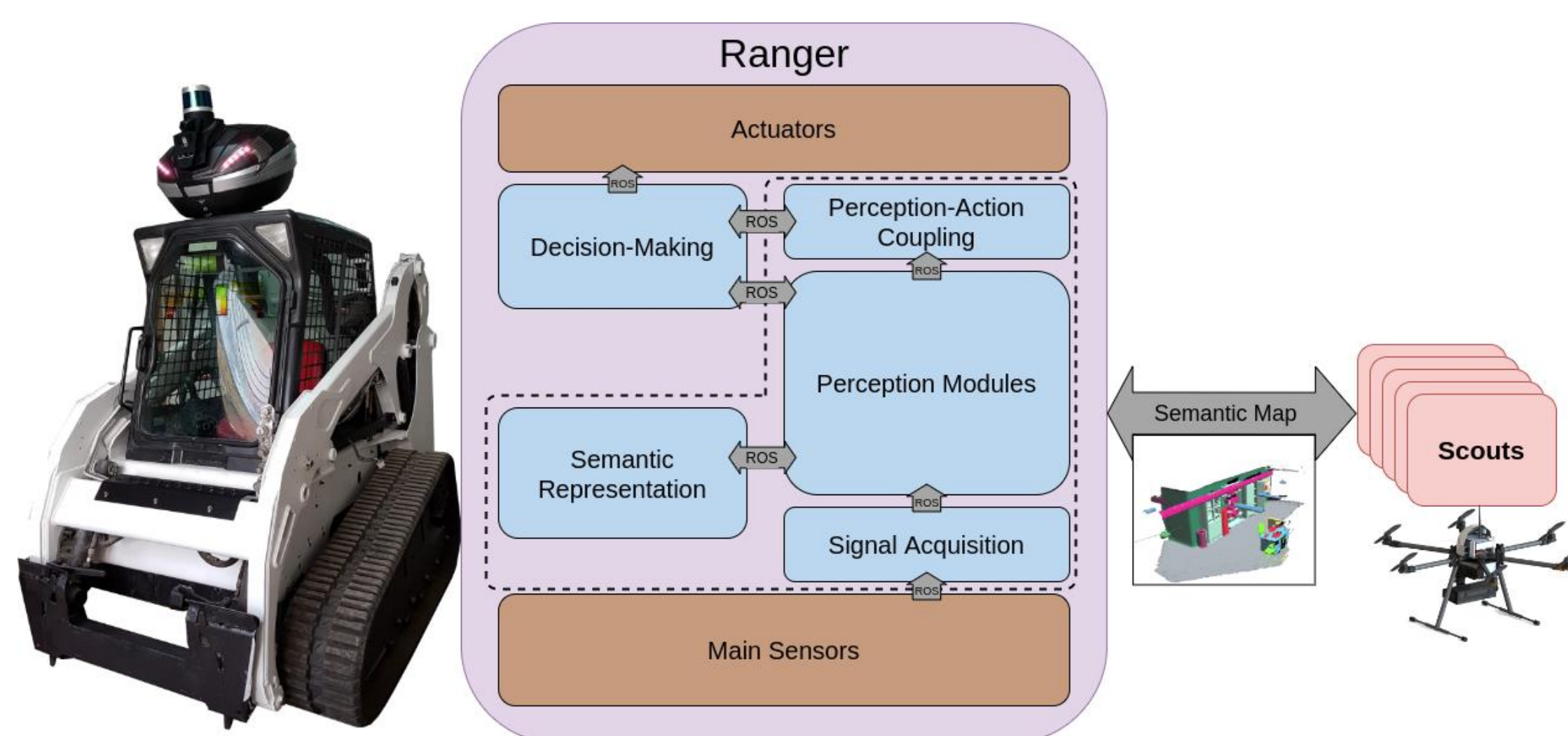


Fig: Preliminary Semantic segmentation mapping, in which dynamic classes (e.g., humans in yellow) are filtered out of the final map.

## Methodology



- Survey and evaluate semantic segmentation, depth completion and semantic mapping techniques.
- Develop and implement perception modules into an unmanned ground vehicle (UGV)
- Test and validate each module before full implementation into real world scenarios.
- Integrate final perception modules with a probabilistic state machine for the decision-making regarding the forestry operations e.g., preserve dynamic entities.
- Continuous publication throughout the Ph.D.

## References

- [1] Couceiro, Micael S., David Portugal, João F. Ferreira, and Rui P. Rocha. "SEMFiRE: Towards a new generation of forestry maintenance multi-robot systems." In 2019 IEEE/SICE International Symposium on System Integration (SII), pp. 270-276. IEEE, 2019.
- [2] M. E. Andrada, J. F. Ferreira, D. Portugal and M. S. Couceiro, "Integration of an Artificial Perception System for Identification of Live Flammable Material in Forestry Robotics," 2022 IEEE/SICE International Symposium on System Integration (SII), 2022, pp. 103-108, doi: 10.1109/SII52469.2022.9708734.

## Ph.D. Timeline

