

Proposing a conceptual architecture for agricultural field robots.



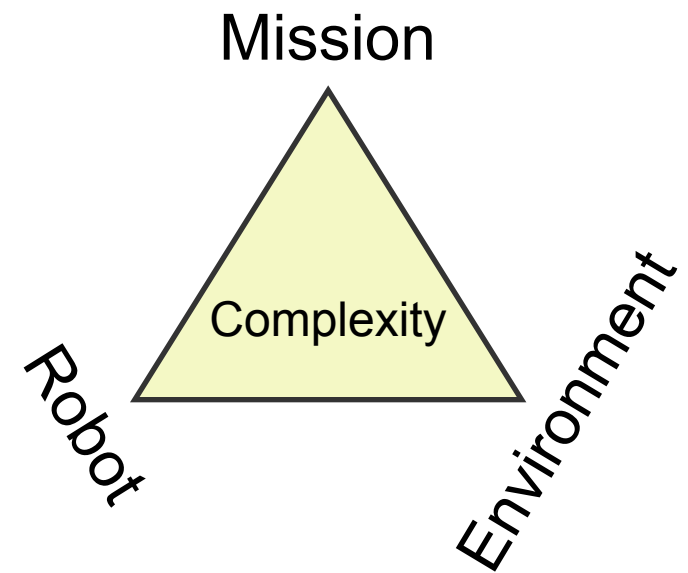
Automation and system technology in plant production
CIGR section V & NJF section VII conference, 30 June - 2 July 2011 Denmark

The problem...

Typical autonomous field robot tasks:

- Mission task management
- Implement support
- Exchange information with collaborating entities

- Sensing
- Localization and mapping
- Route planning
- Navigation
- Actuation
- System feedback
- Safety
- Data logging



State of the art

Commercially available agricultural field robots:

- GPS-based and in-row guidance/steering.
- Static or limited dynamic route planning.
- Basic safety systems, supervision is typically required.
- None or limited interaction with the implement.
- Ignorant or limited intelligent coexistence with other entities.



Current research topics

- True autonomous operation.
- Localization, mapping & object detection typically focusing on 3D laser range scanners & stereo cameras.
- GPS-free positioning.
- Dynamic route planning based on detailed maps.
- Autonomous safety systems validated against proper standards.
- Intelligent implement interaction.
- Intelligent collaboration & coordination with other entities.

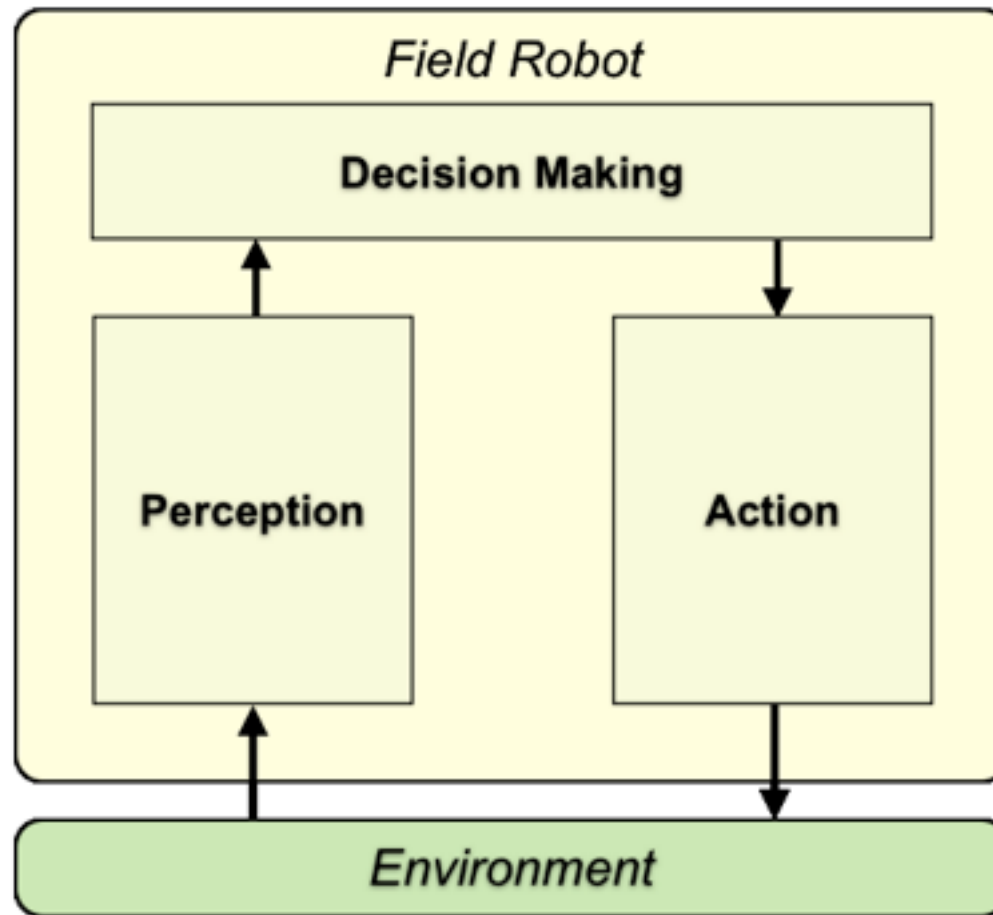


The aim of this project

- A highly modularized conceptual architecture targeted towards autonomous agricultural field robots.
- A software implementation based on an open source framework focusing on modularization, reuse and scalability.
- Application of the architecture to different vehicle platforms to validate the performance.



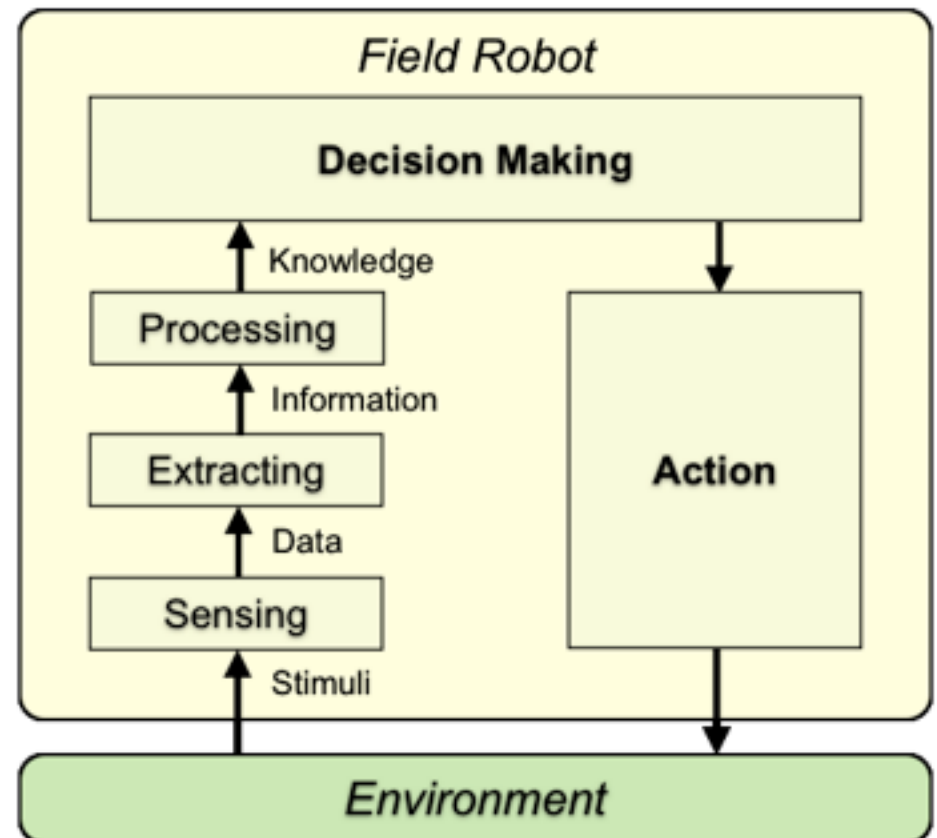
Conceptual architecture



Perception

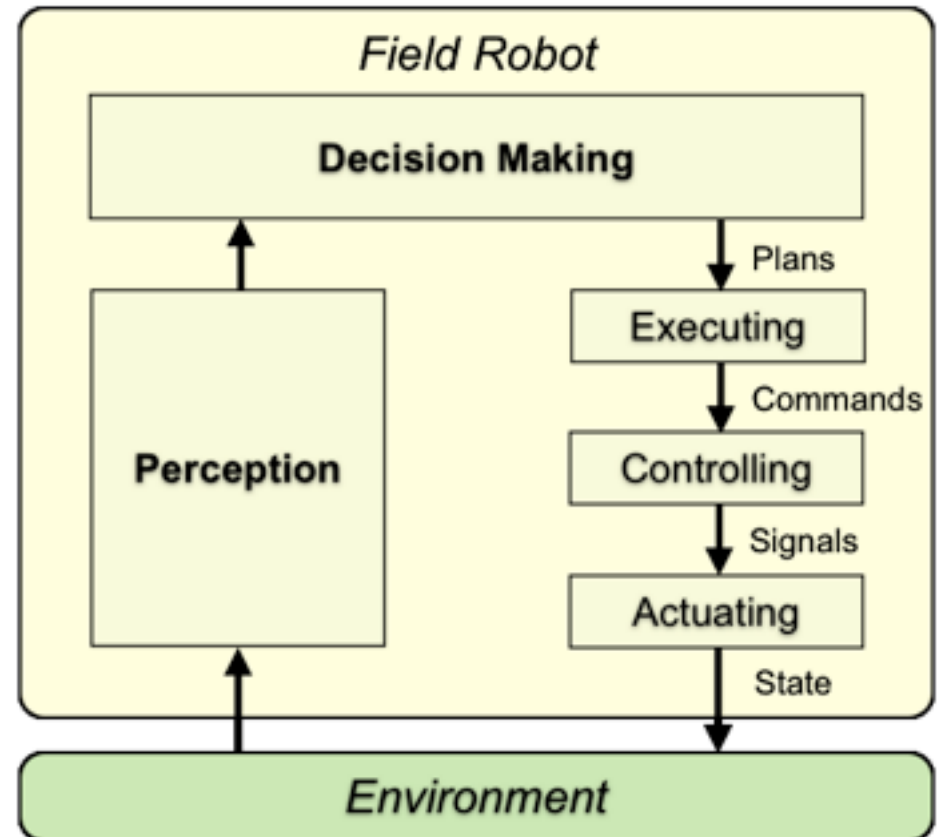
- System feedback
- Implement feedback
- Odometry
- Local sensors
- Global sensors

- Mission task description
- A priori knowledge
- Shared knowledge



Action

- Steering
- Propulsion
- Brakes
- Engine control
- Signal aids
- Implement actuation



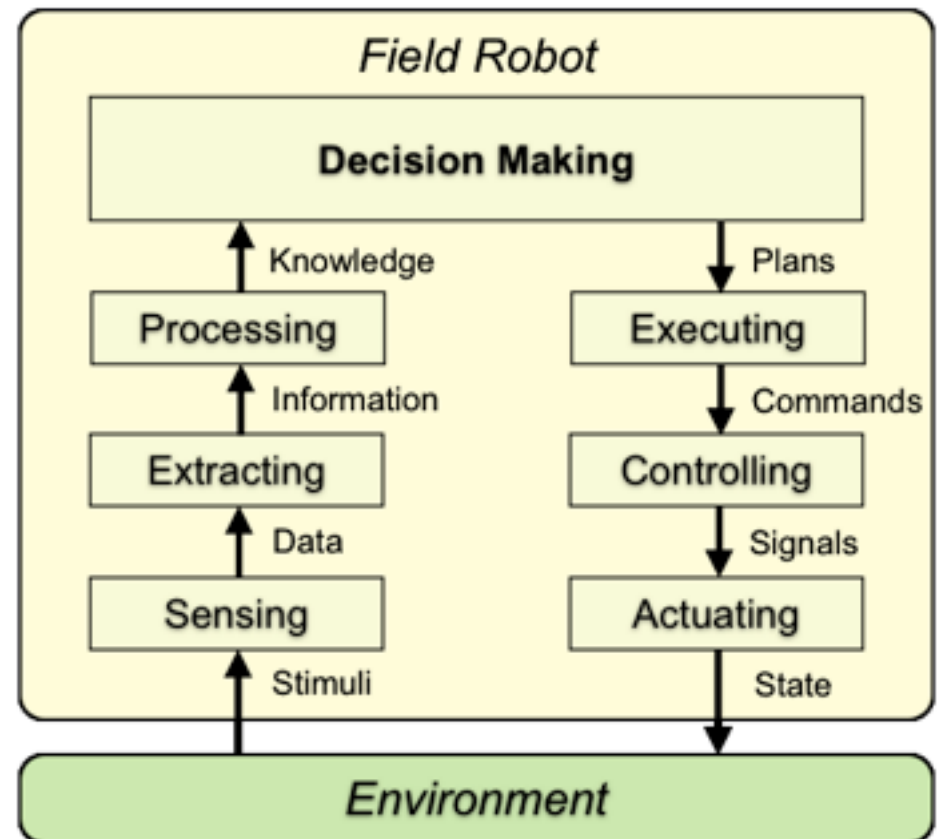
Decision Making

“Can there be a theoretical analysis to decide whether one organization for intelligence is better than another? Perhaps, but I think **we are so far away from understanding the correct way of formalizing the dynamics of interaction with the environment** that no such theoretical results will be forthcoming in the near term.”

- Brooks 1990

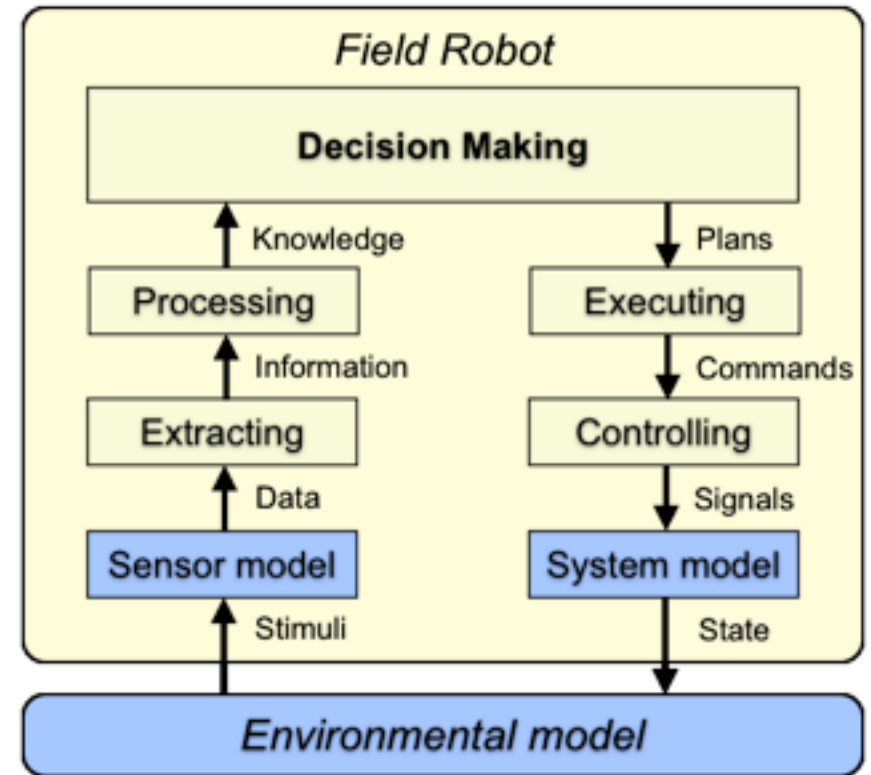
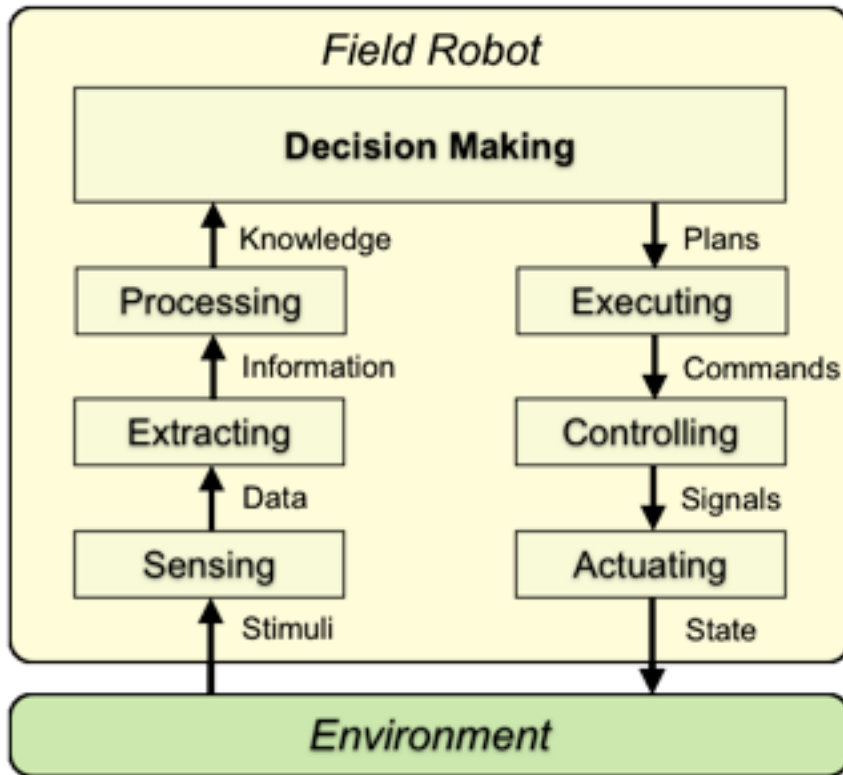
Decision Making

- Mission planning
- Proactive behavior generation
- Motion planning
- Real-time constraints



*Tartan Racing
DARPA Urban Challenge 2007*

Simulation



Software architectures

- Player-Stage/Gazebo
- Microsoft Robotics Developer Studio (MRDS)
- Robot Operating System (ROS)
- Orca (*Orocos*)
- Carmen, SAFAR, MOOS, RoboComp, Coroba, Agriture, SMR, LabView, CLARAty, YARP, OpenJAUS, Umbra...
- FiRECom



	Player	MRDS	ROS	Orca	FiRECom
Modularization	Good	Good	Good	Good	Good
Code reuse	Good	?	Excellent	Good	Limited
Scalability	Good	Good	Excellent	Good	Limited
Real time capability	Yes	No (CCR)	No	Yes	Yes 100Hz
Component interface	Socket	DSS/TCP	ROS (XMLRPC)	Ice	Sharedmem Socket
Simulation	Stage/ Gazebo	Excellent	Stage/ Gazebo	Stage/ Gazebo	RobWork Studio
Language	C++ TCL Java Python	Visual studio VPL other	C++ Lisp Python	C++	C
Platform	Linux	Windows	Linux Cluster	Linux (QNX WinXP)	Linux
License	GPLv2	Commercial Academic	BSD	LGPL/GPL	MIT

Results

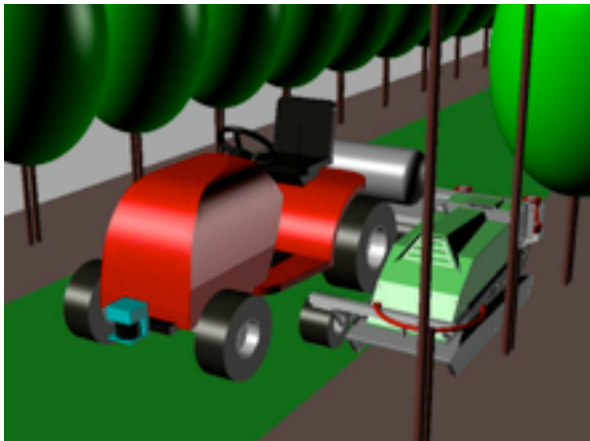
- Proposed FroboMind conceptual architecture.
- FroboMind implemented in Robot Operating System (ROS).
- FroboMind applied to ASuBot, Armadillo & Hilde platforms.
- Platforms demonstrated at FieldRobotEvent 2011

FROBOMIND +  ROS.org +



Work ahead...

- Describe component interface abstraction.
- Implement a scalable decision maker architecture.
- Test scalability towards more complex perception and decision making.
- Create a simulation environment.
- Apply FroboMind to current projects.



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