

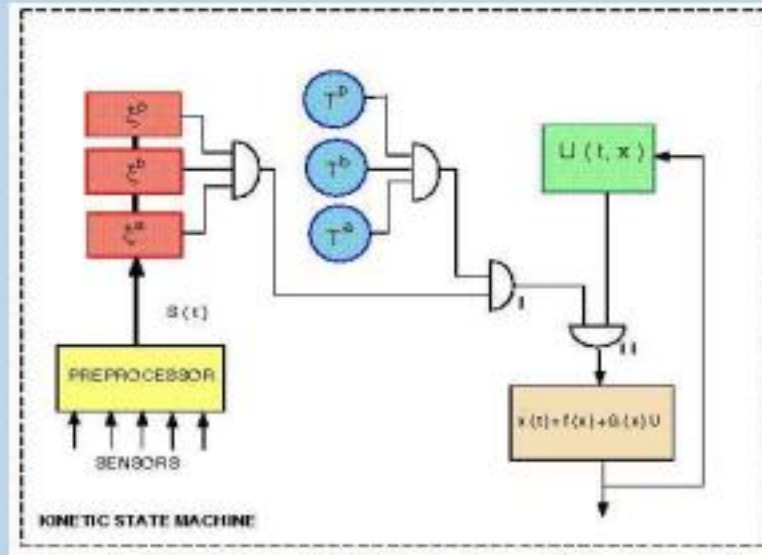
The MDLe Project: Towards a Universal Language for Sensor-based Feedback Control

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Theory

- MDLe: A language for hybrid motion control
- Hybrid system modeled as Kinetic State Machine



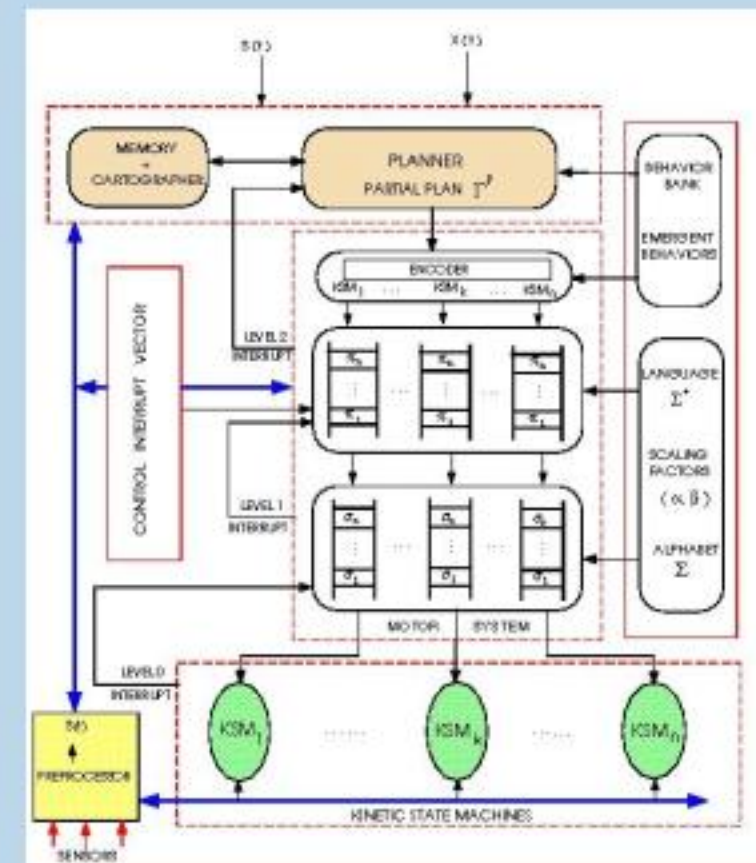
- Interrupt: Boolean function of sensor data
- Atom σ : Control law U with interrupt ξ and timer T
 $\sigma_1 = (U_1, \xi_1^a, T_1^a)$
- Language Σ : Collection of known atoms
- Behavior π : Sequence of atoms with interrupt and timer
 $\pi_1 = (\sigma_1, \sigma_2, \dots, \sigma_n, \xi_1^b, T_1^b)$
- Plan Γ : Sequence of behaviors with interrupt and timer
 $\Gamma_1 = (\pi_1, \pi_2, \dots, \pi_n, \xi_1^p, T_1^p)$

To execute a plan is to step through the behaviors in sequence while the timer has expired and the interrupt has not fired.

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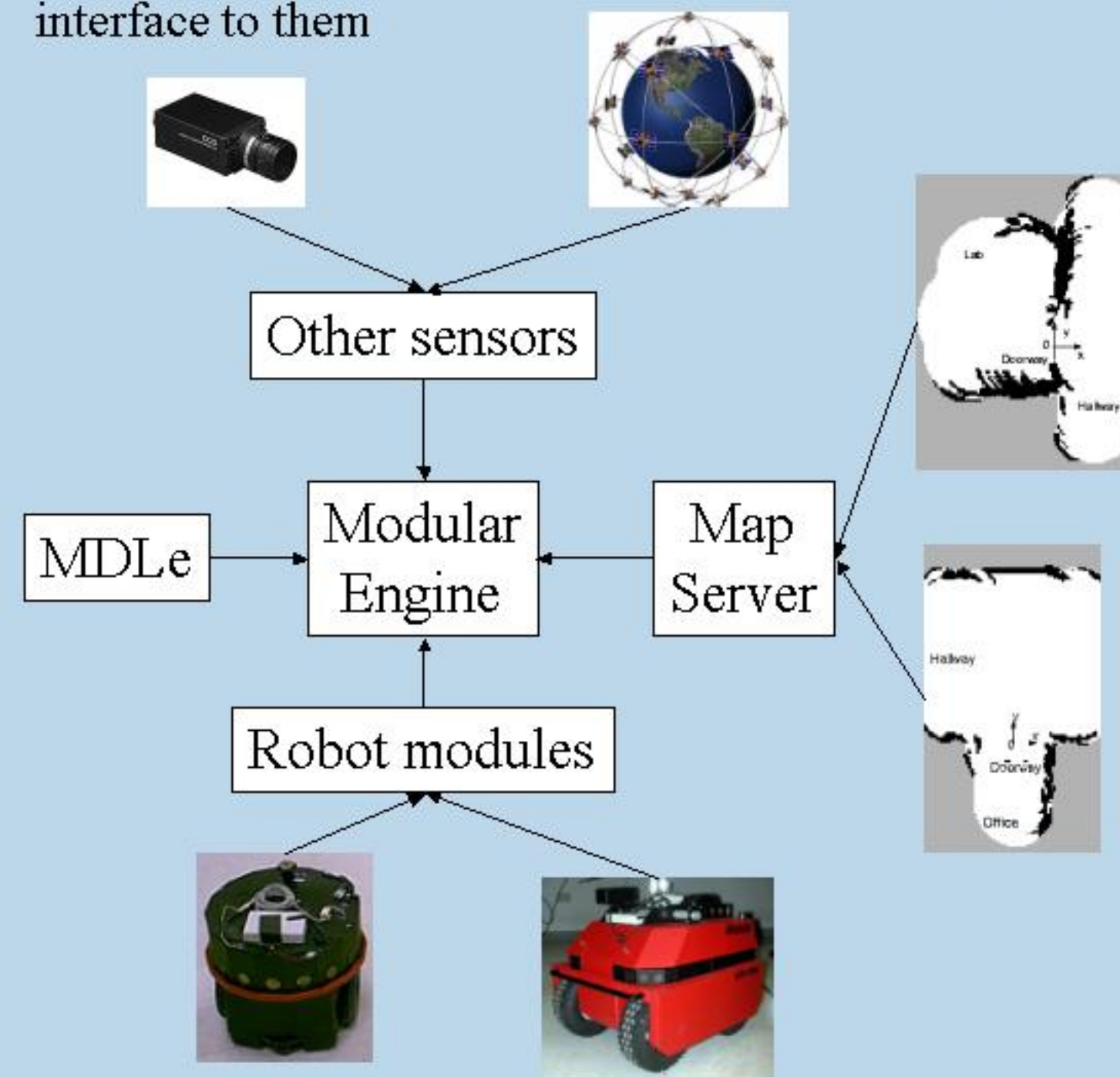
To execute an atom is to run the control on the KSM while the timer has not expired and the interrupt has not fired

System model

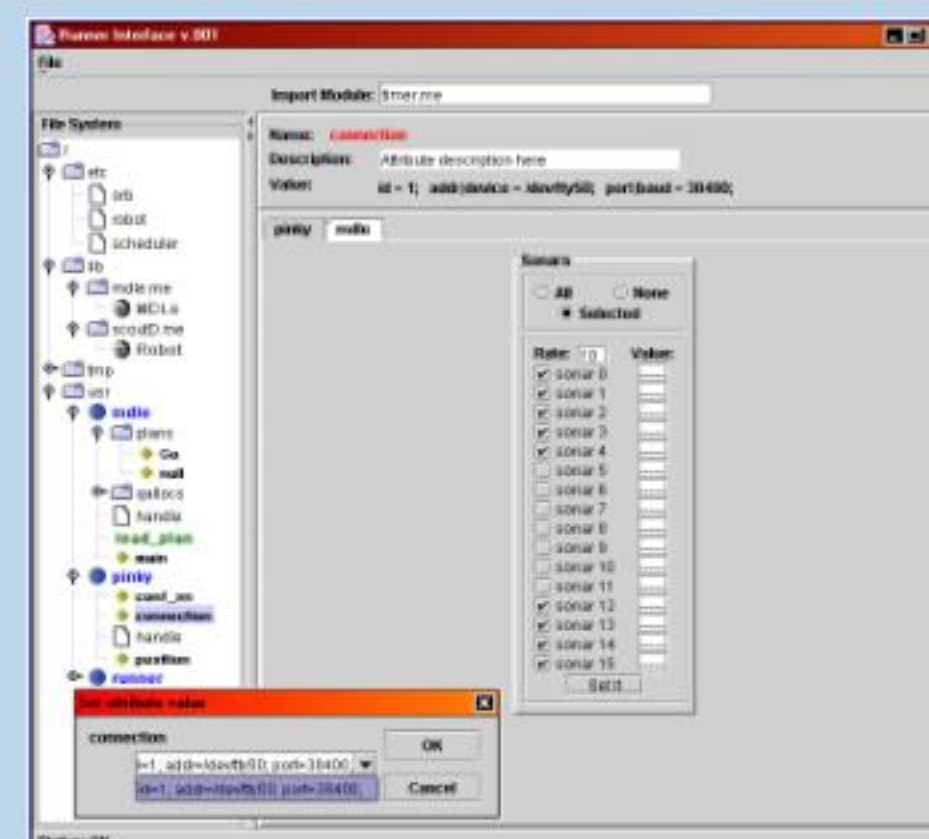


Implementation

- Modular engine executes modules using turn-based pseudo real time approach
- MDLe module: interprets MDLe plans and executes them on connected KSM
- Robot module: provides common interface to robot sensors and controls
- Mapservers: external service managing maps
- Additional sensors can be added by creating modules to interface to them



Java-based Graphical User Interface



Applications and Experiments

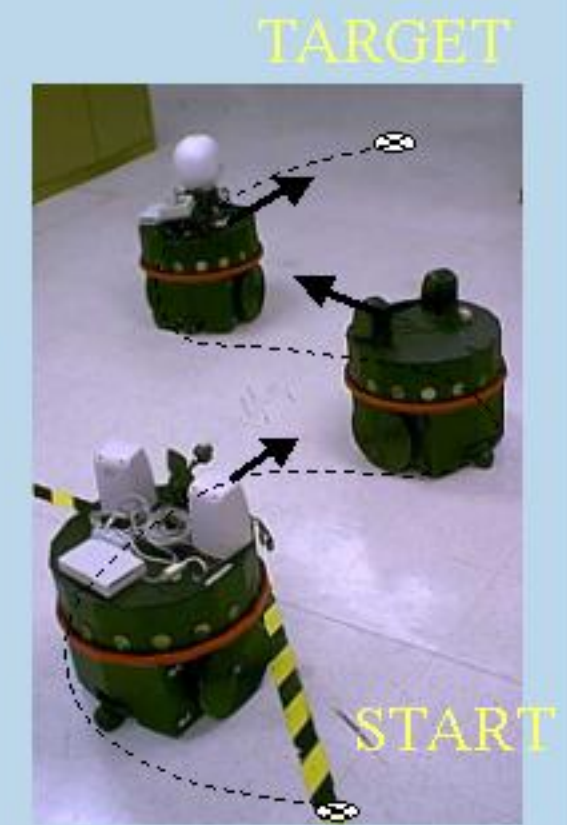
Sound following robot

- Equip robot with mannequin head outfitted with a pair of microphones
- Use interaural time delay to localize sound
- MDLe plan consists of two behaviors
 ((no obstacle seen) (turn towards sound, move forward))
 ((obstacle seen) (put obstacle on side and move forward))



Optimizing path length on uneven terrain

- Leader follows an initial path from start to target location.
- Followers pursue the leader.
- After reaching target, reverse roles and move back to the start
- MDLe plan consists of three behaviors
 ((path not completed) (follow path))
 ((path not completed) (follow robot in front))
 ((not on start) turn around and move to start)



World representation using landmarks and directed graphs

- Efficient representation of far-flung areas of interest
- Connect landmarks with MDLe plans - feedback reduces complexity

Robot formations

- Modify MDLe to support atoms controlling entire groups of robots
- Develop communication protocol to share sensor information among robots

References

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