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Robotic UBiquitous COgnitive Networks

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Robotic Ecologies

A Robotic Ecology is an heterogeneous system of “robotic devices”, including mobile robots, wireless sensor and actuator networks (WSAN), and automated home appliances. By collaborating together, such ecologies:

- extend the variety of robotics applications that can realistically be envisaged
- reduce the complexity of the overall system
- enhance the value of the services delivered by each device

The participants of a RUBICON ecology cooperate using their past experience to improve their performance by autonomously and proactively adjusting their behaviour. Each node of the ecology contributes to a cooperative self-learning dynamic and to a shared and distributed memory infrastructure.

RUBICON will be self-sustaining: the robots will exploit their mobility and better sensing capabilities to provide feedback on the ecology’s distributed intelligence; each part of the ecology reinforces the learning of the others, so that over time the ecology identifies, commissions and fulfils tasks more effectively and efficiently.

In the first six months of the project, the consortium has produced an high-level system architecture [1], which will be used to control each participant of the RUBICON ecology. 

Current Robotic Ecologies lack the ability to proactively and smoothly adapt to evolving situations and to subtle changes in the environment, user’s habits and preferences, as they exhibit:

- Excessive reliance on pre-defined and Symbolic Representations, including models of human activities, environment, services, and of systems’ capabilities.
- Primitive Learning Capabilities
- Excessive reliance on humans for Configuration, Training and Supervision.
- Limited Sharing of Situated Knowledge

The RUBICON Architecture combines:

- [Communication Layer] Existing Robotic Ecologies1 and WSAN Middleware2 to support collaboration among heterogeneous devices using a common tuple-space/publish-subscribe communication abstraction
- [Control Layer] Hybrid Plan4/Agent-based Systems to classify events/activities and find and execute coordinated sensing, action and collaboration strategies
- [Learning Layer] Statistical and computational (neuroscience) learning methods based on Reservoir Computing (RC) models5 to classify events/activities and adapt control strategies to the environment
- [Cognitive Layer] Self-Organising Fuzzy Neural Networks (SOFNN)6 for Novelty Detection driving Continuous Learning and Exploitation of Robot Mobility

Validation & Future Work

The RUBICON consortium has conducted preliminary experiments to validate the use of Reservoir Computing learning techniques to predict user movements in indoor environments.

Future work will implement the RUBICON Architecture and also define a set of adaptive, extensible and robust services (based on activity-recognition, navigation, transport) by leveraging available resources (wireless sensors, robots) while requiring minimum pre-programming, configuration and human supervision. Final validation will be conducted in the Ambient Assisted Living (AAL) TECNALIA Home Lab (left) and in the Stella Maris Hospital (right).

Consortium

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