

Pancakes: A Software Framework for Robot and Sensor Network Applications

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Abstract

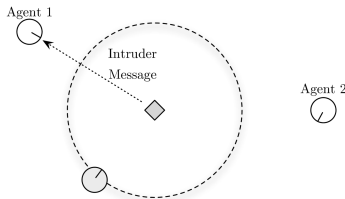
The development of control applications for multi-agent robot and sensor networks is complicated by the heterogeneous nature of the systems involved, as well as their physical capabilities (or limitations). We propose a software framework that unifies these networked systems, thus facilitating the development of multi-agent control across multiple platforms and application domains. This framework addresses the need for these systems to dynamically adjust their actuating, sensing, and networking capabilities based on physical constraints, such as power levels. Furthermore, it allows for sensing and control algorithms to migrate to different platforms, which gives multi-agent control application designers the ability to adjust sensing and control as the network evolves.

Application

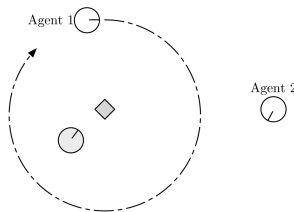
Building Security

Q: "Can we deploy a robot and sensor network application to detain an intruder and have it stay in operation?"

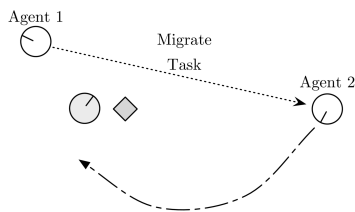
- Sensor network detects an intruder in the building and notifies the nearest robot response unit (Agent 1).



- Agent 1 responds and detains the intruder by encircling it.



- Agent 1 is low on power and delegates the task to a nearby patrolling unit (Agent 2). Agent 2 detains the intruder.



A: "Yes, we can with Pancakes."

Framework

Information Stream

"A configurable set of communication channels between software components."

- Serve as input and output channels.
- May be used to communicate information internally or over the network.

Tasks

"Input/Output software components that are functional units."

- Can be event-driven, time-driven, or a combination of both modes.
- Use communication channels to exchange information with other tasks.

Services

"Controllable sets of tasks."

- Adjust runtime behavior of tasks, such as start, stop, reschedule, or migrate tasks.

Features

Dynamic Adjustment

"Tasks may be adjusted during runtime to respond to changes in the state of the software, the network, or the physical platform."

- For example, a task may be forced to reduce its network transmissions to save power on the physical platform.

Migration

"Tasks may be migrated to another compatible Pancakes platform."

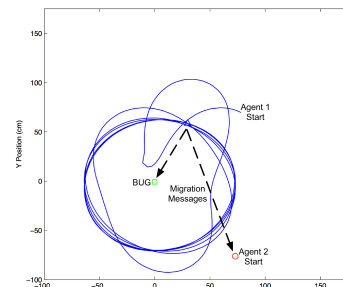
- Task can be migrated to another platform if it satisfies the task's dependencies.
- A cost metric is used to choose a platform for migration among candidates on a network.

Experiment

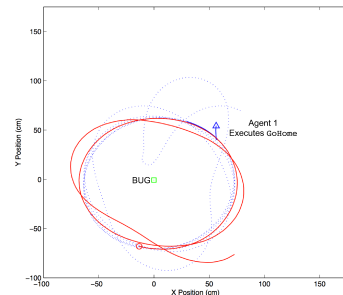
Building Security

"We deployed Khepera III mobile robots and BUG sensor nodes to detain intruders in our laboratory."

- A BUG sensor node detects an intruder in its region and notifies the nearest Khepera III mobile robot (Agent 1).
- Agent 1 responds and detains the intruder by encircling it.
- After some time, Agent 1 runs low on power and delegates the task to a nearby Khepera III mobile robot (Agent 2).



- Agent 2 accepts the migrated task and starts encircling the intruder. Agent 1 returns to its charging station.



- While Agent 1 has returned to the charging station, Agent 2 continues to detain the intruder.

