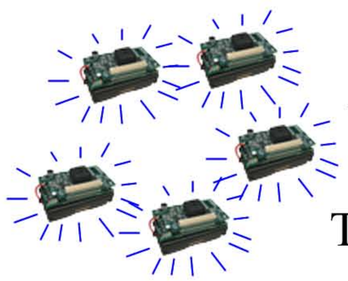


TRI: Bridging the Gap between Wireless Sensor Networks and Autonomous Agents

Todd Sullivan Dr. Yi Shang Undergraduate Honors Thesis University of Missouri-Columbia

Abstract

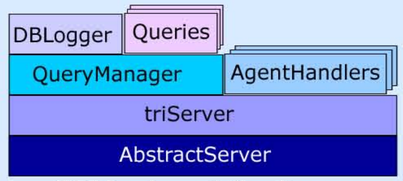
This research project presents TRI, the TinyOS Robot Integration server. TRI is a multithreaded server that provides developers with WSN data management and agent-agent communication channels through a TCP/IP connection and a human-readable message protocol. The TRI server hides the details of retrieving data from and managing a WSN. Thus, developers with standard TCP/IP socket experience can incorporate WSNs into their projects. This research also presents TRI applications executing on a Sony AIBO that responds to its environment by its onboard sensors and the extra sensory data from a WSN.

TRI Server Model

The TRI server allows agents to gather data from a WSN, read past data from the server's database, and communicate with other agents using a human-readable message format. The sensor network's motes run TinyDB, which the server uses to execute queries. The server stores agent information and query data in a MySQL database. The server is multithreaded and has no programming-related limit on the number of agents that can connect, communicate, and execute queries.

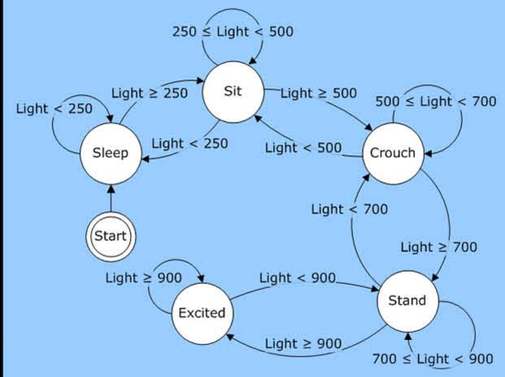
TRI Implementation

The TRI server is a Java application that requires JDK 1.4.1 since the TinyDB Java library does not work with JDK 1.5. The server consists of six main parts: AbstractServer, triServer, QueryManager, Query, AgentHandler, and DBLogger. These layers have similar roles as their names imply.



TRI Implementation Layers

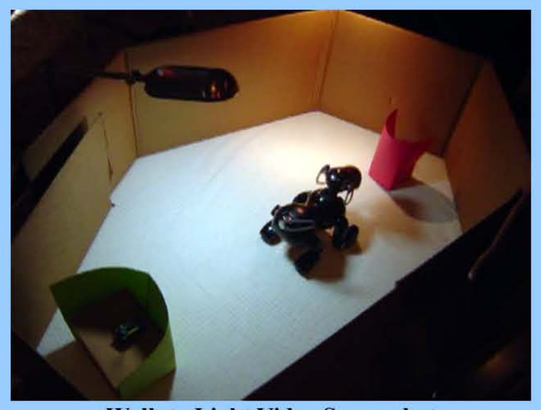
Walk To Light State Machine



Sleep-Sit-Stand State Machine

Application: Sony AIBO

The AIBO demonstrations include Head Movement, Sleep-Sit-Stand, and Walk to Light. Each program demonstrates an application of the TRI server to a robot environment. In Head Movement, the AIBO lies down and moves its head in response to the average light from the WSN. In Sleep-Sit-Stand, the AIBO gradually moves through the states of sleeping, sitting, crouching, standing, and panting as shown in the figure to the left. In Walk to Light, the AIBO walks to the brightest node in the WSN.



Walk to Light Video Screenshot

The two targets (the pink and green boxes) each contain one light-sensing mote. When the second light, which is outside of the picture (above the AIBO), is on, the pink target is brightest. Otherwise, the green target receives the most light from the visible lamp in the image.

Sleep-Sit-Stand Original/Replay Overlay

The ghost-like AIBO is the AIBO during the replay of the original WSN data. The figure includes a screenshot from the original recording and an overlay from the recording of the replay. As seen in the figures, the AIBO's responses are almost identical. The only differences are due to different starting positions on the test setup's floor.

http://research.daysignmedia.com/ug/

Conclusions

TRI allows developers to easily integrate WSNs into their projects without requiring knowledge of the underlying systems for sensing, retrieving, and storing data. The TRI server is accessible for any program that can access the internet or an intranet and establish TCP/IP connections. The AIBO demonstrations provide a basic template for autonomous agent integration with the TRI server and show basic applications where an autonomous agent uses WSN data to make decisions.

http://research.daysignmedia.com/ug/ includes the TRI and AIBO demonstration source code as well as videos of the AIBO applications and tutorials for installing and modifying the TRI server and AIBO demonstrations.

Acknowledgements

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