Motion Planning of Autonomous Robots

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ABSTRACT
In this paper, we describe the demonstration of autonomous mobile networked robots for ubiquitous computing. While these robots are sensing the surrounding environment, they move from an initial position to destination in order to complete their tasks by continuously planning their motion to adapt to changing environment conditions (obstacles and other moving robots). The demonstration is executed on StarBED, large-scale network testbed, through a remote VPN connection. The behavior of robots emulated on StarBED is displayed by our robot motion visualizer at demonstration space.

Keywords
Autonomous mobile networked robot, real time, large-scale emulation

INTRODUCTION
In disaster areas or office buildings, autonomous mobile networked robots may act instead of human beings. The experiments for evaluating new ideas or algorithms for these robots are difficult, since the cost of these real autonomous robots is high. This is particularly true if researchers want to experiment with more than a few robots, and need to test systems with tens or even hundreds of robots. Consequently many researchers try to make experiments or evaluate their algorithms or methods on software simulators. But the results from these simulators are not very accurate. The difference between real systems and simulators can be big. We need solutions for covering this difference.

Our solution for these problems is emulation. It means that we provide the modeling or imitation to represent the behavior of the hardware of robots, for example motors, cameras, some sensors and so on. In unknown and dynamic environments the system needs to discover the changes of the environment. To synchronize the events which happen on every robot at the same time and to administrate all of hardware information, we use a software module called “Map Manager”.

We will describe Map Manager in the next section, explain about our demonstration in the section “DEMONSTRATION DESCRIPTION”, and conclude in the final section.

MAP MANAGER
Figure 1 describes our emulation approach of autonomous robot. Sensor function emulation creates the behavior of the robot sensing hardware.

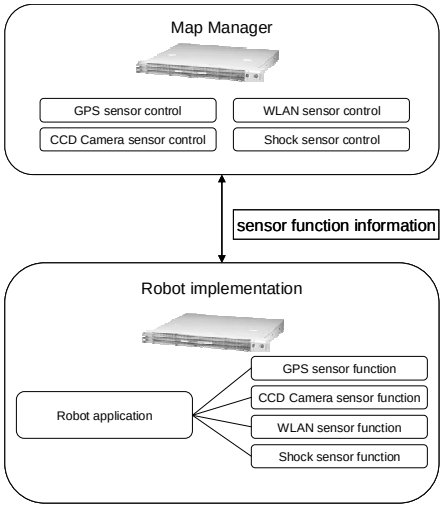

Figure 1: Map Manager: sensor function emulation

Each robot is able to recognize the events of their hardware from the emulated sensing function information, for example positions from “GPS”, images from “CCD Camera”, detection of WLAN radio signal and so on.

Map Manager administrates all of the hardware information on sensor function emulation. Map Manager handles the sensor function and converts the events from device driver to comprehensible information by the robot application.

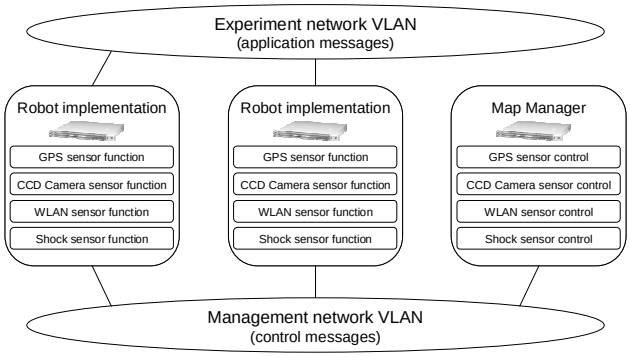

Figure 2: Overall architecture of our system

In demonstration system, there exist two networks which are connected by VLAN. Figure 2 describes the topology of demonstration system. On “Management network VLAN”, the sensing function information is sent. On “Experiment network VLAN”, the robot application messages are sent.

DEMONSTRATION DESCRIPTION

Our demonstration visualizes the behavior of large-scale robot motion experiment. Figure 3 describes our robot motion visualizer.

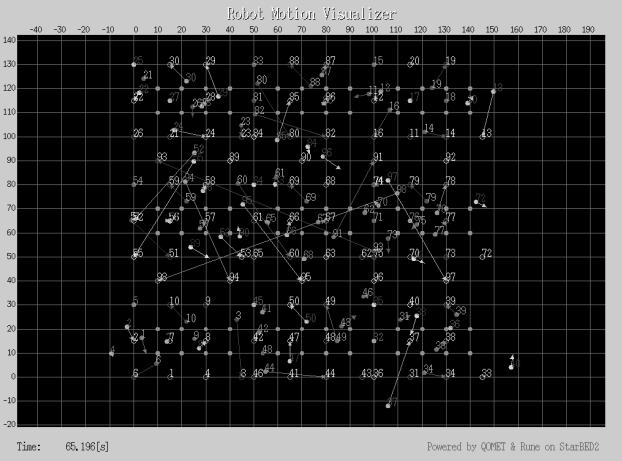

Figure 3: Robot Motion Visualizer

The initial task of each robot is to move from the source to the destination. While they are moving, they detect other robots or obstacles. If they detect possible collisions on their way, they start to plan their motion.

These robots are implemented on StarBED [1] nodes. StarBED is large-scale network testbed which has a large number of PCs (more than 800). These experiment PCs are equipped with multiple network interfaces (100 Mbps or 155 Mbps or 1 Gbps type). These PCs can easily construct large-scale networks by changing switches configuration. Our demonstration PC connects to StarBED PC though VPN connection, controls the experiment, and visualizes the robot motion.

For constructing this demonstration system, StarBED2 [2] architecture is used. To represent for WLAN sensing function emulation, we use QOMET [3], which is WLAN communication emulation engine. RUNE [4] provides an API set which controls experiment environments. By using above software on StarBED, we created a large-scale ubiquitous network emulation environment for real time experiments.

CONCLUSIONS

The experiment on our system made it possible to perform real-time experiment with more than a hundred robots. On the way to testing the system, researchers can check the current state or errors of large-scale experiment in real time.

REFERENCES

1. StarBED project. http://www.starbed.org/
2. J. Nakata, R. Beuran, T. Miyachi, K. Chinen, S. Uda, K. Masui, Y. Tan, Y. Shinoda, “StarBED2: Testbed for Networked Sensing System”, 4th International Conference on Networked Sensing Systems (INSS07), Braunschweig, Germany, June 6-8, 2007, pp. 142-145.
3. R. Beuran, L.T. Nguyen, K.T. Latt, J. Nakata, Y. Shinoda, “QOMET: A Versatile WLAN Emulator”, *IEEE International Conference on Advanced Information Networking and Applications (AINA-07)*, Niagara Falls, Ontario, Canada, May 21-23, 2007, pp. 348-353.
4. J. Nakata, T. Miyachi, R. Beuran, K. Chinen, S. Uda, K. Masui, Y. Tan, Y. Shinoda, “StarBED2: Large-scale, Realistic and Real-time Testbed for Ubiquitous Networks”, *TridentCom 2007*, Orlando, Florida, U.S.A., May 21-23, 2007.