Lupe: Information Access Method based on Distance between User and Sensor Nodes using AR technology

Takuya Takimoto
Keio University
tacky@ht.sfc.keio.ac.jp

Yutaka Karatsu
Keio University
karasu@ht.sfc.keio.ac.jp

Takuro Yonezawa
Keio University
takuro@ht.sfc.keio.ac.jp

Jin Nakazawa
Keio University
jin@ht.sfc.keio.ac.jp

Kazunori Takashio
Keio University
kaz@ht.sfc.keio.ac.jp

Hideyuki Tokuda
Keio University
hxt@ht.sfc.keio.ac.jp

ABSTRACT
This paper proposes the information access method that is based on the distance between users and objects. In addition, demonstrate Lupe system, which visualizes WSN status information utilizing our method. The evaluative experiment shows that our method is useful in where a number of sensors are setup. As a result our method and Lupe system enable to easily brows WSN status information for end-user.

Author Keywords
Reality Oriented visualization, Augmented Reality, Wireless Sensor Network, Ubiquitous Computing

ACM Classification Keywords
H.5.2 Information Interfaces and presentation: User Interfaces.

General Terms
Design, Experimentation, Measurement

INTRODUCTION
Recent progress in information technology has led to a wider use of small sensor nodes equipped with various types of sensors. These sensor nodes, when installed to our environment, enable us to gather real-world information. By using this information, various context-aware applications such as human activities assisting or traceability system has been proposed. However, if many of these applications are installed into one same environment, it's management cost will be increased. For example, there are many sensor nodes environment, user will need to find the sensor node from among them. To leverage many context-aware application in home, end-users, who have no skills or knowledge about wireless sensor network (WSN), should manage WSN by themselves.

There are two processes to manage WSN, (1) finding sensor nodes in trouble and (2) repairing the sensor nodes. This paper focuses to enable end-users to operate first process, easy finding sensor nodes in trouble. To find the sensor nodes in trouble, users must know both (1) the location information of the sensor nodes and (2) the status information of the sensor nodes. To support these tasks, this paper proposes a system called Lupe, a multi-level augmented reality visualization system based on the distance between the user and sensor nodes.

There has been related works which adapts AR techniques to visualize status of sensor nodes. For example, [uMegane] attaches visual marker to sensor nodes, and visualize sensor information in AR space. However, if there are huge number of sensor nodes in environments, it is difficult to recognize all of visual marker simultaneously. This, in turn, makes difficult for users to find sensor nodes in trouble.

The purpose of the Lupe is to solve such situation: Lupe first navigates users to the abstract direction to sensor nodes in troubles. Then, according to the distance between the users and the sensor nodes, the visualized information changes to notice sensor nodes' information efficiently to users. This navigation enables users to know the location and status of sensor nodes easily. We present the design and implementation of the Lupe system, and evaluate it through user studies.

DISTANCE BASED VISUALIZATION
We defined the visualization method called “distance based visualization”. It is made with three phrases. Figure1 shows each phrase.

Copyright is held by the author/owner(s).
UbiComp’11, September 17–21, 2011, Beijing, China.
ACM 978-1-60558-843-8/10/09.
Abstract Information Phase
When the user is away enough from the sensor nodes, system will classify the situation as Abstract Information Phase. Abstract Information Phase displays the abstract information of the WSN status to the user. User scans around the wall using mobile phone in the environment. This phase shows the message like “Warning” as shown in Figure 1. Then, the user can realize where the problem is happening abstractly in the environment.

Detail Information Phase
When the user approach to the sensor nodes, the system will classify the situation as Detail Information Phase. Detail Information Phase displays the detailed information of the WSN status to the user, which is more detailed information than Abstract Information Phase. This phase shows the message like “Low Battery”, which is shown in Figure 1. Then, user can realize what kind of the problem is happening in the WSN.

Specific Information Phase
When the user approach to the sensor, where user is able to recognize sensor node by looking at it, the system will classify the situation as Specific Information Phase and identify it. Specific Information Phase displays the information about the identified sensor. This phase shows the message like “2%” shown in Figure 1. User can realize the state of sensor node.

LUPE PROTOTYPE
We implemented a prototype of Lupe using the “distance based visualization”. The software was written with ARToolkit[1] library on iPhone. Sensors are SunSpot. Sensor information is sent throw by Wi-Fi and displayed on mobile phone. The sensor can be specified by pasting a unique AR marker to each device beforehand.

Figure 2. Sensor nodes on AR marker image

Evaluation
We conduct an evaluation in order to confirm that Lupe could enable users to understand information on the WSN among the sensor nodes that exists in surroundings. It is an experiment that looks for the sensor node that has some error from among huge number of sensor nodes. 50 sensor nodes are placed in the environment. Then we have asked the participants to look for a sensor, which are some error among them. The time that had been required for the task was measured. Firstly, we have asked the participants to do the task with existing AR system, which displays sensor status. Secondly, we asked the participants to do it with our system. The same experiment was conducted with 100 sensor nodes. We have conducted this experiment for 10 participants and calculated average time.

Figure 3. Evaluation result

RELATED WORKS
The visualization system of the Sensor Network includes SpyGlass[3] and uMegane[4], etc. SpyGlass is a framework visualizes the sensor data and traffic on the sensor network, and supports network configuration and management. The gateway node collects sensor information. Visualizer node makes information visible based on the collected sensor data, and it offers the result to the user. User can change the drawing mode by adapting plugins. Next, uMegane is a system that offers 3D sensor visualized sensor information set up in the environment by using the AR technology. The users are not required to have neither specialized techniques nor complicated the operations. This system has a filtering function, and time machine function which shows past sensor data. However, because these systems only focus on making the sensor network visible, it is thought it is not useful when huge number sensors in the environment exist.

REFERENCES
3. Takuya Imaeda and Kazunori Takashio and Hideyuki Tokuda, uMegane: Visualization system of sensor data using AR technology,USN2008-17.