Chapter 5
The Event Search Engine

Takeshi Okadome
Kwansei Gakuin University, Japan

Koji Kamei
Advanced Telecommunications Research Institute International, Japan

Yasue Kishino
NTT Communication Science Laboratories, Japan

Yutaka Yanagisawa
NTT West, Japan

Takuya Maekawa
NTT Communication Science Laboratories, Japan

Yasushi Sakurai
NTT Communication Science Laboratories, Japan

ABSTRACT

In a remote or local environment in which a sensor network always collects data produced by sensors attached to physical objects, the engine presented here saves the data sent through the Internet and searches for data segments that correspond to real-world events by using natural language (NL) words in a query that are input in an web browser. The engine translates each query into a physical quantity representation searches for a sensor data segment that satisfies the representation, and sends back the event occurrence time, place, or related objects as a reply to the query to the remote or local environment in which the web browser displays them. The engine, which we expect to be one of the upcoming Internet services, exemplifies the concept of symbiosis that bridges the gaps between the real space and the digital space.

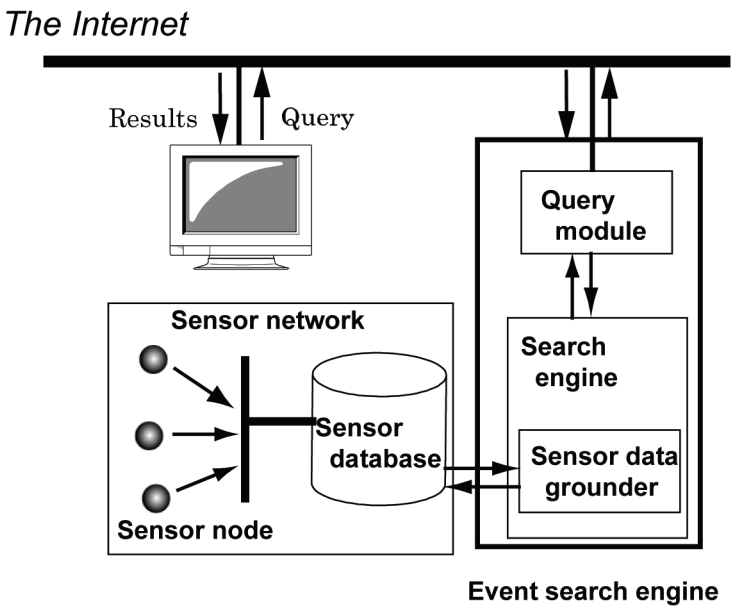
INTRODUCTION

Background

Many surveillance applications based on sensor networks monitor the physical world and detect events that occur in the world on the basis of sensor data. In the applications, events are named according to attributes that have scalar values or ranges of scalar values, such as temperature and light levels. These events, which are described by SQL-like languages (Madden et al., 2003; Bonnet, Gehrke, & Seshadri, 2000; Xue & Luo, 2005; Jiao, Son, & Stankovic, 2005; Li et al., 2002), depend on the value of a particular sensor reading. For example, Li et al. (2002) designed a distributed index that scalably supports multidimensional range queries such as "List all events that have temperatures between 50 and 60° C, and light levels between 10 and

DOI: 10.4018/978-1-4666-1743-8.ch005

Figure 1. The event search engine—overview



20 luces." The event descriptions given by the SQL-languages enable surveillance applications to provide services that are activated by the occurrence of certain events. The languages, however, describe only events that can be represented using values obtained from sensors. That is, the weak descriptive power of the languages shows us a typical gap between the real space and the digital space.

As with a Web search using Google, through the Internet, the engine presented here accepts a word set that denotes events that have occurred in the real world and facilitates a search of these events occurred in a remote or local environment. Instead of queries related to sensor reading values, the system embedded in the sensor-networked environment permits us to pose such queries as "drop," "door open," and "who hide book." Because the engine that can accept natural language words in a query provides us a natural interface between a man and a machine, it exemplifies the concept of symbiosis (Griffith & Greitzer, 2007) that can be expected to bridge the gap.

Overview of the Event Search Engine

Figure 1 shows an overview of this engine, which consists of two modules: a query module and a search engine that refers to the sensor data grounder. Assuming a remote or local environment in which a sensor network always collects data produced by sensors attached to physical objects, the engine saves the data sent through the Internet and returns information about an event that matches an intuitive interpretation of a set of NL words in a query. A web browser in the remote or local environment displays the returned information. Using a simple Google-like interface, users input queries in a word set that may contain a preposition and/or an adverb such as "drop," "what hide," "book move:horizontally," or "who drop vase on:2006.12.31." The engine returns the event occurrence time, place, or related objects as a reply to the query. Also it answers by, for example, displaying a video image recorded by video cameras.

Before describing the event search engine, the next section summarizes an event representation