# Intelligent Network Surveillance System based on Ontology

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***Abstract***: For the surveillance of the area consisting in an integrated framework of networked RFID sensors, CCTVs and smart cameras, we made wide area surveillance systems which provide collaborations between distributed agents having heterogeneous data from various sources. In our intelligent network surveillance system, each of agents has autonomy and collaborates and does reasoning based on distributed knowledge bases.

***Keywords***: Network surveillance system, Physical security, Agent, Context ontology**.**

## I. INTRODUCTION

This paper describes an on-going work aimed at designing and deploying a system for the surveillance and monitoring of province area containing about 15 cities. Our project is also aiming to be included in the construction of the ubiquitous city. We made the design of architecture for the surveillance of the area consisting in an integrated framework of networked RFID sensors, CCTVs and smart cameras. Wide area surveillance system should provide collaborations between distributed agents having heterogeneous data from various sources. We are developing an intelligent network surveillance system in which each of agents has autonomy and collaborates. Various data such as video, feature data including biometrics, event alarms are come from many kinds of input devices such as smart cameras, RFID sensors. They may be in fixed location or put on robot for some dangerous situation. Although agents are ordered by geographic area hierarchy, they have their own knowledge base and inference engine issuing queries independently.

## II. SYSTEM ARCHITECTURE

We have developed system architecture for deploying a network of agents that focus on collaboratively analyzing data came from various sources. This architecture includes that the execution of the elementary tasks are distributed and independently executed with a certain degree of autonomy and/or mobility. It views each of agents as a knowledge processing engine that is to be applied to process data and make some decision. The knowledge base architecture presented in Figure 1 has hierarchy according to administrative divisions. R represents the set of knowledge bases including facts, rules and context ontologies related to raw data extracted from the CCTV, Smart Camera and RFID. It includes ontology representing physical and logical raw entities and associations among them. $W_0$ through $W_n$ represents the set of knowledge bases including facts, rules and context ontologies related to wanted data covering from small area to large area.

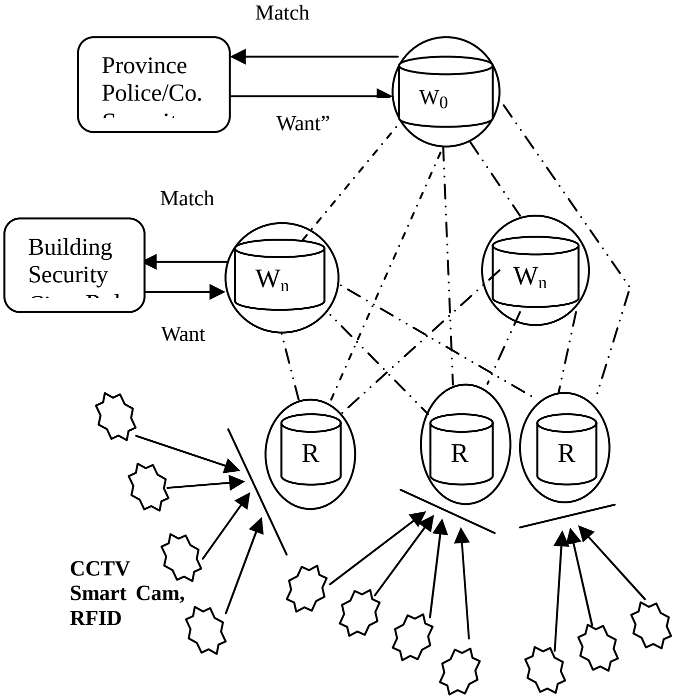


Fig.1. Knowledge base Architecture

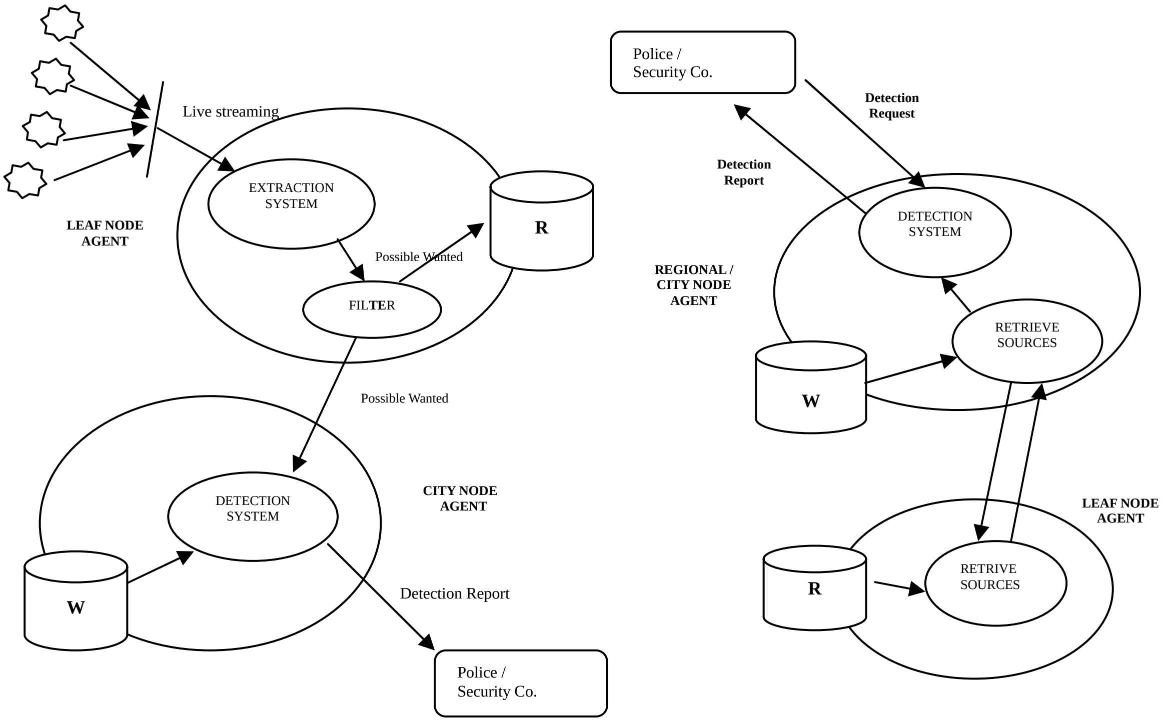
In our network surveillance system, many kinds of input devices are interconnected through Internet and their collected and/or recognized data form a web of surveillance data. We want to make agent's data representation which is not only human process-able but also machine process-able. We would like to extend the current wide area surveillance system to a web of data and allow for agents to exploit the data directly each other with complete independence to their administrative hierarchy. A web of data needs to be augmented for intelligent inference and activity decision by inquiring additional required data to any other agents through common APIs.

## III. KNOWLEDGE-BASED SURVEILLANCE

Making a complex decision is an essential task in networked surveillance systems. We show simplified application scenarios in Figure 2 for the cases detection during real time and detection by request. Extraction system, detection system and filter system make use of semantic information contained in the R and W knowledge base. For the collaboration between distributed agents, data should be uniquely identifiable and we should allow data to link to each other and classify the data to convey some meaning. Furthermore we should use standards for all these.

Semantic web is a collection of standard technologies to realize a web of data to be arranged, liked, classified and uniquely identifiable. Classification is achieved through ontologies and uniqueness is achieved through URIs. Our network surveillance application can be thought of semantic web. Building a semantic web application for network surveillance provides several advantages such as many distributed data sources, decentralized semi-structured images, knowledge base, distributed inference, open systems.

We build a knowledge base to elaborate an inference engine such that it will return different decisions for each different context intelligently. For making better and intelligent decisions we develop huge background data, rules, ontologies and structure them with an annotation label to the links. Inference engines make use of those data. Every search event return related data including still picture, video, feature data, event alarm that are ranked from top to bottom. Our system constructs area profile ontology for each agent by observing events occurrence in the area. For example some sound may indicate burglar alarm in some area. However the same sound might be a school bell in



(a) Detection during real-time (b) Detection by request

Fig.2.Application Scenarios

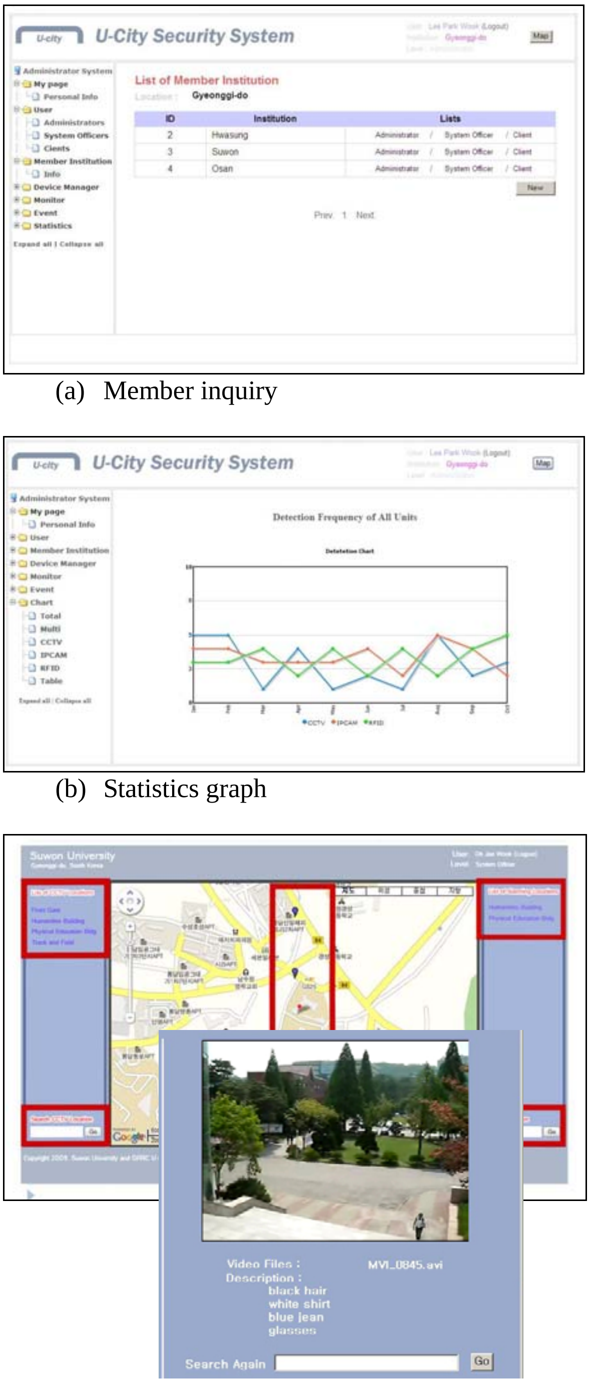
another area. Area profile ontology is further used for reordering query results. Although the training phase needs some set up cost, it helps the agents learn the behaviors in the area and for better inference results.

## IV. WEB INTERFACE

For the availability of small, power-aware, and high-performance camera nodes, amounts of available video data grow. However transmitting video data in affordable rate consumes large amounts of network bandwidth. Developing interactive systems for efficiently querying this data about specific events has become a significant need in surveillance. Such a system should be able to bridge the gap between the high-level users' queries and raw data within leaf node agents. This can be achieved by providing the powerful user interface for submitting queries, providing a mapping from the query into a set of filters that can utilize the feature data provided by other agents to infer high-level semantics, and then displaying the results in such a way the user can reformulate the further in-depth query and use the search results to foster new search inputs. We develop common APIs for each agent for standardized interface between agents and for the public web services. It forms an interactive system for querying surveillance data about events.

The surveillance system manager can control the state of the system via a graphical interface that shows an up-to-date, high-level representation of the system status. We can manage agents through a graphical user interface that supports the monitoring and deployment phases. The user authentication is performed and the configuration can be changed according to the privileges.

U-City Security System web interface has been Implemented and some example pages are shown in Figure 3. Figure 3 (a) shows member list. When we click a member it shows further information including location and privileges. Figure 3 (b) shows statistics graph representing trend and comparison visually. It also gives table with precise number data. In Figure 3 (c), it shows a regular user interface. On the top left side of the screen, the system officer can see the list of surveillance servers in its domain. By clicking specific item, live video from designated server can be seen in the popup window. On the bottom left side of the screen, the system officer can choose other surveillance area under the user access control. On the top right side of the screen, the system officer can see the list of alarming locations. By clicking some specific alarm, stored video or the real-time view of the site can be seen.



List of Member Institution

Location : Gyeonggi-do

| ID | Institution | Lists |
|---|---|---|
| 2 | Hwasung | Administrator / System Officer / Client |
| 3 | Suwon | Administrator / System Officer / Client |
| 4 | Osan | Administrator / System Officer / Client |

(a) Member inquiry

(b) Statistics graph

Video Files : MVI_0845.avi
Description :
black hair
white shirt
blue jean
glasses

(c) Location mapping and video inquiry

Fig.3. U-City Security System

Depend on the characteristics of the event we can see various types of result data. On the bottom right side of the screen, stored video can be searched through typed keywords. Through the center pop-up search form, we can elaborate the search options. Some of our ongoing work is provision of more customizable graphical user interface for specifying user-defined policies and distributed user access control using attribute certificates which is defined in PMI[9].

## V. RELATED WORKS

Networked surveillance systems can be used in many applications requiring images from multiple data sources to be combined in order to interpret the scene and understand the situation[1] such as disease surveillance[2]. For a wide area physical security surveillance, monitoring systems are connected and communicate [3,4,5]. However they do not adopt artificial intelligence technique. To ease the mergence between heterogeneous data, effort for the standardization for physical security is done by PSIA(Physical Security Interoperability Alliance) that defines, recommends, and promoting standards for IP-enabled security products[6]. There are few of surveillance systems adopting ontology-driven technologies. [7] introduces artificial intelligence techniques only for the interpretation of objects. [8] uses ontology but does not build agents for web of data.

## VI. CONCLUSION

In this paper we introduce for wide area security service we connect the regional surveillance systems utilizing the preprocessing of smart cameras and sensor systems. Local region servers act as an intelligent agents doing more intelligent induction with more knowledge. Knowledge base includes facts, rules and context ontologies. Analysis for large areas generally requires combining information from several data source agents or other several region agents. The synergy between the agents allows obtaining more high level, enhanced and intelligent decision.

Our goal is building cooperative intelligent agents. Multi-agent systems have proven to be a powerful technology for building distributed applications. We see our system making a complex decision which is an essential task in networked surveillance systems.

## ACKNOWLEDGEMENT

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