Cooperative ONVIF Camera Network for Integrated Context Reasoning

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***Abstract*—**For the sophisticated wide area surveillance, many collaborating distributed smart cameras are required. We combine several smart cameras together to cover larger space and solve higher level problems through integrated context reasoning. For the ease of interoperability we use ONVIF[1] camera and follow the recommendations in the standard. From the raw data of ONVIF camera, we draw ontology for the inference engine. Local recognized and inferred data is sent between related smart cameras for higher level reasoning helping security person. Furthermore we implemented mobile user interface for the efficient accessibility and functions.

***Keywords*—**Camera network, ONVIF, Context reasoning, Ontology

I. Introduction

FOR the sophisticated wide area surveillance, many collaborating distributed smart cameras are required[2,3]. To provide network interworking, all the smart cameras which are included in our surveillance system are equipped to follow ONVIF standard.

Each camera has agent backend for local context reasoning. In addition, for higher level intelligent reasoning, each agent communicates with other cameras for event information, feature data of recognized object, etc. During the integrated inference, they can request data needed in inference, from multiple cameras.

In this paper, we explain the techniques in the whole procedure as shown in Fig. 1.

II. Procedure for ONVIF Camera Cooperation

A. Raw Data Acquisition

Basic recognition functions are built in ONVIF camera. It tracks person and gives us the values of pan, tilt, zoom. ONVIF camera can store recognized data such as values of pan, tilt, zoom to their RDB(Relational Database).We also can store the related facts such as timestamp, images or videos into its local RDB.

B. RDB to RDF Transformation

For the expandability, each agent which is connected with each smart camera, use ontology. For ontology inference, RDB should be transformed to RDF(Resource Description Framework) or other ontology language. We use D2RQ RDFizer[4] converter which transform RDB data to RDF form. It generates properties automatically as shown in Fig. 2. We can post-process and elaborate it using libraries based on SPARQL(SPARQL Protocol and RDF Query Language)[5].

C. Ontology Inference

We use apache Jena and TopBraid[6] SPIN library for the ontology inference rule engine. SPIN is based on Jena and SPARQL RDF query language. It provides the efficient expression method for defining constraints and new functions. It is mainly used for the specification and running of rule.

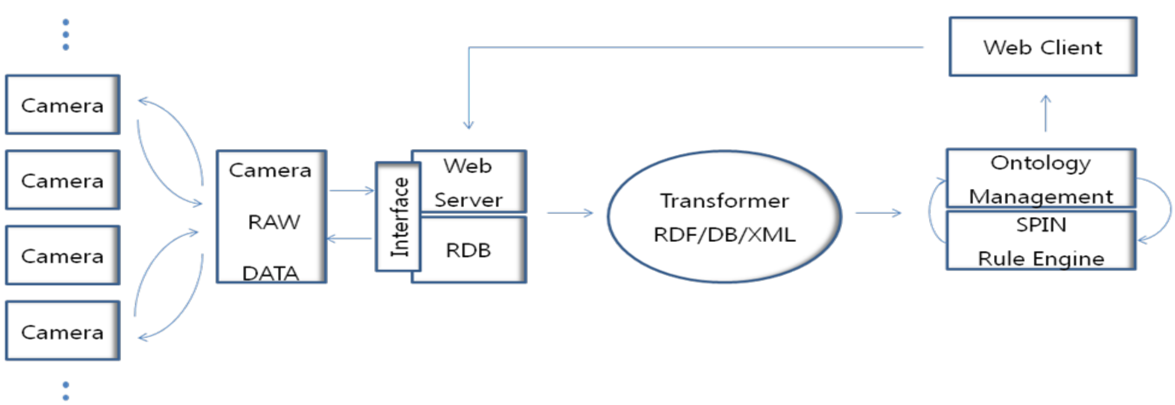

Fig. 1 Inference Scenario in smart camera

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Top Braid Composer includes Google API for geography. It makes it easy for determination of location of object or surveillance area, latitude and longitude. The location information is merged to PTZ(pan, tilt, zoom) values and helps better context reasoning.

D.Communication and Caching

For the wide area surveillance, each camera sends and receives information for the high level integrated context reasoning, according to the ONVIF specification. ONVIF also recommends security issues. We follow the message level security recommendation. Some inference rules require images or videos from multiple cameras to be combined in order to interpret the scene and understand the situation in addition to extracted recognized feature data. Transmitting multimedia data is very expensive and is not scalable. Therefore we build a hierarchical cache structure based on regional hierarchy to improve network bandwidth utilization.

E. User Interface

Built-in interface of smart cameras provides restricted user interface for the viewing and recording videos and tuning the camera configuration. We implement mobile interface, which enhances user accessibility and utilizes the functions of smart phones. It helps security person and general users prompt recognition and response.

III. Conclusion

In this paper, we briefly explain the techniques and scenario for cooperative context reasoning. It consists of several numbers of steps in a procedure to accomplish cooperative wide area surveillance. It includes many controversial issues and we need to evaluate the tradeoffs in the future work. We are plan to develop the adoptive and autonomous surveillance system which does not require lots of monitoring and intervening person.

Acknowledgment

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References

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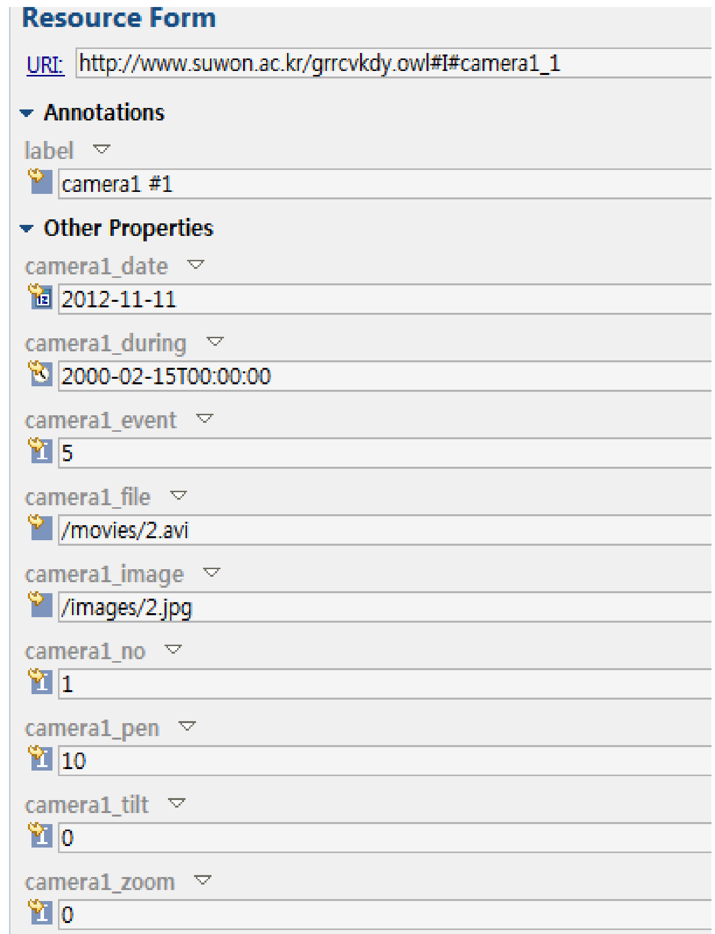
[3] B. Dieber, B. Rinner, and N. Viertl, Flexible Clustering in Networks of Smart Cameras, Proceedings of the IEEE 12th International Conference on Computer Vision Workshops, pp. 834-839, 2009
[4] http://d2rq.org
[5] http://www.w3.org/TR/rdf-sparql-query/
[6] http://www.topquadrant.com/topbraid/

(a) *Example list of result files*



(b) *Example of camera properties*

Fig. 2 Conversion results of D2RQ RDFizer