Surveillance Data Deployment Scheme for Cooperative Inference based on Ontology in Wide Area Surveillance

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Abstract. In this paper we describe a methodology to support the modeling and deployment of surveillance data for cooperative inference in wide area surveillance on the smart camera networks. Advanced smart cameras have the ability to detect motion and track objects. Some experimental smart cameras can identify objects and extract features. Recognized features if properly structured and annotated, can be a useful source of information. This work builds a hierarchical inference data deployment structure and import related and required data to annotate rich data arriving from multiple smart cameras. Proactive deployment provides efficiency to model hierarchical area ontology. We define management policies to compare their performance for the wide area surveillance.

Keywords: Wide Area Surveillance Systems, Multimedia Data, Context Inference, Cooperative Smart Camera Network.

1 Introduction

For the surveillance of the wide area, agents built in networked sensors and smart cameras should collaborate through integration of recognized information[1,2]. Recognized Information includes facial features, type of objects, environmental context and others. Distributed agents receiving heterogeneous data from various sources have autonomy and infer knowledge based on its ontology. For the continuous, higher level reasoning they collaborate with each other based on distributed global ontology. In this paper, we present a framework for the integration of knowledge supplied by a set of agents which are built in smart camera nodes. Distributed and autonomous reasoning is scalable and efficient[3]. It helps security persons by giving appropriate decision or prediction based on huge ontology about situation it gathers.

For the efficient higher level reasoning such as continuous tracking over different regions, we propose a proactive deployment between agents for efficiency and interoperability. Implementation is going on into our distributed surveillance network environment.

The rest of the paper is organized as follows: Section 2 explains our proposed framework. In Section 3, simulation and performance results are presented. We also show our implementation results in progress. Finally, Section 4 concludes with an outline of our future work.

2 Adaptive Surveillance Data Deployment

We design and deploy a system for a wide area surveillance covering Gyeonggi province area containing about 10 cities which can be extended to nation-wide surveillance. The design of architecture for the surveillance of the area consists of an integrated framework of networked sensors and smart cameras. Various data, such as video, feature data including biometrics, event alarms, originate from many kinds of input devices. The surveillance device's purpose is not only to take pictures, record videos and log location data, but also to analyze a scene and report items and activities of interest to the user. Also it is required to take decisions and actions based on prediction by ontology reasoning.

2.1 Proposed System Framework

Cooperative inference such as object tracking requires the cooperation among local agents. The wide area surveillance structure is modeled as a hierarchy of agents. The lowest level server extract surveillance data such as facial features, type of object from raw image or video in their domain. Further low level context reasoning based on local ontology can be done at the leaf node agent.

With a surveillance data distribution, even small agents, with the help of origin agents, can achieve very high hit rate locally, thus reducing significantly the bandwidth requirements of the network connection and the latency perceived by the users. This paper assumes a proactive, rather than reactive, deployment and attempts to explore an optimal surveillance data management strategy and service policy. The system performances like hit rate, disk space, bandwidth gain of the agents, bandwidth for the surveillance network, and latency experienced by the users are derived.

2.2 Data Deployment Mechanism

The image and the vision obtained by each camera depend on its position and orientation. Therefore they are different from those of other cameras observing the same scene. The agents need to carry out the indexing and retrieval of the information distributed across the servers in an efficient manner. To aid the task, we could use a data structure containing only the information related to the requested objects.

In the hierarchical surveillance network structure, agents cooperate with each other in such a way that the request not satisfied at the same level is forwarded to a higher level in the structure hierarchy until it satisfied. With the proactive data deployment, the origin agent broadcasts the data to the neighbor agents before any neighbor agent requests them to fetch data from the higher level agent having related knowledge base. The proactive deployment should accommodate the velocity of the target. The movement of the target can be modeled from the fluid flow model [4] and the forwarding of surveillance data can be operated across national boundaries.

We specify some characteristics of the deployment of surveillance data and present analytical models for evaluating the system performances. We calculate the probability of the each target from the Zipf distribution[5].

3 Performance Evaluation and Implementation

For the performance evaluation we do simulation and implementation. In the simulation for each event probability and network reliability, we inspect the effects to the average packet transmission.

We are implementing our cooperative surveillance data deployment scheme for combined inference by integrating knowledge. Ontology includes the environmental description for the context reasoning and it helps the location based service.

For the practical use we develop various user interfaces. Web-based rich user interface lists biometric data recognized and shows google map with marks for peculiar events. Mobile user interface is implemented for the user’s convenience. We also build the local console for windows 7 and linux.

4 Conclusion

We describe the surveillance data deployment guidelines for better context inference based on distributed ontology framework. Agents communicate each other freely within access control permission to perform their own intelligent distributed inference based on their own ontology knowledge base. Agents not only can get services from regional agents, but also they can consult the higher level agents. In this paper, we propose a flexible deployment scheme which is adaptive to the actual demands and that of its neighbors. Our scheme uses conformity to update and share data in a cooperative way. During the simulation and implementation, our scheme shows the efficiency of surveillance data deployment resulted in better context inference.

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