The Survey of Big Data Problems in the Video Surveillance System

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Abstract: Video surveillance has become the main tool due to its rich, intuitive and accurate information. However, with the large-scale construction of video surveillance systems all over the world, problems such as "useful information and clues cannot be found immediately with video big data" decrease detecting efficiency during crime prediction and public security governance. This paper examines the current techniques including video intelligent analysis and video structured description (VSD), knowledge discovery in database, and cloud computing including virtualization, distributed computing and storage, and proposes a framework of the next generation video surveillance system to explain how to discovery knowledge from video big data, organize and manage massive heterogeneous resources, and provide operating environment and resources for tasks, for the purpose of supporting police to predict crime quickly and efficiently.

1 INTRODUCTION

Recently, the worldwide terrorist incidents and crime events occur frequently, and it is urgent for governments and police to pay serious attention to the public security governance, the traffic accidents, criminal prediction and other incidents. With the help of cloud computing (Liu et al., 2010; Liu et al., 2011), internet of things (Hu et al., 2014; Luo et al., 2011), and Big Data (Xu et al., 2014; Xu et al., 2015), video surveillance has become the main tool due to its rich, intuitive and accurate information. A great amount of video surveillance systems have been built all over the world. China has built more than 23 million video surveillance cameras till 2013, of which 3 million are utilized by police, and the video surveillance are entering the big data era with its 4V properties. That is, the video data has very huge volume, taking one city for example, thousands of cameras are built of which each collects high-definition video over 24 to 48GB every day with the rapidly growth; secondly, data collected includes variety of formats involving multimedia, images and other unstructured data; furthermore the valuable information contains in only a few frames called key frames of massive video data; and the last problem caused is how to improve the processing velocity of a large amount of original video with computers, so as to enhance the crime prediction and detection effectiveness of police and users.

To solve those problems, technologies such as knowledge mining and deduction, pattern recognition and cloud computing are widely utilized in the next generation video surveillance system, to assist police to discover valuable information and predict crime from large amount data. China National Laboratory of Pattern Recognition (NLPR) has developed the distributed video surveillance system (Zh et al., 2012), which is applied to discover unusual behaviour and traffic violations with pattern recognition. The Industrial Technology Research Institute of Taiwan set up the Surveillance Video Analysis Center and built the " Cloud Intelligent Video Analysis and Retrieval System", which provides video retrieval and other video analysis services to aid police to discover crime efficiently. Pacific Northwest National Laboratory (PNNL) founded National Visualization and visual analysis techniques and tools Analytics Center (NVAC) providing sorts of video analysis tools (http://vis.pnnl.gov/). British ADVISOR project (Annotated Digital Video for Intelligent Surveillance and Optimized Retrieval) could estimate crowd density, analyse human behaviour in and around subway and predict potential danger and crime early. IBM has developed a "Smart Vision Suite" with the ability of automatic event detection, and distributed technology is used to large-scale system deployment and internet business.

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Based on the research above, this paper proposes a framework including video intelligent analysis and video structured description (VSD) (Zh et al., 2010), knowledge discovery in database, and cloud computing, and discusses how to analyse, organize, manage and store video big data. The rest of the paper is arranged as follows. Section 2 introduces the problems. The architecture is detailed in section 3. In section 4, recent work and research are given. In the end, some conclusions are drawn and future work is given in section 5.

2 PROBLEMS DESCRIPTION

Surveillance video data has the 4V properties of big volume, variety of data format, low value and slow processing velocity, resulting in several problems in application especially in crime detection and public security management for police:

(1) Little video analysis technology is utilized to recognize vehicle information (license-plate, logo, and colour etc.) and simple applications, however crime prediction and clue discovery from massive video data are most rely on human detection, and it is still hard to discover deep information and complex content by computers, also lack of the standardized description of analysed content.

(2) Due to lack of effective resource management and organization, a great amount of computing and storage resources could not be utilized effectively when analyse and process video big data.

(3) Without the policing repository database, it is hard to mine the more complex relationship and deeper semantics from a great amount of data, also unnecessary to recommend police available information, clues, case trend.

3 FRAMEWORK FOR THE NEXT GENERATION VIDEO SURVEILLANCE SYSTEM

We propose a new framework to show how to process, organize, manage and store massive video data. As shown in Fig.1.

The framework has three parts: video intelligent analysis (Object detection, target tracking, behaviour analysis and event analysis) and video structured description (VSD) are utilized to mine valuable information (persons, cars, unusual behaviours etc.) from large scale video data, which then is expressed in standard format. The second part is construction of policing repository database, which is used to data mining, information describing, moreover knowledge reasoning as the domain knowledge, and provide real cases to assist crime prediction. Furthermore virtualization and cloud computing provide efficient computing environment for techniques all above, and storage environment for various types of structured and unstructured data.

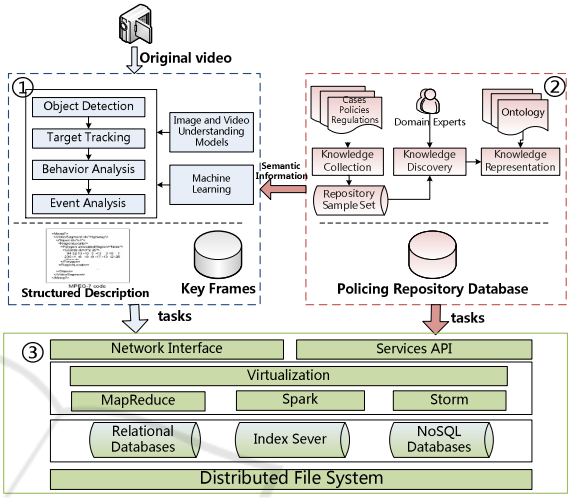

Figure 1: The framework for the next generation video surveillance system.

3.1 Video Intelligent Analysis and Video Structured Description (VSD)

Video intelligent analysis and structured description are applied to deal with original video, of which the results are frames containing persons and cars, and their structured description with standard format.

All the data are packaged with unified standard format and transferred to the distributed cloud platform which provides greatly efficient storing and computing ability. Due to the limited bandwidth, the "front + back" pattern is adopted, that is: simple video analysis algorithms are carried out in the cameras, and results are sent back to "the cloud" to support more complex computing and applications. The pattern could avoid network congestion caused by large-scale video big data.

3.2 Repository Database Construction

Repository database could be constructed as follow steps: first, knowledge collection, that is collecting and analyzing existed cases, policies and regulations, and make them as knowledge repository

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sample set; secondly is knowledge discovery, that domain knowledge are mined, clustered and analyzed from the collected cases and rules, with machine learning such as support vector machines (SVM), or expert guidance; thirdly, knowledge representation, domain knowledge and rules should be represented with unified form such as RDFS, OWL and SWRL , and stored in repository database and model database, from which the information would be utilized to support training models, semantic retrieval, reasoning and crime prediction.

3.3 Virtualization, Distributed Computing and Storage Technology

For types of tasks such as video content analysis, semantic modeling and reasoning, Mapreduce, Spark, Storm and other distributed processing model are applied to deal with corresponding task. Take video retrieval for example, Mapreduce would be used to support the task, of which the key is represented by the time in video, and video data are divided into several parts by the key, then all tasks execute simultaneously.

Moreover, to enhance the efficiency of data storage, the structured description data, images and video data during video analyzing, processing, and retrieval would be classified to optimize the storage management and satisfy a variety of requests for the end-users.

Virtualization is adopted to support IT resource consolidation and optimum use.

4 PREVIOUS WORK

During 2008-2009, the third research institute of Ministry of Public Security introduced video structured description technology for the demand in video surveillance applications, and undertakes a series national science and technology major projects including the Ministry of National Science and Technology Support project, 863 smart city project and the Core Electronic Devices, High-end Generic Chips and Basic Software project. Numbers of public security intelligent video surveillance systems are carried out successfully, including VSD based road surveillance video retrieval system in Shuangliu in Chengdu, Taicang in Jiangsu Province and so on.

5 CONCLUSIONS

In this paper, we propose a novel framework for the next generation video surveillance system, which addresses the problems video big data cause during public security governance and crime predicting. In this framework, Video intelligent analysis and video structured description (VSD), knowledge discovery in database, and cloud computing are introduced, and video intelligent analysis and VSD discover targets and express them with standard format. Knowledge discovery is utilized to repository database construction, since the repository is the “material basis” of domain and supports models training, semantic retrieval, crime prediction and reasoning. Cloud computing techniques such as Virtualization, distributed computing and storage technology provide efficient operating environment, and optimize the allocation of computing, storage and network resources for tasks.

The above techniques provide the basic tools and environment from the point of video big data mining, organization, and management. However, some other problems still exist: it still cannot satisfy the routine detection and application for police. For example, combining crime prediction results with visualization methods is necessary for users during detection. These unsolved problems particularly merit our further study.

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REFERENCES

Liu,Y., Zhu,Y., Ni, Lionel M., and Xue, G. 2011. A Reliability-Oriented Transmission Service in Wireless Sensor Networks. *IEEE Transactions on Parallel and Distributed Systems*, 22(12): 2100-2107.

Liu, Y., Zhang, Q., and Ni, Lionel M. 2010. Opportunity-Based Topology Control in Wireless Sensor Networks. *IEEE Transactions on Parallel and Distributed Systems*, 21(3): 405-416.

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Hu, C., Xu, Z. et al. 2014. Semantic Link Network based Model for Organizing Multimedia Big Data. *IEEE Transactions on Emerging Topics in Computing*, 2(3):376-387.

Luo, X., Xu, Z., Yu, J., and Chen, X. 2011. Building Association Link Network for Semantic Link on Web Resources. *IEEE transactions on automation science and engineering*, 8(3):482-494.

Xu, Z. et al. 2015. Knowle: a Semantic Link Network based System for Organizing Large Scale Online News Events. *Future Generation Computer Systems*, 43-44:40-50.

Xu, Z., Luo, X., Zhang, S., Wei, X., Mei, L., and Hu, C. 2014. Mining Temporal Explicit and Implicit Semantic Relations between Entities using Web Search Engines. *Future Generation Computer Systems*, 37:468-477.

Zh, H., et al. 2010. Video Structured Description: A Novel Solution for Visual Surveillance. *Lecture Notes in Computer Science, Volume* 6298:629-636.

Zh, T., Liu, S., Xu, C., Lu, H. 2012. Mining Semantic Context Information for Intelligent Video Surveillance of Traffic Scenes Industrial Informatics. *IEEE Transactions on Volume:9 , Issue: 1* :149 – 160.

http://vis.pnnl.gov/ .

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