Towards smarter cities: Learning from Internet of Multimedia Things-generated big data

Editorial

Towards Smarter Cities: Learning from Internet of Multimedia Things-Generated Big Data

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Abstract: In today's technological era, smart devices connected through the IoT and giant IoT infrastructures are playing a vital role in making daily life easier and simpler than it ever was. Numerous sensors including IoT-interconnected multimedia sensors communicating with each other generate a huge amount of data. In particular, IoT multimedia sensors play a vital role for green cities, providing secure and efficient analytics to monitor routine activities. Big data generated by these sensors contain dense information that needs to be processed for various applications such as summarization, security, and privacy. The heterogeneity and complexity of video data is the biggest hurdle and a pretty number of techniques are already developed for the efficient processing of big video data. IoT big data processing is an emerging field and many researchers are enthusiastic to contribute in making the cities smarter. Among all these methods, deep learning-based techniques are dominant over existing traditional multimedia data processing algorithms with convincing results emerged recently. This special issue targets the current problems in smart cities development and provides future challenges in this domain and invite researchers working in IoT domain to make cities smarter. It also focuses on some related technologies comprising Internet of Multimedia Things (IoMTs) and machine learning for big data. Furthermore, it covers deep learning-based solutions for real-time data processing, learning from big data, distributed learning paradigms with embedded processing, and efficient inference.

1. Introduction

Smart city's IoT-based infrastructures envision improvement in quality of life through optimal utilization of resources. Integrating diverse sensors through communication technologies generate big data which is collected, processed, and analyzed, revealing knowledge and information to realize the goals of smart cities. Multimedia sensors serve as the mainstay for city administrators, enabling them to monitor activities and assets. The big multimedia data generated by these sensors contain a wealth of information, needed to be processed and analyzed for knowledge extraction [1]. However, the huge volume of this data and its inherent complexity hinders ability of traditional computing infrastructures and algorithms to effectively process and extract actionable intelligence from it. There is a growing demand for efficient yet powerful algorithms to consume Internet of

Multimedia Things (IoMT)-generated big data and extract needed information from it to run the affairs of smart cities.

Deep learning based methods for multimedia data processing and understanding has shown great promise in the recent years [2]. This special issue aims to highlight problems and future challenges in smart cities and provide a highly recognized international forum to presenting recent advances in technologies like IoMTs, machine learning for big data, and embedded/cloud computing, to develop novel methods for addressing issues related to the transmission, processing, representation, and storage of IoMT-generated big data. It also intended to provide novel deep learning based solutions for real-time data processing, learning from multi-modal big data, distributed learning paradigms with embedded processing, and efficient inference. Papers were invited for this special issue considering aspects of mentioned problem, including:

- Data collection and storage for deep learning in smart cities
- Supervised, semi-supervised, and unsupervised feature learning from IoMT big data
- Scalable and semantics-driven indexing of big multimedia data in smart cities
- Context-based summarization and abstraction of IoMT big data
- Online stream processing of IoMT big data for smarter cities applications
- Efficient and scalable inference of IoMT-oriented deep models
- Real-time vision through efficient deep convolutional neural networks (CNN)
- Optimizing deep CNNs for embedded vision in smart cities
- Utilizing embedded processing for ingesting big multimedia data in IoMT sensor networks
- Physical cyber systems related solutions for big data security and privacy in smart cities
- Smarter surveillance
- Real-time emergency detection through visual analytics and response invocation
- Information hiding solutions (steganography, watermarking) in smart cities

2. Content of This Special Issue

After a rigorous peer review process, eleven papers were selected, covering a wide range of topics including smart eHealth, security, automation, traffic network management, and vision.

The first paper “Incomplete data classification—Fisher Discriminant Ratios versus Welch Discriminant Ratios” by Chen [3] focused on incomplete data classification with the support of different partial discriminant analyses. Their study handled the limitation of Principal Component Analysis and Fisher Discriminant Analysis which are inapplicable when samples contain missing values and discriminant analyses. Their study examines various partial discriminant ratios to discover effective approaches for relieving such a problem by considering different variance in computation.

The second paper “Accelerating smart eHealth services execution at the fog computing infrastructure” by Marisol et al. [4] utilized the capacities of current processors and fog computing to improve the servicing of remote patient nodes. Their proposal presents the design and validation of a framework that improves the service time of selected activities at the fog servers; precisely, of those activities requested by remote patients. It exploits the capacities of current processors to

parallelize specific activities that can be run on reserved cores, and it relies on the quality of service guarantees of data distribution platforms to improve communication and response times to mobile patients. Their proposed approach is validated on a prototype implementation of simulated computationally-intensive eHealth interactions, decreasing the response time by 4x when core reservation is activated.

The third paper "Security, Privacy and Trust of different Layers in Internet-of-things (IoTs) Framework" by Tewari et al. [5] focuses on the security problems in IoT. As IoT is built on the basis of the Internet, security problems of the Internet will also show up in IoT. Moreover, as IoT contains three layers: perception layer, transportation layer, and application layer, their proposal analyzes the security problems of each layer separately and try to find new problems and solutions. Furthermore, they also analyzed the cross-layer heterogeneous integration issues and security issues in detail and discusses the security issues of IoT as a whole and tries to find solutions to them.

The fourth paper "A Unified Framework for Big data Acquisition, Storage and Analytics for Demand Response Management in Smart Cities" by Jindal et al. [6], presented a tensor-based big data management technique to reduce the dimensionality of data gathered from the Internet-of-Energy (IoE) environment in a smart city. The core data is extracted out of the gathered data by using tensor operations such as matricization, vectorization, and tensorization with the help of higher-order singular value decomposition. This core data is then stored on the cloud in the reduced form. After reducing the dimensionality of data, it is used for providing many services in smart cities; and its application to provide demand response (DR).

The fifth paper "Electronic Health Record hiding in Images for smart city applications: A computationally efficient and reversible information hiding technique for secure communication" by Parah et al. [7] proposes a high capacity, secure and computationally efficient Electronic Health Record (EHR) hiding technique in medical images in an Internet of Things (IoT) driven healthcare. Their scheme is based on Pixel Repetition Method (PRM) and modular arithmetic. Pixel Repetition Method scales up the input medical image for cover image generation and modular arithmetic embeds the secret EHR into the scaled-up images. Further, the usage of PRM for cover image generation has been found to be highly efficient from computational point of view compared to state-of-the-art in the area and hence is best suited for the exchange of Electronic Health Records (EHR) in an IoT based healthcare system for smart city applications.

The sixth paper "Smart Building Creation in Large Scale HVAC Environments through Automated Fault Detection and Diagnosis" by Dey et al. [8] describes a method to detect faulty Heating, Ventilation and Air-Conditioning (HVAC) Terminal Unit (TU) and diagnose them in an automatic and remote manner in Building Energy Management Systems (BEMS). For this purpose, a typical big-data framework is constructed to process the very large volume of data in this work. A novel feature extraction method encouraged by Proportional Integral Derivative (PID) controller is also proposed to describe events from multidimensional TU data streams. These features are further used to categorize different TU behaviours using unsupervised data-driven strategy and supervised learning is applied to diagnose faults. X-Means clustering is performed to group diverse TU behaviours which are experimented on daily, weekly, monthly and randomly selected dataset.

Subsequently, Multi-Class Support Vector Machine (MC-SVM) is employed based on categorical information to generate an automated fault detection and diagnosis system towards making the building smarter.

The seventh paper "Dimensionality Reduction via Preserving Local Information" by Wang et al. [9] addressed the problem of dimensionality reduction. For this purpose, they presented an effective and efficient metric function, named local similarity preserving (LSP), which can preserve the similarity information of each sample to its homogeneous and heterogeneous neighbors. Their proposed LSP function is helpful to enhance the discriminative capability of subsequent feature extractors. Based on LSP function, they also proposed two novel algorithms, local similarity preserving discriminant (LSPD) algorithm, which can preserve the local similarity information and LSPD algorithm, which can preserve the local similarity and geometric structure information, respectively.

The eighth paper "Optimization of Real-Time Traffic Network Assignment Based on IoT Data Using DBN and Clustering Model in Smart City" by Yang et al. [10] analyzed the processing center's economic indexes and optimized the dynamic transportation network assignment based on continuous big IoT input database, and a high performance computing model is proposed for the dynamic traffic planning. Specifically, while the previous methods exploited the geographical information system (GIS) or K-means separately, the proposed transportation planning is based on the real-time IoT and GIS data, which is processed by DBN and K-means to make the final solution close to the practice and meet the requirements of high performance computing and economic cost, which is regarded as the key target index. Moreover, considering the large data characteristic of real-time online stream, the deep belief network (DBN) model is built to preprocess the data to improve the clustering effect of the -means.

The ninth paper "Flexible Mesh Morphing in Sustainable Design Using Data Mining and Mesh Subdivision" by Gao et al. [11] categorizes the morphing situations into two different classes: algebraic morphine and the free-form morphing. Algebraic morphing patterns in this paper are developed that can be adopted independently or integrated together with complete complicated morphing operation. On the other hand, the free-form morphing control points are obtained through data mining on which mesh subdivision is applied to refine surfaces smoothly. To prove the better results of the system, authors applied it to a truss core panel and a human head model, that clarifies the robust function and high efficiency of their system to deal with complex 3D product model sustainable optimization.

The tenth paper "Kinesiology-inspired Estimation of Pedestrian Walk Direction for Smart Surveillance" by Raman et al. [12] proposed a novel approach for estimating the walk direction of a pedestrian in video data. They performed kinesiology-based study for exploiting the intra-frame features for orientation estimation and lower body kinematics of sagittal plane is identified to be the most suitable choice for feature. They have utilized Least Square Support Vector Machine (LS-SVM) for finding orientation per frame and score-level fusion of estimated results from both features using a rule-based look-up table, producing the ultimate estimate for walk direction.

The eleventh paper “Raspberry Pi Assisted Face Recognition Framework for Enhanced Law-Enforcement Services in Smart Cities” by Sajjad et al. [13] proposed Raspberry Pi and cloud assisted face recognition framework. Their proposal can assist law enforcement agencies in identifying suspects or finding missing persons. They utilized Bag of Words for the extraction of oriented FAST and rotated BRIEF points from the detected face, followed by support vector machine for identification of suspects. Raspberry Pi has limited resources such as storage space, memory, and processing power, and therefore the presented classifier is stored and trained on the cloud.

3. Conclusion

The emerging trends in IoT and the advancements in communication technologies help in making the cities smart by leaps and bounds. These technologies have overwhelmed the traditional networks and methods applied over various sensors. The big multimedia data in IoT is the main problem of the researcher’s concern. Many researchers have proposed solutions to utilize big data for various useful purposes to make cities smarter. This special issue focused on such techniques that exploit big data in smart cities for various applications. Some researchers aimed at accelerating smart eHealth services, security and privacy in IoT, Big data analytics etc. These new proposals related to security and law enforcement service could be a good asset in improving the cities in a positive manner. It is expected that such techniques would play a key role in advancing the cities and improving daily life, making everything easily accessible.

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