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Editorial: Smart Societies, Infrastructure, Systems, Technologies, and Applications

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Editorial

Smart cities provide state-of-the-art approaches for urbanization, having evolved from the developments carried out under the umbrella of the knowledge-based economy, and subsequently under the notion of the digital economy and intelligent economy [1]. Smart cities encompass all aspects of modern-day life, transportation, healthcare, entertainment, work, businesses, social interactions, and governance. Smart cities exploit physical and digital infrastructure, as well as intellectual and social capital, for urban and social development. Technically, smart cities are complex systems of systems that rely on converged and ubiquitous infrastructures. The smart city phenomenon is driven by several interdependent trends including a pressing need for social, environmental, and economic sustainability, and peoples' increasing demands for personalization, mobility, and higher quality of life.

The notion of smart cities can be extended to smart societies; i.e. digitally-enabled, knowledge-based societies, aware of and working towards social, environmental, and economic sustainability [1]. Since knowledge and human and social capital are at the heart of the smart city and smart society developments, the role of education should extend beyond the mainstream "education for employment" scope. It should extend to the notion of social and collaborative governance where the society collaborates to train each other in maintaining its knowledge, moral fibre, operations, good practice, resilience, competitiveness, and bringing innovation and becoming a knowledge-based economy [1]. The key to such efforts would be the creation of an ecosystem of digital infrastructures that are able to work together and enable dynamic real-time interactions between various smart city subsystems [1, 2].

This special issue is a follow up from SCITA 2017, the first EAI (European Alliance for Innovation) Conference on Smart Societies, Infrastructure, Technologies and Applications, held at King Abdulaziz University (KAU), Jeddah, Saudi Arabia, 27th to 29th November 2017 (http://scita.org/2017/; see [3] for the conference proceedings, and [4] for extended research on the topics) . The aim of the conference and this special issue was to invite articles that present robust and innovative approaches towards smarter societies research and development. We named the conference "scita" which means "the sum of all the political, economic, technological, scientific, military, geographical, and psychological knowledge of the masses and of their representatives", and in accordance with this name, the scope of the call for papers and submissions was broad. We invited submissions with topics related to five broad themes: smarter society applications (e.g. healthcare, mobility); smart infrastructure (distributed systems, HPC, big data, etc.), social capital development and eGovernance, innovation & entrepreneurship, and crosscutting themes. The SCITA conference proceedings [3] were structured in themes including infrastructure, eGovernance & transportation, healthcare, and applications. The extended research book on SCITA was structured in themes including smart transportation, smart healthcare, smart applications, big data and high performance computing, and the Internet of Things (IoT).

This special issue is being published at an important time when so much is happening in smart cities and societies

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space. Many new smart districts and cities are being built around the world while many existing cities such as New York, Singapore, Helsinki, and Seoul are evolving or transforming into smart cities. These initiatives include, among many others, the NEOM smart city being built in Saudi Arabia supported by $500 billion from the Saudi government. This special issue will contribute to and shape these smart developments in Saudi Arabia and globally.

Road transportation is the backbone of modern economies, although annually costing 1.25 million deaths and 50 million human injuries globally. Moreover, traffic congestion is among the leading problems in modern cities with concerns including the cost of congestion (for the US alone the cost is $305 billion). We accepted three high-quality contributions on this important topic of smart transportation. The first article is from Alomari et al. [5] who propose Iktishaf, developed over Apache Spark, a big data tool for traffic-related event detection from Twitter data in Saudi Arabia. The aggravating traffic on the roads, bad weather, roadworks, and other uncertainties cause congestion, accidents, and other damages to public health. These causes (events) must be detected to support timely interventions for traffic planning and operations and the reduction of adverse effects on public health and resources. Iktishaf uses machine learning (ML) algorithms to build multiple classifiers to detect eight event types. The tool detects multiple events, fires, rains, inauguration, and celebration events causing traffic congestion. In the second article in smart transportation, Balsa-Barreiro et al. [6] propose a methodology for extracting driving patterns from naturalistic driving data, even from small population samples. They use Geographic Information Systems (GIS), so they can evaluate drivers' behavior and reactions to certain events or road sections, and compare across situations using different spatial scales. A better understanding of driving patterns and their relationship with geographical driving areas could bring great benefits to smart cities, including the identification of good driving practices for saving fuel and reducing carbon emissions and accidents. The process of extracting driving patterns can be challenging due to issues such as the collection of valid data, clustering of population groups, and definition of similar behaviors. Naturalistic Driving methods provide a solution by allowing the collection of exhaustive datasets in quantitative and qualitative terms. However, exploiting and analyzing these datasets is complex and resource-intensive. Moreover, most of the previous studies, have constrained the great potential of naturalistic driving datasets to very specific situations, events, and/or road sections. To this end, the authors analyze some kinematic parameters such as speeds, acceleration, braking, and other forces that define a driving attitude. Their method favors an adequate mapping of complete datasets enabling us to achieve a comprehensive perspective of driving performance.

In the third article on transportation, Alam et al. [7] bring autonomous and connected vehicles together and propose TAAWUN, an approach based on the fusion of data from multiple vehicles. Autonomous vehicles (AVs) are set to address major transportation challenges including safety, efficiency, reliability, sustainability, and personalization. The foremost challenge for AVs is to perceive their environments in real-time with the highest possible certainty. Relatedly, connected vehicles (CVs) have been another major driver of innovation in transportation. TAAWUN aims to share the information between multiple vehicles about their environments, enhance the information available to the vehicles, and make better decisions regarding the perception of their environments. TAWUN shares, among the vehicles, visual data acquired from cameras installed on individual vehicles, as well as the perceived information about the driving environments. The environment is perceived using deep learning, random forest (RF), and C5.0 classifiers. A key aspect of the TAAWUN approach is that it uses problem-specific feature sets to enhance the prediction accuracy in challenging environments such as problematic shadows, extreme sunlight, and mirage. This is the first work where visual information and decision fusion are used in CAVs to enhance environment perception for autonomous driving.

The security of smart infrastructure and applications is of utmost importance. We accepted two high-quality contributions to security. In the first article on this topic, Ahmad et al. [8] propose a self-protection mechanism for mobile devices against unforeseen security threats that can attack the critical resources of mobile devices. Mobile computing has emerged as a pervasive technology that empowers its users with portable computation and context-aware communication. Smart systems and infrastructures can exploit portable and context-aware computing technologies to provide any time, any place digitized services on the go. Despite the offered benefits, such as portability, context sensitivity, and high connectivity, mobile computing also faces some critical challenges. These challenges include resource poverty as well as data security and privacy that need to be addressed to increase the pervasiveness of mobile systems. The authors in this article unify the concepts of autonomic computing and computer security to develop a framework that enables adaptive security to dynamically configure the security measures of a mobile device. For this purpose, they develop a framework and an Android-based prototype that supports automation and user decision to protect the critical hardware and software resources of a device. In the second article in the area of security, motivated by the growing need for secure data exchange in eLearning systems, Kausar et al. [9] explore a Secure E-learning System (SES) for sharing examinations-related materials by ensuring protection against various security attacks. Exam materials include tests, quizzes, question papers, answer sheets, and aptitude

tests. They propose a secure authentication mechanism for students and teachers with a trusted server or a fog server and a Session Key Establishment Protocol (SKEP) to set up keys for a specified time period such as a class, seminar, or exam. They maintain the level of trust and authentication level to regularly check the legitimacy of the students. They use a testbed using web services in ASP.net and C# on the Windows Azure cloud to develop and test the proposed scheme.

The next four articles in this special issue provide important contributions to smart infrastructures. In the first article in this category, Aggarwal et al. [10] provide an analysis of the usage of the strong backbone infrastructure of fog computing for 5G-enabled Tactile Internet with a maximum bandwidth of 1 Gigabyte and a minimum latency of 1 millisecond. It supports low latency and high reliability in Tactile-based applications. Keeping the focus on the issues including resource management, communication infrastructure, fog orchestration, fog networking, healthcare, security, and privacy of fog systems in Tactile-based applications, the authors explore and compare the existing state-of-the-art proposals using various parameters such as energy efficiency, quality of service (QoS), scalability, mobility, and interoperability. The authors also discuss open research challenges of fog computing for 5G-enabled Tactile Internet. In the second article, Kadjouh et al. [11] propose DoTRo, a leader election algorithm based on a tree routing protocol for smart cities IoT infrastructure. It starts with local leaders that launch the flooding process to determine a spanning tree. During this process, their values are forwarded. If two spanning trees meet, the tree that routes the best value continues its process while the other tree stops. The remaining tree root will be the leader. The authors provide the complexity and the proof of convergence of the proposed algorithm. The algorithm has low energy consumption compared to the classical minimum finding algorithm and is efficient and fault-tolerant as it works in the presence of node failures and communication disconnectivity.

Formal verification and model-based testing techniques though useful however suffer from state explosion problems, particularly for large systems such as the Internet of Things and smart cities. In the third article, Krichen [12] review a set of techniques that aim to reduce the cost, duration, and complexity of formal verification and model-based testing techniques for IoT and smart cities. A total of twelve techniques are reviewed for the purpose, six each for formal verification and model-based testing. The techniques include abstraction, modularization and compositionality, symmetry detection, data independence, eliminating functional dependencies, exploiting reversible rules, refinement, and others. In the last article of this special issue, Usman et al. [13] propose ZAKI, a data-driven, machine-learning approach, and tool, to predict the optimal number of processes for SpMV computations of an arbitrary sparse matrix on a distributed memory machine. SpMV is a vital computing operation of many scientific, engineering, economic and social applications, including machine learning algorithms, increasingly being used to develop timely intelligence for the design and management of smart societies. The complexity of computer systems is on the rise with the increasing number of cores per processor, different levels of caches, processors per node, and high-speed interconnect. There is an ever-growing need for new optimization techniques and efficient ways of exploiting parallelism. The aim of this work is to allow application scientists to automatically obtain the best configuration, and hence the best performance, for the execution of SpMV computations. The authors train and test the tool using nearly 2000 real-world matrices obtained from 45 application domains including computational fluid dynamics (CFD), computer vision, and robotics. A discussion on the applicability of the proposed tool to energy efficiency optimization of SpMV computations is given.

The articles in this special issue have contributed to the transportation, security, and infrastructure dimensions of smart cities touching on many areas, IoT, networks, healthcare, and more. Emerging technologies are rapidly evolving our environment, cities, and societies. Many new technologies, concepts, opportunities, and challenges are rapidly transforming our environment, cities, and societies such as smartization [14], green AI [15], responsible innovation [16], deep journalism [17], edge computing [18], 6th generation networks (6G) [19], big data analytics [20] and social media analytics [21], [22]. These are exciting times and we hope that our efforts through this special issue will be fruitful in bringing innovations to smart cities and societies.

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