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Editorial

Transforming Future Cities: Smart City

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1. Introduction

The primitive elements of city transformation include the integration of urban infrastructure and artificial intelligence and cutting edge IoT technologies. It is a comprehensive and integrated approach, strategy and actions implemented to improve the economic, social, physical and environmental conditions of urban space. In this post-COVID-19-era, everyone has realized how vital digital assets have become in unworkable and quixotic environments. Now, the transformation of cities 'digitally" has become buzzword among society, academia and government authorities. It provides flexibility to manage and run services remotely and, at the same time, efficiently. Using data-based analysis approaches and cutting-edge technologies, cities are analyzing and solving the existing challenges of modern urban life. Smart cities are taking on issues such as healthcare, traffic flows, parking, pollution, environmental improvement and even urban heat generation. Data from sensors and public places can be exploited to study and conduct assessment analysis—'big data' and smart civic-analytics for cities is just around the corner, with a major transformation for urban life.

The goal of building a smart city is entirely based on easing infrastructure management, quick and efficient service delivery, and, at the same time, improved quality life. This overwhelming desire to make a smart living in the city is possible due to the smart city's ability to connect people with authorities and services on a digital platform, and this is what it makes it unique compared to traditional cities. Figure 1 shows four pillars of a smart city that stands out from traditional cities: (i) smart mobility, (ii) smart economy, (iii) real-time analytics, and (iv) peer-to-peer communication. This complex organization of infrastructure, services, and people on a common platform has some meaningful impacts on social management and people's lives.

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Figure 1. Four pillars of a smart city.

2. Summary of the Special Issue

There have been tremendous research works carried out to make smart cities. The backbone of this work generally has a backdoor idea on how to transform the existing city equipped with state-of-the-art technologies.

In this line, we would like to remark on the works published in this Special Issue, whose scopes stand out from the use of statistics and IoT technology. Therefore, we have included works that emphasize using artificial intelligence and automation in addition to smart sensors around the city environment. Overall, the research, as well as practical IoT applications, on smart cities trends in the direction of smart energy storage systems, remote infrastructure handling, the industrial Internet of Things, geographic distribution, crowd management, and especially efficient service delivery.

Among the works submitted to this Special Issue related to smart city applications and technologies to transform traditional cities into smart cities, we can find notable works such as the following:

The work developed in [1], with the inspiration to minimize consumed energy cost, peak-to-average power ratio, and consumer waiting time while load scheduling, aims to overcome energy scarcity in the smart industry environment. In this proposed methodology, the authors have designed an algorithm that optimally schedules loads for higher energy efficiency and effective utilization of existing energy resources. To achieve the objectives mentioned, two bio-inspired heuristic techniques—Grasshopper-Optimization Algorithm (GOA) and Cuckoo Search Optimization Algorithm (CSA)—have been deployed for efficient energy usage in a woolen mill. Each algorithm has its purpose. The key objective of this algorithm in an industrial energy management system is to minimize the energy consumption cost, manage peak load and reduce waiting time while scheduling the load for minimum cost and maximum benefits. In the result and discussion section, the authors have considered a woolen mill as a use case, applied algorithms at different load units according to routine functionality, and, finally, scheduled load units with an efficient energy management system (EMS).

The two proposed bio-inspired algorithms, GOA and CSA, mimic an ideal industry that has hundreds of devices, large industrial output, high energy consumed, and a cyclic loop among machines during operation. The general idea is to map the input features which are the pricing signal, the power rating of machines, the real-time pricing (RTP), and the LOTs of machines with grasshopper social behavior, as well as their agent and cuckoo bird egg-laying and the process forward while hatching and feeding. In this way, machines can be allotted or scheduled for operation at different times considering RTP. As a result, by applying bio-inspired techniques, energy price can be minimized by shifting some loads to low-demand hours without disturbing its operation.

In [2], the authors proposed a bio-inspired meta-heuristic optimization technique called the dragonfly algorithm (DA). The sole aim of the proposed algorithm is to reduce consumer the electricity bill and the PAR (peak-to-average ratio) for the stability of the smart grid. To achieve the aforementioned objective, the proposed algorithm considers two types of load appliances, i.e., shiftable and non-shiftable, in smart homes (SH). Shiftable appliances can be shifted or scheduled at any given hour according to real-time pricing (RTP) signal to oversee demand-side load management. Meanwhile, non-shiftable appliances cannot be scheduled as per RTP signal due to their fixed nature. The system model presented for single utility and multiple users has a smart meter (SM) as the key component installed at every single smart home. The smart meter computes the hourly power consumption and communicates the same information to utilities to assess the consumption habit for scheduling purposes by the energy management controller (EMC). EMCs are connected with power utilities and have bidirectional communication systems and unidirectional power flows in real-time. Their purpose is to schedule shiftable appliances according to the pricing signal released by the utility company.

The main goal of the proposed model was the optimization of energy consumption with a policy to operate appliances within a time slot allotted by the scheduling algorithm. The dragonfly algorithm (DA) facilitates the objective of being low cost, low PAR, and having a minimum waiting time following the natural swarming behavior of dragonflies, i.e., static swarms for the exploration of devices and dynamic swarms for energy exploitation. The algorithm intakes day-ahead pricing, the number of appliances, the previous trend of appliance utilization, RTP, iteration of utilization, and certain parameters required for fitness evaluation. The main goal, i.e., the scheduling of appliances, fulfills the objective, and to perform the same, the position of individual appliances is updated according to the fitness function of appliances, which gives an idea of the operation time of each appliance. While scheduling the appliances, the total load is also taken care of in smart grid stability. A prime reason algorithm such as this has been developed for equal and balanced energy distribution, so as to stabilize energy consumption and maintain an equilibrium of energy generation and consumption.

On identifying the load, RTP, and demand of energy, appliances are scheduled at the best available time. On regular optimization through the algorithm, if an improved schedule is assessed, the old best schedule time is replaced by the new best schedule time. The proposed algorithm aims to solve the issue of high energy costs and waiting times in device scheduling environments.

In [3], the authors conducted a study to analyze social media users in Shanghai to understand the characteristics of users' spatial behavior, the relationship between users and social media, and, finally, to collect enough data patterns and evidence to help manage urban planning for responsible authorities. The two methods employed to analyze and compare user densities are point density and kernel density estimation (KDE), respectively. The dataset required in this study to identify social media users and compare their density is collected from the Chinese microblogging site called Weibo. The dataset consists of the geo-location data of users, which constitute specific geo-spatial coordinates of users' current location. With the use of the API interface, 3,500,497 check-ins were recorded along with user ID, valid profiles, and time spent, made by 11,108 users inside the 16 districts of Shanghai. Furthermore, with data processing to eliminate invalid entries, less than 2 entries per month, and during the absence of a user ID or profile, data were refined to result in 786,650 check-ins being made by 10,317 users. Data obtained through API are initially in JSON format and are converted to CSV file format for further operation and analysis. To conduct spatial analysis, a state-of-the-art social media data analytics framework is designed which computes in two phases: in the former phase, data downloaded from Weibo are acquired and cleansed, and in the later phase, analysis of LSBN data is performed. During the analysis stage, firstly, statistical analysis is performed, and secondly, data visualization using point density and KDE is conducted. Statistical analysis helps to study the number of users and the number of check-ins performed by users in every district.

The main objective of this study was to identify crowd density to help serve the purpose of building a smart city while controlling the mobility of people in Shanghai City. Overall, there were two techniques in its core data visualization: point density and KDE on LSBN data. Among both techniques used, KDE was found to be more significant for detailed behavioral analysis of crowd density.

In [4], the authors presented an anomaly detection, dual-stage cascade, one-class SVM (OCSVM) model for a water level monitoring system It has been built to identify anomalies when the water level monitoring is in operation and flag when any abnormality is observed. It generally works as a classifier system that operates in two stages, the first stage detects any point anomalies by running 1-g on the observational data, and the subsequent stage runs n-gram to identify collective anomalies in the broader perspective. The dataset used in the proposed framework to train the model was of a water tank level sensor facilitated by an IT-based infrastructure company, Infranics, which gathers data and provides solutions with proper diagnostics. The data acquired were single-day operative data and were recorded at a sampling rate of 1 Hz. To identify anomalies and patterns, the maximum and minimum thresholds of water inflow and outflow during water distribution were also recorded. An autoencoder was adopted to learn the water pattern, which naturally tries to learn the identity function and makes predictions of future patterns.

To ascertain the principal objective, i.e., to identify anomalies in the water level monitoring system, the authors employed an RBF kernel-based OCSVM cascade model. The novelty of this work was that they had built OCSVM in two stages and used normal class information for the learning classifier. In the first stage of the cascade model, the designed learning algorithm fits the OCSVM model from point observation, and the generated OCSVM detects if a particular data instance is an outlier; this stage is called the point anomaly detection stage. In case of anomaly is detected, the model generates an alert for the responsible authorities. During the second stage of the model, the observational data are constructed into n-gram feature vectors and fed into the SVM learning algorithm to learn the OCSVM model, and the classifier predicts whether a given n-gram feature is an outlier or not. This second is also represented as a collective anomaly detection stage due to its ability to detect every anomaly, and even anomalies passing detection by the point anomaly detection stage. For the performance evaluation of the designed system model and to compare it with other algorithmic models, a 2X2 confusion matrix was generated from the experiment results. The dual-staged OCSVM technique achieved an excellent result of a 99.06% F1-score with the parameter $\nu = 0.3$. Other than that, additional comparisons with other algorithms such as SVDD, Isolation Forest, and Elliptic Envelope were evaluated. The proposed technique outperformed those state-of-the-art algorithms, and it was concluded that the dual-stage OCSVM technique detects different kinds of anomalies in different scenarios effectively.

In [5], the authors used LSBN data to conduct spatial and temporal behavior analyses of park visitors at different locations in Shanghai. The primary objective of this study was to analyze the behavioral pattern of park visitors, including people's behavior according to season, the number of visitors at green parks, and green space. Shanghai was selected to conduct this study because it is the fastest developing metropolitan city in the world and has four seasons with abundant sunshine and rainfall, so as to identify park visiting behavior in different seasons. The dataset used in this study was collected from Chinese social media “Weibo”, equivalent to Twitter. It is preferred due to the fact that Weibo data perfectly represents the interests and behaviors of the individuals in urban areas with access to green space. The check-in data of every individual at parks were acquired through Weibo API, and other locations such as market place, famous persons’ homes, and sidewalks were removed from the data. A strategic data cleansing and filtration process were adopted so as to juxtapose multiple location ids at the same park into one location ID. Out of 3,500,497 check-ins made within the 10 districts of Shanghai, after pre-processing considering valid profiles and check-ins made within a timeframe, a total of 250,632 geo-tagged visits to 122 green parks were included. The data obtained from the API interface are initially in JSON format. To frame data according to unique user ID, check-in data-time, and geo-location, and also to perform further operations, JSON format data were converted to CSV and stored.

The main objective of this study was to identify the behavioral patterns of people visiting public parks and green spaces and to oblige the same, a social-media-data-based check-in behavior analysis framework was designed in which the LBSN data analysis method includes the framework, the data pre-processing, and cleaning, the temporal and spatial analysis of the LBSN data and the statistics that indicate the worth of the LBSN data. Among all the analyses performed, statistical analysis was carried out initially using ANOVA, linear regression, and regression statistics to signify data variables and the correlations among them. To track the user behavior under different time constraints, temporal analysis of the dataset was adopted and check-in time stamps were classified into daily, weekly and seasonal. Finally, to fulfill the primary objective, spatial analysis using the kernel density estimation (KDE) method was used, which is an evolving spatiotemporal technique to inspect several features of social media such as LBSN data analytics, such as users’ online activity and movement trends, check-in behavior and distribution of destinations in communities. On deploying KDE to identify the distribution of users in parks by analyzing the check-in data, the authors concluded that neighborhood green parks are much more crowded than other green spaces, the peak hours to visit parks are from midday to midnight and an analysis of the seasons shows that the number of check-ins is much higher in summer and spring compared to autumn and winter.

The research analysis report presented in [6] aims to study the research trend and analyze the evolution of scientific advancement in the field of IoT technology applications for smart cities. A total of 1232 articles were fetched from the Scopus database (2011–2019), and bibliometric analysis on all the sample articles was performed. Upon bibliometric analysis, information of current and future research proposals along with various salient features from the articles was obtained, such as the evolution of the number of articles, the subject areas where they are classified, the journals where they are published, the authors, the research institutions and the most productive countries. It has been observed that research works in the field of IoT for smart cities have significantly risen between 2017 and 2019 and a total of 1025 research articles were published in this timespan. Another important finding is that the countries with the most research work on this topic are China, the United States, India, and Spain.

The most influential area of study contributing to this cause to development IoT and application for smart cities in Computer Science and Engineering. It is a multidisciplinary field that engages electronics and software in a user-friendly environment. The highest number of researches works on IoT for smart cities are published in the journal *Sensors*, as it includes multidisciplinary areas classified in the thematic areas of engineering. The research lines identified that developing the field of study in smart cities based on IoT technology applications generates contributions on the following: (1) the holistic vision of a smart city; (2) IoT applications; (3) network security solutions; (4) the macroscopic approach to wireless telecommunications systems; (5) the implications of the Internet in the development of smart cities; (6) cloud computing and the availability of data centers; and (7) the automation of processes.

Furthermore, on detailed analysis, it has been observed that research in IoT applications for smart cities is continuously evolving at a rapid speed focusing on a wide area of research application compared to a decade ago. Future research works in this field are in the direction towards (1) Energy Storage; (2) Environmental Temperature; (3) Geographic Distribution; (4) Intentional Contaminations; (5) Remote Health Monitoring; (6) End Users; (7) Electronic Crime Countermeasures; (8) the Industrial Internet of Things (IIoT); (9) Flood Control; and (10) the Social Internet of Things (SIoT).

In conclusion, it has been observed that global research in smart cities based on IoT technology applications shows an upward trend. This field of research has attracted the scientific community and also shows the increasing interest of academia to pursue their research thesis. All in all, due to the subject-wide application and multidisciplinary nature, thousands of research works have been imitated in recent years, and it continues to attract more.

In [7], the authors presented an Android application that allows or blocks the content only after verifying the context. It is essentially developed to prohibit unauthenticated access to data, security, and privacy in users' computing environments. To achieve this, the authors designed and presented a management tool PRIPRO (PRIvacy PROfiles), which is a module of UbiPri middleware especially designed for supporting the development of privacy mechanisms for smart environments. The UbiPri middleware places the environment as the centerpiece of the system, and other elements follow the rules and criteria as demanded by the environment. In this way, UbiPri overtakes other existing middleware due to its service-oriented generic model for control and privacy and its architecture in which each set of specific models has specific characteristics.

The novelty of the security application presented by the authors is its taxonomic model. It is generally a set of rules defined for smart environments and secure methods to update users' profiles to terminate any unauthenticated logins to the smart environment. To define the set of rules and to control and manage users' privacy profiles in the taxonomic model, a set of components is required, which includes communication, the environment, the user, and privacy. Based on this taxonomy, a state-of-the-art solution composed of the client application to run on the user's smartphone and a webserver to manage the evolution of the user's profile and permissions has been developed. The proposed solution lives up to expectations and successfully demonstrates a pilot experimental result where a smart environment is created with the necessary services to manage the user's access to his/her smartphone's resources based on the rules of the environment.

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