Smart Cities Using Machine Learning and Intelligent Applications

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ABSTRACT

The goal of smart cities is to properly manage to expand urbanization, Reduce energy usage, Enhance the economic and quality of life of the locals while also preserving the environment conditions, and improve people's ability to use and adapt modern technology used in information and communication efficiently (ICT). Information and communication technology (ICT) is central to the concept of smart cities because it facilitates the development of policies, decision-making, implementation, and, eventually, the provision of useful services. This review's main objective is to examine how machine learning, deep reinforcement learning (DRL), and artificial intelligence are advancing smart cities. The previous strategies are effectively utilized to provide the best policies possible for a number of challenging issues relating to smart cities. The uses of the earlier methods are thoroughly discussed in this survey. in intelligent transportation systems (ITSs), Cybersecurity, as well as smart grid energy efficiency (SGs), ensuring the best 5G and beyond 5G (B5G) networking service, as well as a smart city with a smart health system, by effectively using unmanned aerial vehicles (UAVs). Finally, we list a number of the above-mentioned research problems and potential future directions approaches can be extremely helpful in bringing the idea of a smart city to life.

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1. INTRODUCTION

The statistics state that by 2050, 66% or 70% of people worldwide are predicted to live in metropolitan areas. The ecology, administration, and security of cities will be drastically affected by this level of urbanization growth [1]. Numerous nations have promoted the idea of "smart cities" as a way to manage resources and reduce energy use in order to handle the explosive development in urbanization. By creating and implementing low-carbon emission technology, the smart cities initiatives may specifically deal with ensuring a green environment [2]. To effectively address the potential oncoming difficulties, several governments (such as the US, EU, Japan, etc.) throughout the world have planned and accomplished the smart cities programs. Information and communication technologies (ICTs) must be used effectively to manage data analysis, data communications, and the successful execution of complicated strategies that will ensure the safe and secure operation of a smart city.

Most smart city applications, which produce a staggering quantity of data, have the IoT as their most crucial and critical component [3]. It's challenging to exactly choose the most accurate and effective actions when there are so large and complicated volumes of data [4]. Advanced methods like artificial intelligence (AI), machine learning (ML), and deep reinforcement learning (DRL) may be used to analyze massive data in the best possible ways to make the best conclusion. The aforementioned methods take a long-term goal into account and can provide the best or nearly best control decisions [5]. By increasing the amount of training data, the aforementioned methodologies' accuracy and precision may be further improved, as can the effectiveness of automated decision-making [6]. The authors of have demonstrated that the use of advanced data analysis methods for Big Data and the notion of smart cities have both grown significantly over time [7]. Unmanned aerial vehicles (UAVs), the Internet of Things (IoT), Blockchain, smart cities, and the use of AI, ML, and DRL-based approaches are all still in the developmental stages and will present additional opportunities in the future (see Figs. 1–3).

Various industries, including intelligent transportation, cybersecurity, smart grids (SGs), and UAV-assisted fifth- and sixth-generation (5G and B5G) communication, are involved in smart city initiatives. are essential [8]. Big data analytics and the successful use of AI, ML, and DRL-based approaches that may boost their efficiency and scalability in a smart city project have a significant impact on all the aforementioned smart city industries. In order to implement self-driving cars, secure the security of linked cars, optimize passenger search, and promote safe travel, ML and DRL-based approaches have a significant impact on the present intelligent transportation system (ITS). in which the authors investigated the function of

Fig. 1. The environment sensing, communication protocols, data transfer, security, and privacy components of a universal architecture for smart city applications. Applications for smart cities clearly demonstrate the importance of the security plane.

On ITS, DRL-based procedures have been considered. The key component of an advanced metropolis may achieve a smart city's ideal design is cyber-security [9]. The suggested architecture must be planned and drawn to include all of the component pieces in order to implement the security plane depicted in the image [10]. A smart city's practically all of its sectors have been profoundly influenced by the role that AI, ML, and DRL-based approaches have played within cyber-security [11]. In, the authors conducted a thorough analysis of the role that ML and DRL approaches play in IoT device cyber-security, which is crucial for applications involving smart cities [12]. A smart city must have the ability to generate, manage, and consume energy, in conjunction with big data analytics significant influence on the operations of ICT-based SGs (see Table 1) [13].

Every day, AI has a greater and greater influence on our daily lives [14]. Our daily tasks are being quickly altered by AI, which is also having an influence on how we traditionally think and interact with our surroundings. How can the new laws be structured to minimize AI's negative effects on mankind while maximizing its good effects on the present and future generations? And how laws and policies should be created with AI assistance to assure social and economic advancement. The authors of presented an effective a DRL-based and neural network-based crime detection solution for smart cities quickly locate and assess any illegal behavior. Similar to this, the authors in presented an ML-based architecture that might be used to anticipate accidents and produce responses before they occur.

The most recent advancements in AI, ML, and DRL-based applications in several smart city sectors are described in this paper. We concentrated on examining the function and effects of the aforementioned methodologies on the most significant elements ITS, cyber-security, smart grids, UAV-assisted 5G and B5G connectivity, and smart health care are examples of aspects of smart cities. Section 2 has conducted a study of the literature on various ML and DRL methodologies. Section 4 presents a thorough analysis of current advances in cyber-security, Section 5 outlines creative developments related in smart cities, energy production and control, and Section 3 provides in-depth insights on ITS. The most recent evaluation of There are supplied UAV apps for 5G and B5G communication. in Section 6. Similarly, Section 7 focuses on developments the industry for intelligent health care, Section 8 describes upcoming scientific challenges, solutions and trends and Section 9 wraps up the study.

2. An introduction to machine learning

Machine learning techniques are grouped into three groups: supervised, unsupervised, and RL. In the many circumstances shown in Fig., the RL employs algorithms from every branch. 4. With examples, we will now quickly describe learning that is both supervised and unsupervised We will also outline RL's primary algorithms.

In supervised learning, an artificial intelligence (AI) network is trained to develop With a dataset of input and target values, a mapping function transforms input data to output. The division of supervised learning continues

Table 1

Acronyms used in this article.

Acronym	Text	Acronym	Text	Acronym	Text
ML	Machine Learning	DRL	deep reinforcement learning	UAV	Unmanned Air Vehicle
UAV	Unmanned Air Vehicle	UAS	Unmanned Aerial System	BS	Base Station
MDP	Markov Decision Process	Relay-BS	Relay Base Station	UE	user equipment
LTE	Long Term Evolution	AI	Artificial Intelligence	R&d	Research and development
DS	Delivery System	RMS	Real-time multimedia streaming	ITS	Intelligent transportation systems
RL	Reinforcement Learning	TD	Temporal Difference	MC	Monte Carlo systems
DP	Dynamic Programming	LoS	Line of Sight	ESN	echo state network
ELM	Extreme Learning Machine	QoE	quality-of-experience	CSI	Channel State Information
SGs	smart grids	ICT	information and communication technology	US	United States
EU	European Union	IoT	Internet of Things	MEC	mobile edge computing
DNN	Deep Neural Network	GPS	Global Positioning System	ECC	edge cognitive computing
ANN	Artificial Neural Network	PMUs	phase measurement units	PLC	power line communication

and categorization, respectively. Known supervised learning examples include linear regression, support vector machines, and random forests.

The AI network is trained to uncover hidden patterns, solutions, and distributions using just an unlabeled and unclassified input dataset in unsupervised learning. Clustering and association are examples of many unsupervised learning issues. The auto-encoder method and k-means algorithms are a few of examples [15].

Markov Decision Process (MDP) The Markov Decision Process (MDP) is the foundation for the majority of the RL issues [16]. In order to solve sequential decision problems (SDP), an MDP must look for the best solutions [17]. While an MDP cannot give absolute answers in the case of stochastic SDPs, it can assist in providing an optimal or the best solutions among all other options [18]. A transition model, a group of conditions, a sequence of events, and a reward function all form an MDP model. Reward and transition are influenced by the present state, the selected action, and the next state's outcome [19].

Reinforcement Learning (RL) The RL agent seeks to increase its aggregated long-term reward by repeated interactions with the environment [20]. A "agent" is the interaction- and learning-doing portion of the RL algorithm [21]. An agent used an ideal policy to accomplish this goal [22]. An ideal policy is one that optimizes the total long-term payoff. A collection of measures for a certain group of nations is referred to as a policy. Exploiting established actions while also investigating novel actions that could offer higher rewards than the best actions now available is a vital task for an agent [23]. In the RL scenario, finding the right balance between maximizing reward from known maneuvers and looking for new frontiers that could potentially produce greater results is crucial. Model-based and model-free RL algorithms may generally be separated into two categories. Model-based RL techniques are regarded as sample-efficient and employ function approximators. Poor probabilistic performance of generalization and model-based algorithms complicated models with large dimensions is a significant problem in the RL framework, though. Models of transition, value function, policy search, and return function are some of the methods used to resolve model-based RL issues [24]. RL methods without models include Monte Carlo and Temporal Difference. Examples of the TD approach include the SARSA and Q-Learning procedures, which will be discussed later [25].

Richard Bellman created the mathematics and computer programming technique known as "dynamic programming" (DP) in the middle of the twenty-first century. A difficult assignment is gradually divided into smaller, easier problems using the recursive process known as decomposition parsing (DP). Model-based DP method need thorough environmental knowledge that can be observed [26]. Therefore, DP is utilized to identify a value iteration or policy iteration approach to create an ideal policy approach in specific RL issues when the provided environment model is an MDP model.

The Monte Carlo (MC) approach use randomness to find solutions to issues. First-time MC and recurring MC

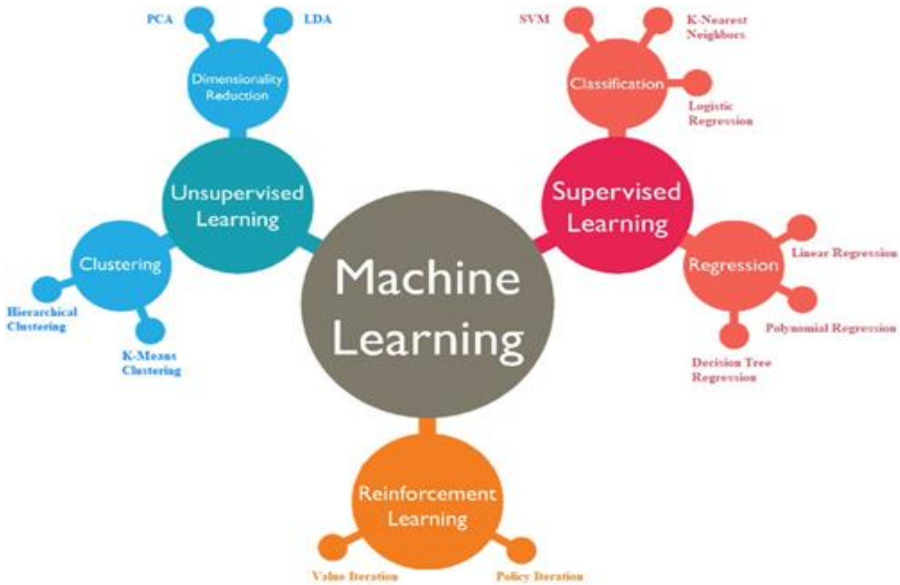

Fig. 2. Classification of machine learning techniques.

both MC methods, but they're distinct. The sum of the returns that come after is a state's initial visits throughout a set of episodes is known as the First-Visit MC, whereas the Every-Visit MC is the average of all returns following a state's initial visits throughout a set of episodes. The key benefits of MC over DP include I the ability to employ sample models. (ii) MC algorithms are quick and simple to use. (iii) Through direct engagement, MC discovers the best answers.

Temporal difference approaches A drawback of MC techniques is that one must wait until the conclusion of an episode for an update. Temporal difference (TD) techniques, a family of model-free RL algorithms, alleviate this issue by gaining knowledge by starting with the forecast of the current value function. In the RL framework, TD is utilized for the prediction of long-term future rewards instead of the usual amount It is reliant on the upcoming values of the signal supplied. It is among the techniques for policy assessment that is most frequently utilized. Brief explanations of Q-learning and SARSA, the two main TD-based algorithms, are provided below [27].

Because of its resemblance to Q-learning, SARSA State-Action-Reward-State-Action (SARSA) was first described as "modified Q-learning." Later, Sutton referred to SARSA as an active RL-TD control case approach. SARSA is an on-policy learning algorithm, unlike Q-learning, which is comparable. The update's name makes it apparent that it is based on the "State-Action- Reward-State-Action" model. As a consequence, it derives the best Q-value from the outcomes of actions taken in accordance with the current policy rather than greedy ones.

Q-Learning It is suggested that, in a stochastic context, the Q-learning approach be used as a DRL strategy. Q-learning is an approach for TD control that is model-free, policy-based, and forward-learning. The Q-learning algorithm determines the most advantageous course of action by utilizing off-policy or learning by observation. For the state that has the greatest Q-value, a', the following action is selected in Q-learning. This policy is off-policy learning, which is a greedy deviation from the existing policy. We might additionally utilize eligibility traces to hasten the convergence of SARSA and Q-learning. The effectiveness of the previous technique declines when there are several repeated states and diverse activities. Function approximations are frequently required by the Q-learning approach.

acting review algorithm The actor-critic approach is based on established RL algorithms. This hybrid strategy makes use of both a functional form and a policy. The actor adjusts the policy in response to the criticism made by the critic, while the critic's algorithmic component calculates the value function. It falls in between the value-based and policy-based end of the value-based and policy-based approach spectrum because it estimates both the policy function and the value function. This covers both small state-action-state spaces and large state-action-spaces. Techniques that are exclusive to actors and critics are meant to be connected by the prior strategy. In order to teach a value function, the critic approach uses simulations and an approximation framework. The actor's policy values are afterwards changed with the help of the value function to increase efficiency.

methods using Bayes The reward for a DRL agent is guaranteed to rise with time and they can choose from a number of incentives from different states. The agent gains the ability to move away from states with low benefits and toward ones with greater payouts. The environment's unclear information is vital for maximizing the payoff. For determining and researching a model's uncertainty, the Bayesian models provide a computationally effective analytical approach. By including uncertainty in particularly for identifying and avoiding over-fitting, Bayesian techniques may be used to overcome the exploitation-exploration issue. The Bayesian approximation methods Myopic Sampling and Thompson Sampling are both well-known. Thompson sampling could be able to overcome the exploration-exploitation problem.

The Deep Q Network TD technique, specifically Q-learning, is one of the well-known RL algorithms, however it has issues with generality in very large state spaces. In previous methods, the look-up tables or matrix contained the value function. A two-dimensional array is used, for instance, to store the Q table when utilizing Q-learning. When there is a It is challenging to visit and estimate because of the enormous state space and numerous linked activities the value functions for every state. When RL based on neural networks is used for function approximation, the generalization problem can be overcome. The Deep Q-Network (DQN) employs a neural network in order to estimate the value function across a large state space. The network is trained using the Q-learning update rule.

3. Transportation system with intelligence

The ITS, a combined application of cutting-edge ICT that produces data from sensors, control systems, etc. enormous amounts of data, has had a tremendous impact on smart cities as a concept and the future of ITS. AI, ML, and notably the DRL techniques make it feasible to accurately real-time traffic flow data monitoring and estimation in an urban setting critical feature of a sustainable ITS. The most recent ITS innovations that would be essential to the deployment of a smart city are briefly reviewed here.

In order to examine how ML and DRL are employed in ITS and how they may be used to develop smart cities, Veres et al. conducted a detailed analysis, encompassing subjects like logistics operations, passenger search, MEC channel estimate, accident likelihood estimation, and traffic flow analysis. In ITS, A study was created by the writers that concentrates on issues by utilizing Edge analytics and DRL approaches. that may be essential for the development of smart cities (such as designing trajectories, managing a fleet, and cyber-physical security, etc.) A better decision-making strategy for driving behavior in a variety of traffic environments has been proposed by the authors of this study. Data is compressed using a data compressor into a hyper-grid matrix using this technique, To determine the best potential policy, a DRL approach is used in conjunction with an artificial neural network using two streams to extract the most significant latent properties. By using simulation data from several connected car traffic scenarios, the efficiency of the proposed scenario has been confirmed. With mobile edge computing, the authors focus on new security issues (MEC). In order to effectively address possible security problems, a DRL-based technique is presented using unsupervised learning to discover numerous assault options. Current ML-based techniques have been compared to the proposed model. The findings show a 6% extra boost in accuracy from the proposed approach. The authors of employed a DRL-based model to forecast the flow of traffic in the near future on a route. Researchers carried out a research project utilizing the Deep Long-Short Term Memory Recurrent Neural System in order to estimate traffic on the Gyeongbu Expressway in South Korea (LSTM-RNN). Regarding the prediction of traffic flow on a roadway in the near term networks, the experimental results sparked a significant response. The authors performed research to see how well passenger scouting might be accomplished using GPS trajectory data of taxis in a region. The proposed efficient and effective recommendation system (TRec) is constructed using the DNN architecture. Using taxi drivers as teaching resources to forecast traffic patterns and assess their net revenues, TRec finds passengers. The recommended recommendation system (TRec) has its effectiveness and efficiency evaluated using a real dataset. Long short-term memory (LSTM) network was used as the foundation for the novel prediction method that the authors of presented in order to forecast diverse to provide the best system performance, wireless channels should be used for communication characteristics. The spatiotemporal relationship between several communication channel variables may be easily examined thanks to the LSTM network's arrangement of the lucky data. Results from simulations have been used to verify the suggested model's effectiveness in the given context. The authors of employed a DRL approach to develop a sophisticated offloading system for vehicle edge computing. In order to mimic the communication and computation states, the authors created a finite Markov chain in order to improve the quality of the user experience. They also devised a mixed using job and resource management, solve an optimization problem (QoE). The recommended NP-hard problem is further separated into two smaller problems, and numerical results show that this division is successful in handling the NP-hard problem. In, Ye et al. developed a brand-new for V2V communication, a decentralized resource allocation method based on DRL moreover, that applied while broadcasting and unicasting. Individual cars or v2v links are free to decide whether to search for the best power level under the specified method without needing to wait for global communication, for sub-band and data transfer. The simulation's findings demonstrate how any user or agent may successfully pick up the necessary skills to adhere to v2v networks' stringent latency constraints To lessen interference in interactions between vehicles and infrastructure (V2I). The authors develop DRL-based techniques to mimic traffic flow. To comprehend the numerous characteristics of traffic flow, it is recommended and applied the stacked auto-encoder model, which is trained greedily layer-by-layer. In comparison to existing techniques, the suggested strategy for traffic flow prediction outperformed them. Due to its fast motions, ease of deployment, increasing payload capabilities, extended durability, and economical production, In the IT systems for smart cities, UAVs already play a significant role. From the transfer of blood to packages, the aforementioned advantages of UAVs have found use in ITS. The ML and DRL techniques have made a considerable improvement to the movement, energy use, and effectiveness of UAVs in ITS. The authors of recommended using a traffic-aware technique to let UAVs be deployed with the purpose of raising the level of service in a moving environment. In a setting with heavy traffic and associated events, the deployed UAVs function as MEC nodes. The effectiveness of the recommended strategy has been confirmed using simulated results. For mobile customers inside a certain area, coverage services are provided, the authors suggested a decentralized aerial UAV architecture based on DRL. The proposed approach seeks to increase UAV coverage of relevant locations while minimizing UAV energy consumption and maintaining their interconnection. Additionally, it aims to limit the quantity of airborne UAVs that are permitted to fly over the relevant region. The outcomes of the simulation support the superior performance of the proposed model. The writers of looked at the possibilities of employing UAVs to convey data for automobiles with the maximum throughput. Using the MDP problem as its foundation, the proposed model examines several UAV and vehicle transition stages. Three separate DRL approaches served as the foundation for DDPG algorithms proposed in order to effectively assess flying UAVs' energy requirements. The suggested model's utility is assessed the simulation's outcomes are more accurate when conducted in a more realistic environment utilized to support this.

4. Cyber-security

intelligent city should include linked sensors, actuators, and relays that are safe, secure, and dependable for gathering, processing, and transmitting data in order to guarantee reliable and effective digital services. It is necessary to address the cyber-security challenges brought on by the interconnectedness of numerous devices. IoT devices using the cloud produce the majority of the data, which is essential for many smart city applications.

The authors of have created a concise survey to examine a number of important and critical components of a smart city. Assuring data privacy and security, defending networks from potential cyberattacks, promoting an adult and an ethical culture of data sharing, and making practical use of AI, ML, and DRL approaches are a few of the important concerns that have been explored. In order to examine many research issues with the idea Regarding the communication, privacy, and security of the architecture of smart cities standpoint, Hadi et al. performed a comprehensive survey in. They mainly concentrated on examining the variety of complex problems that emerge during the fusion of current sensor, actuator, and infrastructural protocols for communication. In, Mohammad et al. created a thorough investigation and examined the function of ML and DRL approaches from a cutting-edge the IoT's latest security standpoint released security risks. The authors evaluated the benefits, drawbacks, and potential IoT security of ML and DRL protocols and suggested future study topics. In order to examine the function and potential applications of ML and DRL approaches in the bioinformatics and healthcare industries, Riccardo et al. prepared a review in. They looked at a number of issues and suggested fixes for effectively utilizing technologies based on ML and DRL in the cutting-edge healthcare industry. The self-teaching DRL's skills and potential approaches were used by the authors to investigate the training dataset's latent pattern and distinguish between regular and abnormal traffic. They suggested using deep learning distributed to find and recognize cyberattacks smart cities' IoT applications. Compared to the shallow models-based method, the suggested strategy is more efficient. Anomaly Detection-loT (AD-IoT) is an architecture based on Random Forest ML that was suggested by the authors of with a focus IoT device security in the smart city. Making use of datasets for machine learning assessment, the suggested method may effectively detect any type of suspicious behavior occurring at the dispersed fog nodes. In, the authors suggested a ground-breaking DRL-based architecture to protect a smart city's digital infrastructure from any kind of cyber incursion. The network may be protected in advance thanks to the suggested model's early detection of intrusions based on data behavior. The approach mentioned above can aid in the creation of a variety of private and secure applications for the smart city idea. In order to reduce latency and energy use, the authors of introduced a framework for secure computational offloading based on machine learning (ML) for the Fog-Cloud-IoT context. The suggested system has a Neuro-Fuzzy foundation model that assures the gateway's data security lets Internet of Things devices choose the best utilizing particle swarm optimization with fog nodes for computation offloading (PSO). The suggested approach performs better in terms of minimizing latency. In, the authors discussed the main issues and offered the design of an edge cognitive computing (ECC) network. Additionally, the ECC design was developed to provide active and dynamic shifts in service. The previous ECC architecture is built on the habits and routines of cognitive mobile users. The ECC framework's performance study demonstrates that it is more efficient than conventional computing architecture. To build binary decision offloading skills through experience, the authors of presented a DRL-based Online Offloading approach in. In binary offloading techniques, every work is either totally or partially offloaded to a MEC device. Results from simulations have been used to verify the performance of the earlier method. The authors concentrated on the GPS spoofing assault, which allows fake signals to get through UAVs and their ground controllers. To recognize and expose the GPS spoofing attempts, they suggested using ML-based ANN. The suggested method categorizes GPS signals based on Signal pseudo-range, SNR, and Doppler shift. The suggested methodology has a high likelihood of finding GPS spoofing attacks and a minimal rate of false alarms Its authors created a DRL-based method in to prevent attempts to jam flying UAVs. The suggested method is modeled independent of the jammer's position, UAV channel model is another option. By evaluating the UAV transmission quality, this approach determines the UAV's trajectory and amount of power transfer. According to the simulation findings, the aforementioned method raises the deployed mission-specific UAVs' QoS.

5. Smart grids

Big data is significantly influencing the operational structure of SGs and effective energy use in smart cities. The SGs are built on cutting-edge IoT devices, communication infrastructure, and massive amounts of data.

Heterogeneous data from many sources enters SGs where it may be efficiently processed and used to make appropriate management and operational choices. Analytics with big data the potential to improve power grid performance, management, and power sharing decision-making in smart cities. Nevertheless, the most current fad demonstrates that SGs are effectively utilizing big data from smart meters for several purposes, including load assessment and forecast, baseline estimate, detrimental data deception, and demand response, demand-side optimization, load balancing, and damaging data manipulation assaults. Big data analysis for phase measuring units (PMUs) is primarily utilized for transmission grid visualization, dynamic model calibration, and state estimation. In, their writings produced a current research that examines a number of big apps in SGs that use data as assistance. The writers examined the function and uses of 5G connectivity in SGs. From the standpoint of SGs, a thorough analysis of the present and potential 5G communication topologies has been given. In, the authors have created a thorough review that explains the function of ML and DRL approaches in applications that pertain to SGs, and their effectiveness in SGs' cyber-security is explored in depth. In, the authors explored several ways that DRL approaches were used for fault investigation, the forecasting of loads, transient stability, evaluating fresh strength production, and managing electrical system. The authors of proposed a scenario in which pooled energy resources and machine learning-based approaches serving as a whole element of the SGs system that aids in making complicated logical judgments based on available data. The ML-based model keeps the system operating well and directs power to vital loads under challenging and unfavorable conditions. Using actual energy market data, the authors of designed and tested DLSTM (Deep Long Short Memory) model in order to anticipate power demand and price for the day and week ahead. Mean Absolute Error (MAE) and Normalized Root Mean Square Error (NRMSE) were used as benchmark parameters to assess the model's performance. Regarding precise forecasting of pricing and load, the suggested DLSTM model outperformed the already accepted standard techniques. To investigate and evaluate demand response's effects (DR) strategies under various time-dependent power costs, The result was the creation of a precise building simulation prototype. To monitor and manage a combined heat pump and thermal storage system, ML-based and rule-based DR procedures were both employed. To make the best choice possible with regard to energy consumption, cost, environment, utility, calculation, the two methods were trained, and assessed utilizing metered data together with a prediction model. When creating ML-based applications, the authors of presented the idea of an autonomous ML platform to aid in the creation of decision-making criteria. By maximizing the amount of intricate designs and knowledgeable breaks, the previous platform may be encourages advanced study. The performance of the suggested platform is particularly useful for ML-based database management uses in smart city applications. The authors of have suggested employing ML and SG an intrusion detection and position-finding system using power line communication (PLC) modems technique. The PLC modems constantly check the CSI and notify any variation brought on by the alleged intrusion. Monitoring energy use is possible using the suggested methodology. The security testbed for SGs systems was proposed by the authors of (see Table 2). It is a distributed platform that spans domains and replicates the information found in active power plants. Using the ISAAC platform, researchers may test and assess their security options for computers. The authors of have created a research that details the numerous difficulties ML- and cyber-based approaches in SGs confront. In, the writers suggested a DRL-based method dubbed deep-Q-network detection (DQND) to defend against accuracy of data threats under AC power networks. During the training phase, the suggested procedures are applied against the primary and intended networks to learn the best protection strategy. According to the experimental findings, the aforementioned procedure outperforms benchmark methods when it comes to detection and speed precision. The writers of suggested a novel DRL-based method for employing UAVs to check the power line infrastructure. The suggested model effectively finds a variety of power line faults, such as pole fractures, decay, and woodpecker damage, etc. The experimental findings demonstrate the effectiveness of the suggested approach in smart power line monitoring, which further boosts SG efficiency.

6. Applications of UAVs in 5G and B5G based on DRL communications

the present-day method for mobile wireless communication is moving toward 5G and B5G communications due to the rising need for high data speeds, high dependability, and low latency. The best method for addressing the numerous complicated communication problems requiring large amounts of network data has been recognized as AI, ML, and notably the DRL-based approaches. We will focus more on the use of unmanned aerial vehicles (UAVs) in 5G and B5G communication in the next sections, even if the aforementioned methods have contributed significantly to the development and sustainability of smart cities.

In a successful assess and identify cyberattacks networks for 5G and B5G communications, the authors have presented a novel paradigm. By examining many characteristics of network flows, DRL methods are used to gauge network traffic. A method to detect cyberattacks networks for 5G and IoT was provided by the authors in. The suggested method relies on a technique for deep auto-encoded dense neural networks that effectively identifies several online assaults.

UAVs still confront a lot of unresolved problems while having promising uses. For instance, LTE cellular service is not ubiquitous, especially in the sky. Serving BS antennas in LTE are down-tilted and mostly built for serving ground-based user equipment (UEs). Due interference and LoS-related issues with its design constraints, and cost difficulties, even 5G and B5G communication struggle to provide ubiquitous sky coverage. A ideal model must realistically take into account route loss, channel and antennas, and end-to-end communication topography or environment models, among other constraints, in order to function. The majority of optimization issues in modern system of communication also extremely non-convex and challenging to effectively address.

Table 2

Use of ML and DRL techniques in SGs based applications.

References	Year	Approach	Summary
[70]	2019	Anomaly detection algorithm	ML on physical data is used for identification of cyber–physical attacks.
[71]	2019	Simple fuzzer and DRL technique	To reduce the computational complexity of testing process.
[72]	2019	DRL-based intrusion detection system (IDS)	To stop cyber attacks on SGs, the proposed model utilizes the generation of blocks using short signatures and hash functions.
[73]	2019	ML	Designing anomaly detection engine for large-scale SGs, that can distinguish between actual fault and cyber intrusion.
[74]	2019	DRL techniques	Analysis of energy efficiency and delay issues in HetNets for SGs data communication under different delay constraints.
[75]	2019	DRL	Effective utilization of the energy storage appliances with varying tariffs structures.
[76]	2019	DRL and DNN	To help the service providers in acquiring energy resources from different customers to balance the energy variation and improve SG reliability.

To effectively handle many types of such difficult issues, such as avoiding aerial UAV collision by learning UAVs flight dynamics, UAVs landing over movable platforms, and UAVs identification based on numerous rotors, an ML-based technique known as DRL may be the best option, Precision farming methods that estimate soil moisture content and identify plants using data collection and image processing techniques; joint optimization issues based on UAV flight paths and schedules for receiving updated data from GTs; etc. Following, we provide an overview of a few research projects to deftly address various issues related to UAVs. For the trajectory optimization of many airborne UAVs, Challita et al. developed a deep (RL) framework utilizing an echo state network (ESN). The suggested approach makes it easier for UAVs to reduce interference at GBSs and improve the latency of data connection. Every UAV is an autonomous actor and learns the direction, power of the transmission, and association vector separately and collectively under the proposed system. A DRL method based on ESN was presented to guarantee UAVs' optimum trajectories and access to associated resources. The author claims that this is the first time the ESN-based DRL technique has been used for UAV communication to improve delay, interference, and energy effectiveness caused at GBSs. In, Herald et al. presented an architecture in which UAVs carry BSs and participate as users supporting the network. The sum rate is improved while in the airborne condition by using the reinforcement Q-learning technique. For UAV control and interference level optimization at ground BSs, Challita et al. used an ESN-based DRL method. Pattern recognition benefits most from machine and deep learning, which might also provide an appropriate study avenue for classifying and identifying UAVs employing the use of radar (see Table 3).

6.1. mmWave communication with DRL-based UAVs

When leveraging mmWave bandwidth for wireless The WSNs supported by UAVs can communicate handle greater data rate transmission. The mmWave technology's shorter wavelength enables the development of beam-forming antenna arrays and is perfect for communications aided by unmanned aerial vehicles (UAVs). Additionally, the mmWave beam's directionality contributes to improved data security and interference reduction. Figure 5 illustrates Even a human presence can prevent a mmWave connection from working and a flying UAV delivering coverage of the network using mmWave communication. A basic introduction to DRL and its uses in 5G mmWave communication is provided in this subsection. To address current issues and enhance mmWave communication, several attempts have been undertaken to create various essential strategies. We will concentrate on several DRL-based methods for designing effective 5G mmWave communications in the sections that follow. In order to offer a region with cost-effective 5G network coverage, Fadi et al. suggested a methodology for using the ideal number of UAVs. Equations for linear optimization are used to represent the issue, then genetic and simulated annealing (SA) techniques are used to effectively solve it. In, Meng et al. suggested a dynamic BS-based UAV-based communication system. An adjustable cylindrical antenna is included with the UAV to offer omnidirectional coverage. Additionally, a deep neural network-based attitude estimation mechanism was used in place of the conventional attitude estimate approach to create a communication link that is more dependable. Utilizing data from simulation trials, the effectiveness of the suggested strategy has been confirmed.

6.2. Positioning of UAVs for dumping data and maximizing throughput

The consumers' experience devices' quality of experience (QoE), In et al. suggested using CRAN environment with cache-enabled UAVs. The suggested approach makes advantage of everyday routines and human behavior to determine user-UAV relationships, the best location for UAVs, and the data must be stored for UAVs effective usage. Based on network availability and user data, the authors effectively predicted users' actions (such as mobility and content requests) using the ESNs approach. The writers determined both the information and the optimum position for the UAVs that should be stored at UAVs using the information presented above. A system was put out by Zhang et al. to forecast the deployment of UAVs as relay-BS to support cellular BS in circumstances including hot spots or high user congestion. In order to simulate cellular data patterns and the potential

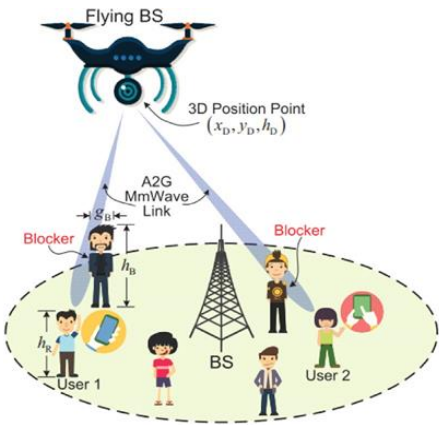

Fig. 3. Illustration of an aerial UAV that can block mmWave links and cover networks using mmWave communications.

Wavelet decomposition and compressive sensing-based ML approaches are used to the problem of network congestion. To allocate the most UAVs to the areas with the most anticipated data consumption, the contract matching problem was presented. According to simulation findings, the suggested UAVs predictive deployment greatly boosts ground BSs' overall performance in hot spot zones. In order to increase user throughput and system performance, Yirga et al. recommended using multi-layer perceptron (MLP) and long short-term memory (LSTM) approaches to forecast the best UAV placement. When previous approaches (such MLP and LSTM) are combined with the K-means clustering procedure to generate classes, the system's performance is assessed. The comparative analytical research demonstrates that the suggested method improves user throughput while providing an accurate UAV position.

7. Machine learning and smart city health care

Improved health care systems known as "health intelligence" now extensively employ methods using AI, ML, and DRL. This is due to the introduction of cloud computing, powerful IoT devices, and advanced sensors, as well as an increase in data rates. The aforementioned methods are essential for diagnosing diseases, predicting treatments, analyzing social media for a specific illness, and doing medical imaging. The latest research trends and initiatives related to health care in smart cities are briefly discussed in the sections that follow.

The review that the authors have created examines the role that 5G communication will play in the healthcare system, as well as the techniques, hardware, and architecture that will be needed and the important goals. Their main contributions are concentrated on the health care infrastructure powered by 5G and component technologies, a classification of network layer and communication protocol technologies problems (include traffic management, scheduling, and routing.) IoT-based health care systems must act quickly. Big data analysis in healthcare systems using applications of AI, ML, and DRL has been extensively researched and published by the authors. The authors highlight a wide range of advantages those already stated approaches, including categorization, diagnosis, and analysis of difficult data, sickness risk, optimal medication, likewise, patient survival estimates. However, there are a few challenges that need to be properly handled when using the aforementioned strategies, such as exact model training, clinicians' knowledge of the data analysis techniques and the data being researched, solving actual clinical concerns, and take into account certain ethical requirements. The authors offer four areas and refute the notion that doctors would be entirely replaced by AI in future health care systems

Table 3

Use of DRL algorithms in UAVs oriented applications.

References	Year	Approach	Summary
[90]	2019	ANN	UAVs connectivity, security, and secure operations.
[87]	2018	ESN-based DRL framework	Trajectory, latency, & interference optimization.
[88]	2019	Q-learning	UAVs as BS to improve sum-rate .
[89]	2018	DRL algorithm	UAVs utilization for interference optimization.
[91]	2019	Genetic and Simulated annealing (SA) algorithms	Optimal number of UAVs to ensure 5G communication
[92]	2019	Attitude estimation mechanism using a DNN	Improvement in network coverage.
[93]	2017	ESN technique to model users behaviors	Improvement in Quality of Experience (QoE).
[94]	2018	ML techniques	Assisting cellular BSs in high congestion zones.
[95]	2019	MLP and LSTM techniques	UAVs optimal positions to maximize data throughput.
[96]	2019	Q-learning and MDP	Optimal decision to charge sensor nodes, data collection, and UAVs hovering speed.
[97]	2019	Q-learning and ESN technique	Joint optimization of power control and sum-rate.
[98]	2018	DRL	UAVs handover issue and improvement in data rate.

In certain circumstances, the aforementioned tactics can be quite beneficial (including clinical decision-making, administration, patient monitoring, and health care mediation). The cornerstone for building a successful Using actual data, an AI-enabled system from the given area. The writers go through in detail how the idea of implementing using artificial intelligence to find new drugs impact both the study's medication development processes now used by the pharmaceutical sector. Numerous possible AI, ML, and DRL methods that might the IoT-based healthcare sector should be improved have been detailed by the authors of. Continuous monitoring is done via the HealthGuard of the core procedures for a variety of SHS equipment measures vitals and assesses changes taking place within the sick person's body order being able to distinguish calm and troubling activities. An REST API and communication protocols-based telemonitoring system have been proposed by the author that is based on remote body sensors and ontology rules. In order to enhance healthcare and planning, the authors of proposed the idea of analyzing satellite images and mapping rural settlements using ML and DRL methods. To investigate how DRL techniques affect medical image processing, the authors of have written a review Then sort a variety of spleen and stomach ailment types into different categories. The authors of the creation of an ML-based algorithm to estimate the chance of the patient surviving following a procedure for opening up the heart (PCI) (see Table 4).

8. Issues and upcoming objectives for the study

The use of AI, ML, and DRL in applications has yielded encouraging results. according to a body of writing that is currently accessible on smart cities. The following open research questions might be their primary focus, nevertheless, for the academic and corporate expert that is adept in enhancing the efficacy of smart cities through the application of AI, ML, and DRL:

• The ML and DRL methods require a significant amount of training data in order to be adequately trained (such as the location, the speed of the vehicle, the space between them, the driver's conduct, the height of the UAVs, relay BS, etc.) are required.

• By collaboratively maximizing the UAV's onboard resources, the effectiveness of ITS during UAV-vehicle communication may be significantly raised ML algorithms are used to analyze the trajectory of data and its dependencies (like computational, processing, sensor, and communication resources, or caching).

• Vehicles and unmanned aerial vehicles vehicle-UAV, vehicle-Vehicle, UAV-UAV, and UAV-GBS channels, while being around, etc. both common and irregularly built infrastructure, with varying UAV with different directions' vehicle speeds.

• Standardizing the growth of large data in SGs, selecting the best AI, ML, and DRL strategies that might improve SG performance to a level that is almost ideal, as well as the communication protocols used when several SGs devices work together.

• The standardization of SGs' communication architecture is required in order for them to efficiently interoperate with 5G technology, which is projected to be released in 2020 using the most recent 5G technologies.

• The ideal way to handle power-down scenarios is what any SGs or electric companies are mainly worried about. It is essential to conduct a communication delay evaluation research before designing a network with high efficiency. By using ML and DRL-based approaches, it is feasible to create techniques for transferring between 5G communication technologies while maintaining a stable supply of power.

Table 4

Use of AI, ML, and DRL techniques in smart healthcare applications.

References	Year	Approach	Summary
[109]	2019	AI	Using AI for drug discovery applications.
[111]	2019	DRL	HealthFog platform to analyze heart diseases.
[112]	2019	ML	HealthGuard platform to continuously monitors and compare the connected devices operations and body conditions.
[113]	2019	REST API	Remote patients care using telemonitoring and ontology regulations.
[114]	2019	DRL	Communities mapping for better healthcare using satellite imagery and DRL techniques.
[116]	2019	ML	Estimating patient chances of survival after PCI .
[117]	2020	AI System and three DRL Techniques	An AI system that surpasses human expertise in breast cancer detection.
[118]	2019	Genetic Programming	To differentiate between benign and fatal breast cancer.
[119]	2020	DRL	Breast cancer detection through mammograms screening.
[120]	2020	DRL	Categorization of invasive ductal carcinoma breast cancer.
[121]	2020	Logistic dependent model	Breast Cancer detection through Biomarker using innovative generalized logistic dependent model.

• In smart cities, security problems are application-specific. Ineffective SGs, for instance, might be the consequence of a smart meter security attack that modifies energy. Therefore, ever-sophisticated and cutting-edge solutions built on big data analytics are required to assure the applications for smart cities' cybersecurity and safety.

9. Conclusion

We looked at the latest trends and advancements in the field of smart cities research, as well as the work being done in both academia and industry to solve a wide range of difficult issues. What's important principles have been developed using AI, ML, and DRL methods. compiled into a brief study by our team. For a number of applications that are regarded to be crucial to the success of smart cities, we looked into the utility following the aforementioned protocols in order to design nearly perfect blueprints. We spoke about the need for new regulations that are AI-aided and SGs, cyber-security, and ITS that are compatible with AI and are energy-efficient UAV-aided The most current uses of AI, ML, and DRL in creating intelligent governance, as well as Smart cities using B5G connectivity. Just now, touched on how the aforementioned methods are becoming increasingly significant in smart health care, including their potential to help with the accurate diagnosis and restoration of health as well as the search for the most useful treatments. We covered the challenges facing smart city research now as well as potential future possibilities for this field of study in our last talk.

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