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Emerging Technologies for Smart Cities

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Preface

The International Conference on Emerging Global Trends in Engineering and Technology (EGTET) 2020 is the first International conference in the EGTET series, organized by Assam Don Bosco University as a continuation of its efforts to promote an environment of research and development in Northeast India. EGTET 2020 has provided a platform to scientists and researchers from all over India and abroad to present and share their contributions towards the achievement of sustainable technology.

EGTET 2020 attracted researchers not only from varied fields of Engineering and Technology but also from Physics and Chemistry. A total of 63 papers were received from various institutions all over India and neighbouring countries. A double-blind review process was then adopted for selecting the papers. After proper scrutiny of the research papers, around 30 papers were accepted out of which 23 papers were presented at the conference. Apart from the papers by the researchers, there were around 6 invited lectures presented at the conference by renowned scientists from India and abroad.

The proceeding of EGTET 2020 is a collection of 23 good-quality articles. These articles cover a plethora of topics such as IoT-based technology, Machine Learning, Sustainable Renewable Energy, Deep Learning, Biomedical Engineering, Reinforced Concrete Technology and Antenna Design.

We would like to convey our heartfelt gratitude to the Honorable Vice-Chancellor of Assam Don Bosco University, Fr. (Dr.) Stephen Mavely, for his constant support and motivation. We also would like to thank the Pro Vice-Chancellor of Assam Don Bosco University, Fr. Joseph Nellanatt, and Director—School of Technology, for their guidance and support in organizing this event. Our sincere gratitude to all keynote address presenters, invited speakers, session chairs, editors and other high officials from various organizations for their gracious presence on the campus on the occasion.

We thankfully acknowledge all the researchers for their contribution to this conference. We acknowledge all the organizations who have extended financial help towards this event.

We hope that the researchers from varied fields of Engineering and Technology will be benefited from the articles of this proceeding. Technologists from Industry would also find this volume to be a good source of reference.

Guwahati, India

Prabin K. Bora
Sukumar Nandi
Shakuntala Laskar

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About the Editors

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Indian Institute of Technology, Kharagpur. She has nearly four decades of teaching experience. During her teaching career, she had worked in reputed institutes like Assam Engineering College, Guwahati and Samundra Institute of Maritime Studies, Lonavala. Her major areas of research interests include Electro-optics, MEMS and Sensors. She has published quite a number of papers in reputed national and international journals. Prof. Laskar is also the Editor-in-Chief of ADBU Journal of Engineering and Technology (AJET).

Integration of IoT and Blockchain Technology for Smart Cities

Jerry Casper Kharbhih, Kausthav Pratim Kalita, and Rup Kumar Deka

Abstract In this modern era of the digital revolution, urban development is growing rapidly and many cities around the world are continuing to develop in many areas be its health sector, government sector, education sector and so on. But there is no denial that information and technology (IT) is one of the main contributors to this development. With the growing demand for smart devices such as smartphones along with various internet services, there is no doubt that communication has been made extremely easy for everyone. IoT is one of the emerging technology that can contribute to a smart city. It is seen that many IoT-based systems are currently used in various sectors from healthcare to parking systems and is proved to be efficient. But IoT suffers from security issues and is vulnerable to attacks. Blockchain on the other hand is a technology that is secured by design. It uses cryptography techniques to secure the data and is meant to be a trusted technology in a trust-less environment. In this paper, we discuss the existing systems that integrate these two technologies and mention the challenges faced when such systems are deployed in a working environment.

Keywords Smart cities · Internet of things · Block · Blockchain · Distributed · System

1 Introduction

If we see in recent years, urban growth has increased due to the increase in population. More and more people are moving into cities mainly because the opportunities

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in rural areas are quite less comparatively. So to earn a living, people from rural areas are moving into cities to get more opportunities so as to make a living. With the increase in population, many challenges also arise. Modern technology can help in coping with these challenges by optimizing the resources of the city, reducing the cost, provide better facilities that are reliable in various sectors such as health, transport, finance, etc. In the present world, we observe that there is significant growth in the field of IoT and wireless communication. With these technologies, we can easily connect various sensor devices and store the information in the cloud. We can also transmit data more easily between the various devices in a more optimized way with a minimum affordable cost. If these smart systems are integrated with the infrastructure of a city, then that city can be called a smart city. But one of the issues that arise when it comes to wireless networks and IoT is security. Many threats and attacks have been reported in trust-less or not fully reliable. Many approaches have been proposed to secure an ecosystem from such threats and one of the ways where such a system can be secured is by integrating blockchain technology into the smart system. Blockchain technology is secured by design as it uses cryptography techniques such as asymmetric cryptography, hashing and also digital signature to preserve the integrity of stored content. Its properties such as immutability, auditability, transparency, persistence and decentralization make the ecosystem better and more trusted.

1.1 Blockchain

Blockchain represents a chain of information where a single block stores transactions or information about the transfer of digital assets, thus, creating a shared ledger. Blockchain technology is decentralized in nature and there is no central server or central authority. Hence, the peers in the network need to keep the existing of the ledger by storing copies of it in their own machines. To make sure that the correct copy of the blockchain is considered, a consensus has to be reached between the various participants in the peer-to-peer network so that only the legitimate copy of the chain is considered. To solve this, various consensus algorithms have been proposed by different researchers. Among them, proof of stake and proof of work has been extensively used by various blockchain platforms. The blockchain basic element is a block. A block is composed of two distinct components which are the header and the body. The block header keeps the hash of the previous block which is the fundamental principle that allows restoring the immutability feature in this technology. It also enhances the security of the ecosystem. The last field in the block header stores application-specific details. This field is different for different blockchain technologies. Some of the information are block signature, nonce value, other data. The data in the block body depends on the services where blockchain is used. For example, if the service is a cryptocurrency service, then the data will be transaction records, if the service is related to smart contracts, the data will contain data related to the contracts and so on [1, 2].

1.2 Internet of Things

Internet of Things (IoT) serves as a network of energy-efficient devices that communicate among themselves using the internet. IoT technology uses various sensors to collect data from different types of sources ranging from environmental conditions to human health-related measurements. The data once accumulated is stored in a server (preferably could storage) and from the stored data, information is extracted which enables the system to take appropriate actions. Many IoT based system has been developed over the years and has helped a lot in various areas such as healthcare, agriculture, road safety, home security and so on. Research states that by 2020, almost all smart devices will use IoT at its core architecture. A smart city is one that integrates IoT into its infrastructure meaning, almost all of the sectors in the city will use IoT such as smart parking meters, smart healthcare, smart homes, smart environment and so on. But one of the prime challenges of IoT is security. IoT tends to suffer from various types of network attacks. Many methods have been proposed for securing the network and our study reveals that numerous research work suggests the utilization of blockchain to construct a secured platform to run IoT-based applications. With these two technologies, smart applications can be built for smart cities that are user-friendly, trusted and secure as well [3, 4].

2 Existing Systems

In smart cities, IoT applications are the main part of their infrastructure [3]. Blockchain on the other hand is a technology that is secured by design. In this section of the paper, we will see how these two technologies can be integrated and how they can contribute to the infrastructure of a smart city. A smart city security framework using IoT and blockchain is made of four layers namely the physical layer which consists of sensors and actuators, communication layer which consist mainly of network devices and wireless technologies, database layer which is represented by a shared ledger (private or public) and an interface layer containing various smart applications [3]. Each and every layer in the framework is secured using blockchain technology for example in the communication layer, blockchain is used for providing security during data transmission by various wireless communication.

[5] proposes an IoT and blockchain integrated system called “The CitySense System” whereby data from the city like temperature, humidity, traffic and are collected with the help of sensors and also a CitySense mobile app is used to collect data from users who are willing to co-operate and contribute to the system. The mobile app will also allow the transfer of information from the various sensors. Other functionalities of the app include a feedback and reporting system. The data collected is stored in a blockchain and will be analyzed. Based on the data collected, decisions are made for the benefit of the city. A user using the CitySense mobile application will also get the benefit of knowing the status of the environment, quality

Table 1 Existing systems integrating the internet of things and blockchain technology

Smart City issues	Proposed system	Blockchain used	Consensus algorithm	References
Vehicular network	Block-VN	Public	Proof of Work	[10]
Review Of The City's Environment	CitySense	Public/private	Proof of Stake	[5]
Energy Grid	Blockchain based Smart Energy Grid	Public	Proof of Identity	[11]
Data Management	Blockchain based hybrid network architecture for a smart city	Public	Proof of Work	[6]
Traffic and Vehicle Management	Speedy Chain	Private		[12]
Real Estate	Smart Contract For Real Estate	Private	Proof of Work	[13]
Law Enforcement	Custody Tracking System	Public	Proof of Concept	[14]
Efficient electrical energy transaction between prosumers	Blockchain-based peer-to-peer (P2P) energy transaction platform	Public/private	Proof of Work/Proof of Stake/Proof of Concept	[15]

of a particular area in the city and also the problems that are currently going on in the city. This system follows the same security framework in [3] and uses blockchain to secure all four layers.

According to the requirements for a smart city to be well established, data must be transmittable not only within a closed environment but also across cities. In [6], the authors propose a hybrid architecture for smart cities where technologies like blockchain and software-defined networks are merged to enable a scalable platform. The consensus mechanism used in their architecture is proof of work. The network is composed of two categories, namely, the core network and the edge network. Other proposed systems that integrates IoT and blockchain technology systems that can be can be summarized in Table 1.

3 Challenges in Blockchain Technology and IoT Integration

Integration of IoT and Blockchain technology will enable the development of smart systems that are user friendly, trusted, secure and reliable But as with any other technologies, IoT and Blockchain integration have some challenges of which some are discussed below. city, reducing the cost, provide better facilities that are reliable

in various sectors such as health, transport, finance, etc. In the present world, we observe that there is a significant growth in the field of IoT and wireless.

3.1 Storage Capacity

IoT devices when implemented in real-time can generate data in GBs per day. Blockchain may not be able to handle the rate at which the data is generated as it takes some time for a transaction to be verified by the nodes in the network. The consensus mechanism used also contributes to this factor. So hence this will be one of the challenges faced when integrating IoT and blockchain [7].

3.2 Security

One of the main issues of IoT is security. Although using blockchain can solve this issue, but one thing to keep in mind is that the data in the blocks are the only reliable data. There is a possibility that the data from IoT devices are not reliable or may be corrupted, hence using blockchain will end up with a chain of blocks containing non-reliable data or corrupted data which is not desirable. Hence this is another challenge faced when integrating IoT and blockchain [7].

3.3 Processing Power

Systems using IoT consist of various devices connected to each other in a network. These devices have different processing time and power. This means that the various devices will run the same encryption algorithm at their own time and speed. This might result in a case where the speed and time taken by any of the IoT devices for running the encryption algorithm will not meet the required speed and time [8].

3.4 Legal Issues

As Blockchain aims to develop systems that are decentralized and not under the control of any authority or third party, the manufacturers and the service providers will have certain issues. This is one of the reasons many are not adopting blockchain in their business and applications [7, 8]. Apart from the challenges mentioned, IoT and blockchain technology have challenges on their own as well. Examples of issues in IoT are mainly related to security such as jamming attacks, replay attacks, wormhole

attack, sybil attacks, etc. On the other hand, example issues related to blockchain are 51% attack, nothing at stake problem, double spend attack and forks [4, 2].

4 Conclusion

Seeing the advancement in the field of IoT, it will not be long one will see the growth of smart cities in the coming years. With smart devices and smart systems coming up and also with the coming up of 5G wireless technology, it is evident that cities will start adopting smart systems as they are fast and more efficient than traditional systems. It is also seen that a lot of research is done on blockchain technology and there are also some current applications of it such as cryptocurrencies(bitcoin, nxt coin, ppcoin), smart contracts, hyperledger [2, 9]. With these two technologies combined, smart systems can be made that are not only efficient but also secure, reliable and trusted. In this paper, we have discussed about the Internet of Things, blockchain technology, the existing system that integrates both the technologies and finally the challenges faced when integrating both the technologies.

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An IoT and Machine Learning-Based Crop Prediction System for Precision Agriculture

Saria Parween, Arunangshu Pal, Itu Snigdh, and Vinay Kumar

Abstract With the advancement of intelligent devices we stand among a plethora of technologies, tools, state-of-the-art techniques, and proof of concepts for a number of applications that essentially use a huge volume of data. Our precision agriculture system aims towards low input, high accuracy with the help of machine learning and the Internet of things towards sustainable agriculture. This article presents results that show that the prediction of fertilizer with different classifiers can be calculated accurately with corresponding heatmaps. We show that Naive Bayes is more accurate as it depends on probabilistic features. Hence, this classifier can be used for better crop prediction.

Keywords SVM · Naive bayes · Machine learning · IoT · Precision agriculture

1 Introduction

IoT is defined as a system that is built for bigger things rather than smartphones and wireless devices, connected by communication infrastructure with a range of software and work according to the sensed environment without human intervention. Such applications find wide use in Climate Science, Neuroscience, Environmental Science, Precision Agriculture, Epidemiology/Health care, Traffic Dynamics, Crime data, etc. These applications need sensor networks to collect data for the necessary analysis and prediction. IoT (Internet of Things) in smart agriculture refers to the use of cameras,

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sensors, and other devices wherein every action has been done corresponds to related data. India's start-up ecology is the 3rd largest technical ecology in the world with 60-65% start-ups where 70% of them are not more than 7 yrs old. These startups focus on customers as well as agricultural and industrial areas [1] since the Industrial sector contributes 31% of the Indian GDP while the agriculture sector contributing around 16% of the Indian GDP.

Smart agriculture is a need of our modern world to grow more food with effective use of the land. Based on this idea many countries have started the implementation of smart agriculture. Researchers from different parts of the world have proposed and published their ideas to solve the traditional farming challenges. Since there is a need to evaluate and monitor industrial agricultural enterprises, as it is currently a high-tech sector of the economy, precision agriculture finds its important place in the Internet of things applications. Smart agriculture has been realized with diverse technologies, some of which are computationally constrained like wireless sensor networks approach or computationally intensive like machine learning models. Internet of Things is the technology that employs both sensors as well as for analytics for implementing precision agriculture.

Current technologies provide common practices done at the farm level with the help of geo-referencing or meteorological data. Some of them include electromagnetic soil mapping, soil sample collection, and crop yield data collection. Others focus on soil types, soil characteristics, drainage level, Arial imagery and crop and soil index mapping [2, 3].

With the use of intelligent systems and without the requirement of regular human intervention, monitoring the agricultural lands and products would create an efficient system. Smart agriculture applications adapt to handle monitoring and decision-making remotely through intelligent devices like sensors and actuators. The current techniques for precision architecture are enumerated as follows:

1. Use of GPS

Access to position locating satellite enables the farmers to closely monitor their crops against weeds, intruders and weather notifications enabling convenience. However, these require expensive and bulky equipment to be installed in the fields wherein the monitoring of devices becomes an overhead.

2. VRT(Variable Rate Technology)

This enables the variable application of input. It controls the number of inputs like fertilizers, pesticides that farmers apply to a specific location. It allows the soil to recover its lost nutrients, maintains soil fertility, prevents soil erosion. The cultivation of different crops in a sequenced season is done in this type.

Moisture, temperature, pH and soil water are important aspects of plant growth. As the demand for food increases day by day, we need to increase food production with the efficient use of limited resources like freshwater. In this view, IoT can be a game-changer because the IoT devices, especially the sensors, can constantly monitor the different environmental conditions as well as the soil condition by continuously

collecting data about them. With the help of these data, IoT can assist an automatic system to control irrigation, pest control, etc. in a better direction to grow more and quality food [4, 5].

2 Related Work

Wireless sensor-based smart agriculture use microcontrollers to monitor the soil moisture with the help of ground- implanted sensors. The system sends the data from sensor to the database server through the internet and also automatically notifies the users if the moisture level reached a certain level. In [6], the author reviewed different use of WSN technology used in the aeroponic method of cultivation. The aeroponic system is a new and modern plant cultivation technique of agriculture, where plants are cultivated under a completely controlled condition in a closed chamber by giving a small amount of mist of nutrient solution in place of the soil. In a periodical basis, the nutrient mist is ejected through atomization nozzles. They discussed that using WSN we can easily detect and diagnosis the fault at an early stage without depending upon the laboratory test. It is also mentioned that by using WSN remotely a farmer can able to control the aeroponic system. Similarly, IoT-based systems have been used to overcome the constraints of bandwidth and power of sensor nodes, by designing a state of the art for LoRaWAN [7], where sensor nodes are enabled with the feature of low power consumption and long-range communication. They also proposed to learn and adopt an algorithm to extend the operational lifetime of the sensor nodes as well as the WSN. In this work, each sensor node has the capability to decide which data must be sent to the fusion center, for that author proposed a two-step decision algorithm.

Computational intelligence [8–10] is a powerful tool to develop an automated decision-making system for precision agriculture. Many researchers have been shown the advantages of neural networks in many applications like simultaneously handle quality and quantitative information in agro studies, which can be effective for handling nonlinear and linear responses. It has been accepted by researchers that Artificial Neural Networks (ANN) based model can be trained based on different physical soil information to monitor and predict soil health. Some researchers predict the crop product with the help of combining satellite image information, electrical conductivity value of soil particles, soil fertility, and elevation. However, their proposed system was unable to forecast the spatial variation in the yield because the soil fertility and soil conductivity properties are closely correlated to yield. Machine learning is one of the most suitable methods for solving multi-valued statistical problems and it can also work in unsupervised mode with the help of clustering data. Non-linear-based algorithms have also been proposed by researchers for yield prediction, but the results obtained are not very promising. Also, laboratory methods are very time-consuming and expensive.

Ongoing progressions in Machine learning have furnished the science and engineering community with an adaptable and quick forecast system, demonstrating a