Chapter 10
Blockchain-Enabled Internet of Things (IoT) Drones for Smart Surveillance: Architecture, Challenges, and Future Directions

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ABSTRACT

This chapter discusses how blockchain can be combined with Internet of Things (IoT); unmanned aerial vehicles (UAVs)/drones to form a safe, autonomous, and smart system of surveillance. Given that traditional surveillance systems are exposed to centralization, risk of data manipulation and limitations on scalability, blockchain embedded into the use of the IoT-powered drones provides a solution that is decentralized and tamper-free. The most important applications used throughout border security, disaster rescue, and urban security are discussed, and the technological, operational, and regulatory issues of these applications are also examined critically. Future research directions are also given, such as the integration of AI, as well as lightweight blockchain protocols suitable to drones. The chapter can be of perspective help in providing the overview to the extent in which the blockchain-IoT drones can change the future of surveillance systems.

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I. INTRODUCTION

Our modern culture has made surveillance a significant part of our every-day life, ranging as far as national security, environmental observation, catastrophe relief, traffic control, agricultural practices, and intelligent city infrastructure. The demand of efficient, real-time surveillance systems has never been higher as urban life gets more complicated and the crimes against public safety grow more advanced. Surveillance is no longer a luxury or an optional support but it is a vital tool helping in the governance as well as the wellbeing of the people. In that regard, the proliferation of changes in surveillance technologies can be viewed as a paradigm shift wherein passive camera systems are no longer in use but as intelligent and data-driven ecosystems (Yazdinejad et al.,2020).

Appearance of drones or rather Unmanned Aerial Vehicles (UAVs) has transformed the radius of surveillance systems. There is the mobility and flexibility that a drone provides, unlike the usual surveillance equipment installation which is fixed or semi-portable. Their ease of flying across rough terrains, giving aerial views, as well as reaching locations in the far or dangerous places makes them a priceless object used in many ways. Whether taking a look at large agricultural territory or establishing search-and-rescue operations in the areas affected by a disaster, drones are re-engineering real-time data gathering and examination strategies. In conjunction with IoT sensors, i.e. gadgets able to sense movement, temperature, air quality, sound, etc., drones become dynamic hubs of data which then become part of a decentralized and smart surveillance network (Tychola et al.,2024).

The combination of drones and IoT is exciting but does not lack shortcomings. Data management is one of the greatest problems. As thousands of sensors transmit information in real-time to centralized systems, the problem of information overload, latency and single-point failures arise. In addition, inquiries on information protection and legitimacy become increasingly essential as sensitive data comes to be exchanged across networks. Conventional surveillance systems based on the principle of centralized designs pose the greatest threat to any cyber-attack, manipulation and data integrity loss. This highlights the necessity of more effective and safe technological infrastructure that should be able to resist the growing complexity of the contemporary surveillance systems (Prabadevi et al.,2021).

Essentially, blockchain involves a non-hierarchical record system that brings in the qualities of decentralization, data immutability, and irreversibility, along with data security in the transactional context. However, as opposed to conventional databases which exist under a central authority, blockchain spreads the data among a set of nodes, and therefore is not vulnerable to tampering and other malicious changes. By combining the use of a blockchain with drone and Internet of Things technologies, blockchain can enable a verifiable history of surveillance data that may improve trust and accountability. Every single piece of data that a drone or an IoT gadget captures may be timestamped on the blockchain and encrypted, and it will be impossible to delete the information or hide it without a trace (Aggarwal et al.,2020).

By combining the blockchain technology with the capabilities of drones powered by IoT, an ultimate surveillance infrastructure can be developed, which meets the fundamental shortcomings of current systems. As an example, a drone with thermal imaging and motion sensor can fly and scan the entire perimeter, storing information on a blockchain network, without a crew in the case of a border security application. This does not only provide real-time monitoring but also ensures the data will be secure and nobody will be able to manipulate it using malicious purposes. In the same way, drones used in traffic management can be used to gather data on vehicular and pedestrian traffic, which through the use of a blockchain could be employed to control the traffic lights in a way that maximizes security of the populace without invading personal privacy (Gul,2022).