Smart Surveillance Cars in the IoT Era: A Review of Wireless Technologies

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***Abstract*—Smart surveillance cars are a new and powerful way to keep places safe. Unlike fixed cameras, these cars can move around, collect live information, and send it over wireless networks. Due to the Internet of Things (IoT), they can be controlled from far away, drive by themselves, and show live video. This paper looks at what smart surveillance cars are, what parts they use, and where they are helpful, like in patrolling, helping after disasters, military use, and checking restricted areas. It also compares old methods with these new smart systems. Special focus is given to the wireless technologies that make all this possible, such as WiFi, Bluetooth, 4G/5G, LoRa, and ZigBee. These are compared based on how far they work, how fast they are, and how much power they use. In the end, the paper talks about how future work can make these systems even better by using more advanced and energy-saving technology.**

***Index Terms*—Smart Surveillance Cars , Internet of Things (IoT) , Wireless Communication , WiFi Control , Remote Monitoring , Mobile Surveillance , 4G/5G Networks , Real-time Video Streaming , Autonomous Vehicles , IoT Security Systems**

I. Introduction

In recent years, surveillance technology has improved very quickly, mostly because of progress in the Internet of Things (IoT) [1]–[3]. In the past, we mostly used regular CCTV cameras and people to monitor security. But now, smarter and more connected systems are taking over [4]–[6]. One big improvement is the smart surveillance car. These cars can move around and monitor different areas, which helps fix the problems of cameras that stay in one place [7]–[9].

Smart surveillance cars use several advanced technologies [10]–[12]. They can drive themselves (autonomous navigation), have high-quality cameras, use artificial intelligence (AI) to think and learn [13]–[15], and connect wirelessly using modern communication systems [16]–[18]. These mobile systems can work in many places—from city streets to dangerous disaster zones—and they help monitor situations in real time without putting people in harm's way [9], [19]–[21].

There are a few main reasons why smart surveillance cars have become more popular. First, there is a growing need for better security in both public and private areas [22]–[24]. Second, the technology for self-driving vehicles has improved, making these cars more useful and trustworthy [25]–[27]. Third, faster wireless networks like 5G have solved older problems with slow data transmission and delays [28]–[31].

In this paper, we will focus on the wireless systems that allow the cars to communicate and help people control or interact with the system [32]–[34]. We will look at how current systems are being used, compare different technologies [35]–[37], and discuss the problems and opportunities that lie ahead [38]–[41].

This review is important for two groups. For researchers, it gives a clear summary of current technologies and shows where more work is needed [42]–[44]. For people who work in security or make policy decisions, it offers useful information about what these systems can and can't do, helping them make smarter choices when planning or improving surveillance systems [20], [38], [45]–[51].

II. System Architecture

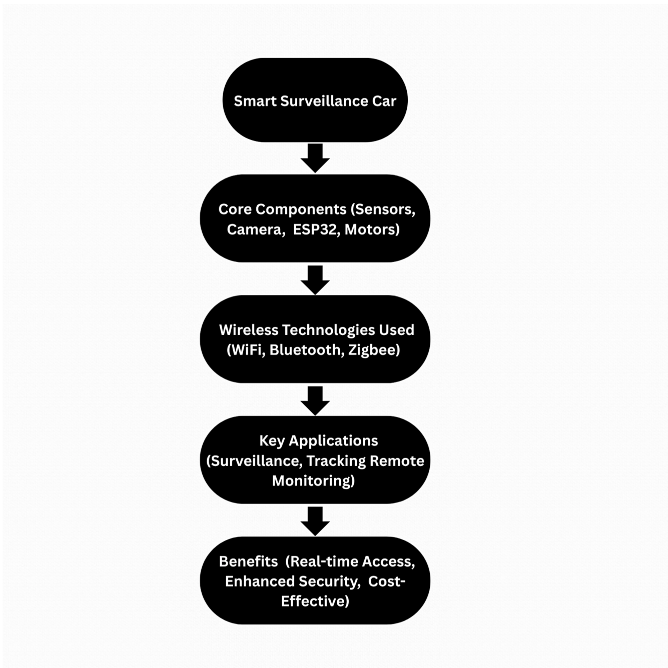

Fig. 1. Block diagram of Smart Surveillance Cars

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III. Smart Surveillance Cars: Concept and Applications

Smart surveillance cars are autonomous or remotely controlled vehicles equipped with cameras, sensors, and communication modules. These vehicles can collect and transmit video, audio, environmental data, and other metrics in real time, making them suitable for a variety of scenarios that require mobile monitoring.

A. Key Components:

- Embedded Systems
- Cameras and Sensors
- Wireless Communication Modules
- Power System
- Chassis and Mobility Mechanism

B. Key Components Explanation:

Smart surveillance cars are built from a combination of different components that work together and allow remote monitoring, movement, data collection, and communication. Important components are embedded systems, cameras and sensors, wireless communication modules, a power supply system, and the physical chassis with mobility mechanisms. Each part plays an important and unique role in making the vehicle intelligent, mobile, and capable of performing tasks in various environments.

1) Embedded Systems : Embedded system is one of the most essential component of a smart surveillance car, which controls the entire vehicle like our brain control our body. This is typically a small yet powerful microcontroller or microprocessor, both can be used, like the ESP32 or Raspberry Pi. The ESP32 is known for its built-in WiFi and Bluetooth support and is often used in low-power applications that require wireless communication and sensor control. On the other hand, Raspberry Pi is a more capable small computer system, suitable for tasks that involve image processing, video streaming, or running full-fledged operating systems like Linux. These systems collect and process data received from sensors and cameras, make decisions, and control motors and communication modules, all in real time.

2) Cameras and Sensors : Another important component of the smart surveillance car is the set of cameras and sensors installed onboard. Cameras are primarily used for filming video. They capture and stream live footage to a remote user or control center, allowing the controller to get information by monitoring of the environment. Depending on the application, these can be basic webcams, night-vision cameras, or HD modules capable of facial recognition. Besides cameras, various sensors are used to help the vehicle understand and interact with its surroundings. Ultrasonic sensors help to measure the distance of nearby objects to avoid collisions, infrared sensors assist in low-light or line-following operations, and GPS modules provide accurate location tracking. According to the environment different sensors like gas detectors or temperature sensors can be installed to monitor air quality or detect fire and toxic gases. Together, these sensors form the eyes and ears of the surveillance car.

3) Wireless Communication Modules : The car must have a reliable wireless communication module to communicate with its operator or a central system. These modules allow the car to exchange data over different wireless standards. WiFi modules are commonly used for local control and fast data transmission, especially when streaming live video. Bluetooth modules offer low-power, short-range connectivity and are suitable for basic command control in small areas. For long-distance communication, 4G/5G LTE modules are used, which connect the car to the internet through cellular networks. This makes it possible to control the car from virtually anywhere in the world and to send real-time updates, video feeds, and sensor readings back to a server or mobile device. Choosing the right wireless technology depends on the use case, such as the need for speed, range, and reliability.

4) Power System : The power system is another essential part of the vehicle. Since the car is often used in the field, it runs on rechargeable batteries, usually lithium-ion or lithium-polymer due to their high energy density and long life. These batteries supply power to all the onboard systems, including the motors, sensors, controller, and cameras. Along with the batteries, power management circuits are included to handle safe charging and discharging, prevent overvoltage or undervoltage conditions, and regulate the power supplied to different components. In some advanced models, solar panels are integrated into the chassis to extend operation time without manual recharging, especially useful in remote outdoor environments.

5) Chassis and Mobility Mechanism : Chassis and Mobility mechanism form the body and movement system of the car. The chassis is the structural frame that holds all the components together and must be strong yet lightweight. It can be made from plastic, aluminum, or composite materials depending on the requirements. Attached to the chassis is the mobility system, which includes wheels, DC or servo motors, and sometimes steering mechanisms. For flat surfaces, a simple two-wheel drive with a caster wheel is enough. For rough surface, a four-wheel drive or even tracked wheels are preferred for better performance. The motors are controlled through a motor driver that receives signals from controller, allowing the car to move forward, backward, and turn smoothly. This mobility system help the car to navigate its environment efficiently, even in challenging conditions.

C. Applications:

Smart surveillance cars posses lot of real-world applications where typical surveillance systems does not have. Because these vehicles are mobile, connected to internet and intelligent, they provide flexibility and responsiveness in situations where fixed cameras and human patrols may not be too 'effective or safe and send necessory information to the control center. Their ability to stream live video, collect environmental data, and move autonomously makes them unique q for many important fields.As shown in Table 1, smart surveillance cars offer better coverage and flexibility compared to traditional fixed CCTV systems, allowing them to monitor wider areas and adapt to different environments [7], [19].

- Security and Patrolling
- Disaster Response
- Military and Defense
- Remote Monitoring

D. Application Explanation

1) Security and Patrolling : One of the most common uses of smart surveillance cars is in security and patrolling where satellite and drones cannot work like tunnels. These vehicles can be deployed in places like large campuses, industrial areas, airports, parking lots, and residential communities to patrol regularly without human involvement. Since it is possible to control and stream live video and respond to events like motion or sound, they provide real-time updates to security teams. This helps prevent theft, vandalism, and unauthorized access, especially during night or in areas with low visibility.

2) Disaster Response : Another important application is in disaster response. After a natural disaster like an earthquake, fire, flood, or chemical leak, it's often too dangerous to send humans into affected areas immediately. Smart surveillance cars can be sent into these zones to analysis the damage, search for survivors, detect hazardous substances, and provide live video footage to emergency teams. With the help of sensors, they can also check air quality, temperature, or hazardous gas levels to warn about dangerous conditions.

3) Military and Defense : In the field of military and defense, these cars are used for missions that require stealth, surveillance, and safety. They can patrol borders, monitor war zones, or scout ahead in risky areas without putting soldiers life in danger. Some are even equipped with thermal imaging or night vision cameras for operations during night time. Their ability to move quietly and send back secure, encrypted video makes them valuable assets in modern warfare and intelligence gathering. It also can be used in tunnel war where the risk of trap is unexpected and high.

4) Remote Monitoring : Surveillance cars be used where the entry of human is restricted. In those places where risk is high line nuclear power plants, research labs, or chemical factories, safety regulations often limit human access. These cars can easily navigate through such areas, monitor equipment, check for leaks or overheating, and report issues to the command center. They reduce the need for humans to be exposed to dangerous conditions and can work continuously with minimal maintenance.

TABLE I
COMPARISON OF SMART SURVEILLANCE CARS WITH TRADITIONAL METHODS

Application Area	**Traditional Methods**	**Smart Surveillance Cars**
Security and Patrolling	Fixed CCTV or manual patrols	Mobile patrolling, live video, quick response
Disaster Response	Delayed response, risky for human teams	Immediate Access, safe data collection
Military and Defense	Needs human scouts, risk to soldiers	Autonomous scouting, remote viewing
Restricted Area Monitoring	Limited access, unsafe for humans	Safe, real time inspection without human entry
Real-time monitoring	Manual review of footage	Live video feed and alerts
Wide area coverage	Multiple fixed cameras needed	Covers large area by moving
Remote control and navigation	Mostly manual patrols and fixed systems	Controlled remotely, responds quickly

E. Advantages of Smart Surveillance cars over Traditional Methods

Smart surveillance cars offer many advantages compared to traditional methods. Unlike fixed cameras it cover much larger area. It makes them ideal for places where things are unpredictable or where full coverage is hard to achieve with human security. They can also be quickly sent to specific spots when something unusual happens, allowing for a faster response. Traditional systems often rely on people sitting in control rooms to notice problems, but smart cars can send real-time alerts and videos, helping decision-makers act immediately. They can even move through tough terrain where normal equipment can't go. Overall, smart surveillance cars are more flexible, faster, and provide better coverage, making them a big improvement over older surveillance methods.

IV. WIRELESS TECHNOLOGIES FOR REMOTE CONTROL AND SURVEILLANCE

The effectiveness of a smart surveillance car heavily depends on the robustness and efficiency of its wireless communication system. Various wireless standards offer different advantages in terms of range, speed, power consumption, and reliability. There are several wireless technologies used to control smart surveillance cars from a distance, each with its own strengths and weaknesses. WiFi is one of the most common options because it's fast and works well over short to medium distances, especially in areas with strong internet coverage. It's great for live video streaming and sending commands quickly. Bluetooth is useful for very short distances and low-power tasks, but it doesn't work well over long ranges. Cellular networks like 4G and 5G are powerful for long-distance control, allowing the car to be used in wide outdoor areas without needing a local network. They also support high-speed data transfer, which helps in real-time video and remote updates. However, they might not work in places with weak signal coverage. Technologies like LoRa and ZigBee are not commonly used for video or real-time control because they are slower, but they are very energy efficient and can be useful in simple sensor-based applications. In summary, WiFi and cellular networks are the most practical for smart surveillance cars, especially when fast and reliable control is needed. Table 2 provides a comparative analysis of wireless technologies used for remote control and surveillance applications, highlighting key attributes such as range, speed, power consumption, and reliability. The table summarizes various communication methods like WiFi, Bluetooth, Cellular Networks, LoRa, and ZigBee, along with their respective advantages and limitations [7], [19], [29], [38]. In Fig. 2, the graph depicting the wireless technologies used in remote control surveillance systems is shown, as referenced in [29], [19], [20], [7], and [22].

A. Overview of Communication Standards

- WiFi (IEEE 802.11)
- Bluetooth
- Cellular (4G/5G)
- LoRa and ZigBee

1) WiFi : WiFi is the most common choice for smart surveillance cars, offering a reasonable range (around 100 meters) and high-speed data transfer, especially useful for live video streaming and real-time control in areas with good internet coverage. However, it can be limited in terms of range and may not work well in remote areas with weak signals.

2) Bluetooth : Bluetooth has a much shorter range (around 10 meters) and lower speed (around 2 Mbps). It is most useful for applications where low power consumption is a priority and the control needs to happen in close proximity, such as personal devices or small-area surveillance, but it's not suitable for live video streaming or large-area control.

3) Cellular (4G/5G) : 4G/5G offers the best long-range capabilities (over 10,000 meters), high-speed data transfer (up to 1000 Mbps), and low latency, making it ideal for real-time remote control and live video streaming in outdoor and large-area applications. It's perfect for situations where quick response and high-quality video are required over long distances. However, it can be costly, and coverage might be weak in remote or rural areas.

4) LoRa : LoRa is a long-range, low-power wireless technology that works well for simple sensor data transmission (like temperature or motion). It has an impressive range of over 15,000 meters, but the speed is very low (0.05 Mbps), so it's not useful for video or high-bandwidth needs. LoRa is best used in IoT applications where minimal data needs to be transmitted over long distances.

5) ZigBee : ZigBee is a low-power, short-range option, with a range of around 100 meters and speeds of 0.25 Mbps. It is best for sensor-based applications that need low power usage and moderate data rates, like monitoring environmental factors or simple security devices, but it's not suitable for high-speed video streaming or large data transmission.

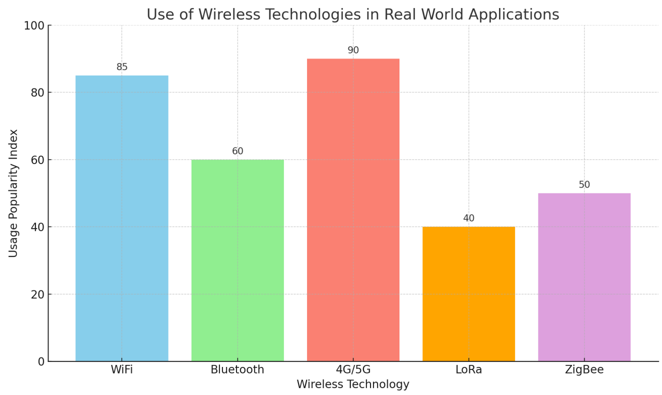

Fig. 2. wireless technologies used in remote control surveillance system graph [29], [19], [20], [7], [22]

B. Advantages and Drawbacks of each Wireless Technologies:

- WiFi: is great for medium-range applications with high-speed data needs like video streaming but is limited in outdoor or remote areas.
- Bluetooth : is best suited for low-power, short-range applications with minimal data needs, but not for large-area or video surveillance.
- Cellular (4G/5G): excels in long-range, high-speed control and live video streaming in outdoor settings, ideal for large and complex surveillance needs.
- LoRa offers excellent range and power efficiency but is only useful for low-bandwidth applications like sensor data.

TABLE II
WIRELESS TECHNOLOGIES COMPARISON FOR REMOTE CONTROL AND SURVEILLANCE

Tech.	Range(m)	Speed (Mbps)	E**	S**	Use Cases
WiFi	100	100	2	4	Ideal for areas with strong internet coverage, useful for live video streaming and remote control over medium distances
Bluetooth	10	2	4	2	Best for short distance control, low power devices, not ideal for large areas or live video
Cellular (4G/5G)	10,000+	1000	2	5	Excellent for long range control, real-time updates and high speed video streaming in wide outdoor areas
LoRa	15,000+	0.05	5	2	Ideal for low power, long distance sensor-based communications but not suitable for video streaming
ZigBee	100	0.25	4	2	Efficient in terms of power for simple sensor data transfer, not suitable for large data usage.

*E for Power Efficiency, S for Suitability and Scale is 1=Low, 5=High

- ZigBee : is effective for small-range, low-power applications but is unsuitable for high-speed control or large-area coverage.

C. Power Efficiency and Reliability:

Wireless communication modules consume varying amounts of power, impacting battery life. Bluetooth and ZigBee are power-efficient but lack bandwidth for video. Cellular and WiFi consume more power but offer better performance for video and control. Signal reliability is essential in mobile environments, and redundant systems or fail-safes are often required to ensure consistent operation.

V. CONCLUSION

Smart surveillance cars represent a significant evolution in mobile monitoring technology. Powered by IoT, these systems combine mobility, automation, and real-time wireless communication to provide flexible and responsive surveillance solutions. They are well suited for a variety of critical applications, including public safety, disaster response, and military operations.

Among wireless communication technologies, WiFi and cellular networks stand out for their support of real-time video and control. Each wireless standard has its own trade-offs in terms of range, power, bandwidth, and latency, and the choice largely depends on the specific use case.

Future research may focus on hybrid communication systems that combine multiple wireless technologies for greater resilience and adaptability. In addition, advances in AI, edge computing, and energy-efficient hardware will further enhance the capabilities of smart surveillance cars, paving the way for broader adoption in both urban and remote environments.

REFERENCES

[1] A. F. Santamaria, P. Raimondo, M. Tropea, F. De Rango, and C. Aiello, "An iot surveillance system based on a decentralised architecture," *Sensors*, vol. 19, no. 6, p. 1469, 2019.

[2] A. K. Gupta and R. Johari, "Iot based electrical device surveillance and control system," in *2019 4th international conference on internet of things: Smart innovation and usages (IoT-SIU)*. IEEE, 2019, pp. 1–5.

[3] S. N. Ibrahim, A. H. Basri, and A. L. Asnawi, "Development of web-based surveillance system for internet of things (iot) application," *Bulletin of Electrical Engineering and Informatics*, vol. 8, no. 3, pp. 1108–1116, 2019.

[4] H. Razalli, M. H. Alkawaz, and A. S. Suhemi, "Smart iot surveillance multi-camera monitoring system," in *2019 IEEE 7th Conference on Systems, Process and Control (ICSPC)*. IEEE, 2019, pp. 167–171.

[5] A. Rego, A. Canovas, J. M. Jim'enez, and J. Lloret, "An intelligent system for video surveillance in iot environments," *Ieee Access*, vol. 6, pp. 31 580–31 598, 2018.

[6] R. Ke, Y. Zhuang, Z. Pu, and Y. Wang, "A smart, efficient, and reliable parking surveillance system with edge artificial intelligence on iot devices," *IEEE Transactions on Intelligent Transportation Systems*, vol. 22, no. 8, pp. 4962–4974, 2020.

[7] S. Akter, R. A. Sima, M. S. Ullah, and S. A. Hossain, "Smart security surveillance using iot," in *2018 7th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO)*. IEEE, 2018, pp. 659–663.

[8] M. S. Shin, B. C. Kim, S. M. Hwang, and M. C. Ko, "Design and implementation of iot-based intelligent surveillance robot," *Studies in Informatics and Control*, vol. 25, no. 4, p. 422, 2016.

[9] M. A. Alsmirat, Y. Jararweh, I. Obaidat, and B. B. Gupta, "Internet of surveillance: a cloud supported large-scale wireless surveillance system," *The Journal of Supercomputing*, vol. 73, pp. 973–992, 2017.

[10] A. Šelek, D. Juri'c, A. Čirjak, F. Mari'c, M. Seder, I. Markovi'c, and I. Petrovi'c, "Control architecture of a remotely controlled vehicle in extreme cbrne conditions," in *2019 International Conference on Electrical Drives Power Electronics (EDPE)*. IEEE, 2019, pp. 273–278.

[11] P. A. Hoeher, J. Sticklus, and A. Harlakin, "Underwater optical wireless communications in swarm robotics: A tutorial," *IEEE Communications Surveys Tutorials*, vol. 23, no. 4, pp. 2630–2659, 2021.

[12] I. Calvo, E. Villar, C. Napole, A. Fern'andez, O. Barambones, and J. M. Gil-Garc'ıa, "Reliable control applications with wireless communication technologies: Application to robotic systems," *Sensors*, vol. 21, no. 21, p. 7107, 2021.

[13] N. S. K. Gunda, S. H. Gautam, and S. K. Mitra, "Artificial intelligence based mobile application for water quality monitoring," *Journal of The Electrochemical Society*, vol. 166, no. 9, p. B3031, 2019.

[14] T. Otani, H. Toube, T. Kimura, and M. Furutani, "Application of ai to mobile network operation," *ITU Journal: ICT Discoveries, Special Issue*, vol. 1, pp. 1–7, 2017.

[15] T. A. R. Sure, "The role of mobile applications and ai in continuous glucose monitoring: A comprehensive review of key scientific contributions," *International Journal of Artificial Intelligence in Medicine (IJAIMED)*, vol. 1, no. 1, pp. 9–13, 2023.

[16] A. M. Vegni, M. Biagi, and R. Cusani, "Smart vehicles, technologies and main applications in," *Vehicular Technologies: Deployment and Applications*, p. 1, 2013.

[17] D. Tardioli, "A wireless communication protocol for distributed robotics applications," in *2014 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC)*. IEEE, 2014, pp. 253–260.

[18] V. Srovnal Jr, Z. Machacek, and V. Srovnal, "Wireless communication

for mobile robotics and industrial embedded devices," in *2009 Eighth International Conference on Networks*. IEEE, 2009, pp. 253–258.
[19] A. R. Chougule and K. Suganthi, "Iot based smart car monitoring system," in *2018 Tenth International Conference on Advanced Computing (ICoAC)*. IEEE, 2018, pp. 281–285.
[20] N. Thakur, P. Nagrath, R. Jain, D. Saini, N. Sharma, and D. J. Hemanth, "Artificial intelligence techniques in smart cities surveillance using uavs: A survey," *Machine Intelligence and Data Analytics for Sustainable Future Smart Cities*, pp. 329–353, 2021.
[21] S. Wan, Z. Gu, and Q. Ni, "Cognitive computing and wireless communications on the edge for healthcare service robots," *Computer Communications*, vol. 149, pp. 99–106, 2020.
[22] M. Keertikumar, M. Shubham, and R. Banakar, "Evolution of iot in smart vehicles: An overview," in *2015 International Conference on Green Computing and Internet of Things (ICGCIoT)*. IEEE, 2015, pp. 804–809.
[23] H. Afreen, M. Kashif, Q. Shaheen, Y. H. Alfaifi, and M. Ayaz, "Iot-based smart surveillance system for high-security areas," *Applied Sciences*, vol. 13, no. 15, p. 8936, 2023.
[24] R. Srinivasan, A. Sharmili, S. Saravanan, and D. Jayaprakash, "Smart vehicles with everything," in *2016 2nd International Conference on Contemporary Computing and Informatics (IC3I)*. IEEE, 2016, pp. 400–403.
[25] K. Alli, C. Ijeh-Ogboi, and S. Gbadamosi, "Design and construction of a remotely controlled vehicle anti-theft system via gsm network," *International journal of Education and Research*, 2015.
[26] I. Rhiu, S. Kwon, S. Bahn, M. H. Yun, and W. Yu, "Research issues in smart vehicles and elderly drivers: a literature review," *International Journal of Human-Computer Interaction*, vol. 31, no. 10, pp. 635–666, 2015.
[27] C. Oham, R. A. Michelin, R. Jurdak, S. S. Kanhere, and S. Jha, "B-ferl: Blockchain based framework for securing smart vehicles," *Information Processing Management*, vol. 58, no. 1, p. 102426, 2021.
[28] D. Singh, G. Tripathi, S. C. Shah, and R. da Rosa Righi, "Cyber physical surveillance system for internet of vehicles," in *2018 IEEE 4th World Forum on Internet of Things (WF-IoT)*. IEEE, 2018, pp. 546–551.
[29] K. Shah, C. Sheth, and N. Doshi, "A survey on iot-based smart cars, their functionalities and challenges," *Procedia computer science*, vol. 210, pp. 295–300, 2022.
[30] M. Di Felice, R. Doost-Mohammady, K. R. Chowdhury, and L. Bononi, "Smart radios for smart vehicles: Cognitive vehicular networks," *IEEE Vehicular Technology Magazine*, vol. 7, no. 2, pp. 26–33, 2012.
[31] G. Lackner, "A comparison of security in wireless network standards with a focus on bluetooth, wifi and wimax." *Int. J. Netw. Secur.*, vol. 15, no. 6, pp. 420–436, 2013.
[32] Z. Wang, M. Zhou, and N. Ansari, "Ad-hoc robot wireless communication," in *SMC'03 Conference Proceedings. 2003 IEEE International Conference on Systems, Man and Cybernetics. Conference Theme-System Security and Assurance (Cat. No. 03CH37483)*, vol. 4. IEEE, 2003, pp. 4045–4050.
[33] H. Schiøler and T. S. Toftegaard, "Wireless communication in mobile robotics a case for standardization," *Wireless Personal Communications*, vol. 64, pp. 583–596, 2012.
[34] J. Fink, A. Ribeiro, and V. Kumar, "Robust control for mobility and wireless communication in cyber–physical systems with application to robot teams," *Proceedings of the IEEE*, vol. 100, no. 1, pp. 164–178, 2011.
[35] H. A. Chan, "Comparing wireless data network standards," in *AFRICON 2007*. IEEE, 2007, pp. 1–15.
[36] J.-S. Lee, Y.-W. Su, and C.-C. Shen, "A comparative study of wireless protocols: Bluetooth, uwb, zigbee, and wi-fi," in *IECON 2007-33rd Annual Conference of the IEEE Industrial Electronics Society*. Ieee, 2007, pp. 46–51.
[37] N. Gandal, D. Salant, and L. Waverman, "Standards in wireless telephone networks," *Telecommunications Policy*, vol. 27, no. 5-6, pp. 325–332, 2003.
[38] N. K. Dewi, "Review of vehicle surveillance using iot in the smart transportation concept," *International Journal of Engineering and Manufacturing*, vol. 11, no. 1, p. 29, 2021.
[39] S. Kumar, S. Swetha, V. T. Kiran, and P. Johri, "Iot based smart home surveillance and automation," in *2018 International conference on computing, power and communication technologies (GUCON)*. IEEE, 2018, pp. 786–790.
[40] E. Ferro and F. Potorti, "Bluetooth and wi-fi wireless protocols: a survey and a comparison," *IEEE Wireless Communications*, vol. 12, no. 1, pp. 12–26, 2005.
[41] G. Bhatti, H. Mohan, and R. R. Singh, "Towards the future of smart electric vehicles: Digital twin technology," *Renewable and Sustainable Energy Reviews*, vol. 141, p. 110801, 2021.
[42] H. Shokravi, H. Shokravi, N. Bakhary, M. Heidarrezaei, S. S. Rahimian Koloor, and M. Petr, "A review on vehicle classification and potential use of smart vehicle-assisted techniques," *Sensors*, vol. 20, no. 11, p. 3274, 2020.
[43] N.-A. Le-Khac, D. Jacobs, J. Nijhoff, K. Bertens, and K.-K. R. Choo, "Smart vehicle forensics: Challenges and case study," *Future Generation Computer Systems*, vol. 109, pp. 500–510, 2020.
[44] M. Guinaldo, E. F'abregas, G. Farias, S. Dormido-Canto, D. Chaos, J. S'anchez, and S. Dormido, "A mobile robots experimental environment with event-based wireless communication," *Sensors*, vol. 13, no. 7, pp. 9396–9413, 2013.
[45] L. K. Gunnemeda, S. C. Gadde, H. Guduru, M. B. Devarapalli, and S. K. Peketi, "Iot based smart surveillance system," *International Journal for Advance Research and Development*, vol. 3, no. 2, pp. 166–171, 2018.
[46] R. Rajavel, S. K. Ravichandran, K. Harimoorthy, P. Nagappan, and K. R. Gobichettipalayam, "Iot-based smart healthcare video surveillance system using edge computing," *Journal of ambient intelligence and humanized computing*, vol. 13, no. 6, pp. 3195–3207, 2022.
[47] P. L. Chong, Y. Y. Than, S. Ganesan, and P. Ravi, "An overview of iot based smart home surveillance and control system: Challenges and prospects," *Malaysian Journal of Science and Advanced Technology*, pp. 54–66, 2022.
[48] H. Yang, B. S. Yeow, Z. Li, K. Li, T.-H. Chang, L. Jing, Y. Li, J. S. Ho, H. Ren, and P.-Y. Chen, "Multifunctional metallic backbones for origami robotics with strain sensing and wireless communication capabilities," *Science Robotics*, vol. 4, no. 33, p. eaax7020, 2019.
[49] Z. Jeddi and A. Bohr, "Remote patient monitoring using artificial intelligence," in *Artificial intelligence in healthcare*. Elsevier, 2020, pp. 203–234.
[50] R. Samanoodi, A. Alrasheed, A. Felemban, A. Althobaiti, Y. Alnumay, H. Trigui, A. Algethmi, A. Alsomali, and S. Patel, "Ai-powered mobility application for field inspection rounds," in *Abu Dhabi International Petroleum Exhibition and Conference*. SPE, 2023, p. D041S136R002.
[51] S. Garawi, R. S. Istepanian, and M. A. Abu-Rgheff, "3g wireless communications for mobile robotic tele-ultrasonography systems," *IEEE Communications Magazine*, vol. 44, no. 4, pp. 91–96, 2006.