Review on Development of IoT-based Multi-Parameter Observing Robotic Vehicle for Various Application

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Abstract: ***The IoT-based robotic systems are applied for monitoring applications in agriculture, environmental sensing, mining safety, and surveillance with sensors and wireless communications that offer real-time data gathering and processing. This paper reviewed the recent IoT-enabled robotic monitoring systems and classified these based on application, sensing, and communication methods involved. A short comparison is included, showing the inadequacies of the existing ones. Key challenges and major areas of future improvement were also discussed.***

Keywords: IoT, robotic monitoring systems, agricultural robotics, environmental monitoring, gas detection and wireless communication

1.Introduction

IoT technology has enhanced robotic systems by allowing for real-time monitoring and operation of systems remotely. IoT-based robots have wide applications in agriculture, environmental monitoring, and mining safety and security applications. Though these systems enhance automation and safety, most of the systems still have challenges with respect to their mobility, sensing capability, and autonomy. This review paper studies existing systems and identifies research gaps to support future development.

2.Review of Related Work

Gowtham K. [01] developed an IoT-based multipurpose agricultural robot for monitoring soil and environmental parameters to support smart farming. The system improved automation in agricultural operations; however, it lacked advanced autonomous navigation and decision-making capabilities.

Preethichandra [02] proposed an IoT-enabled smart robotic system for environmental monitoring, integrating sensors for temperature, humidity, and gas detection with cloud-based data visualization. While effective for remote monitoring, the system showed limited validation in large-scale outdoor environments.

Koodtalang [03] presented an IoT-based framework for monitoring and controlling multiple mobile robots in outdoor environments. The system demonstrated scalability and coordinated robot operation, but increased system complexity and communication overhead remained key challenges.

Jitesh Kumar Sahu [04] developed Indri, a remote-controlled robotic system for hazardous gas detection in mining environments. The robot enhanced worker safety through real-time gas sensing, though its mobility was restricted in uneven and confined underground terrains.

Pradnya Bhoye [05] reviewed IoT-driven robotic systems and emphasized their role in enhancing automation, connectivity, and operational efficiency. The study provided valuable insights; however, it did not include experimental validation or practical implementation results.

Nakul Pandit [06] designed a multipurpose agricultural robotic vehicle (Agribot) capable of performing basic farming tasks with IoT connectivity. Despite its cost-effective design, the system lacked advanced sensing features such as gas detection and vision-based monitoring.

Balaji et al. [07] developed a smartphone-operated multipurpose agricultural robot, enabling remote control of farming activities using mobile applications. The system was easy to operate but suffered from limited communication range due to Bluetooth-based control.

Burra Hymavathi [08] focused on the design and structural analysis of a multipurpose agricultural robot, emphasizing mechanical configuration and task flexibility. However, real-time IoT monitoring and cloud integration were not addressed.

Chandana R. [09] proposed a multipurpose agricultural robot for automatic ploughing, seeding, and plant health monitoring. Although effective for precision agriculture, scalability and real-time data analytics were limited.

Jhansi Rani [10] presented an IoT-based environmental monitoring system for collecting real-time environmental data. The system was effective for static monitoring applications but lacked robotic mobility and autonomous operation.

3.Classification of Existing Systems

The existing IoT-based robotic monitoring systems analyze the current research trends based on their classification into application domain, sensor integration, communication technology, level of autonomy, and system architecture.

Agricultural robots support soil analysis, crop health monitoring, and farming operations but mostly lack gas sensing and intelligent navigation. Environmental monitoring robots, on the other hand, perform air quality and climatic parameter measurements and are often stationary or semi-mobile.

While mining and hazardous area robots rely on gas sensors and remote-control methods to protect workers from harm, surveillance and defense robots rely on cameras and wireless communication, although both are limited by factors of mobility, cost, and power efficiency.

Based on sensor integration, systems that include environmental sensing, gas detection, agricultural sensing, and multi-sensor fusion robots can be developed to give higher accuracy with increased system complexity and cost.

Communication, autonomy, and architecture a computing are based on the following classifications: Wi-Fi, GSM/GPRS, LoRa, and cloud platforms; manual to fully autonomous operation; and centralized or distributed designs involve trade-offs in terms of performance, scalability, and reliability.

4.Comparative Analysis of Existing Systems

Author	Year	Application	Sensors Used	Communication	Limitations
Gowtham K.	2025	Agriculture	Soil moisture, Temperature, Humidity	IoT (Wi-Fi)	Limited autonomous navigation
Preethichandra	2024	Environmental Monitoring	Temperature, Humidity, Gas sensors	IoT (Cloud-based)	Limited outdoor field testing
Koodtalang	2023	Multi-Robot Outdoor Monitoring	Environmental sensors, GPS	IoT	High system complexity
Jitesh Kumar Sahu	2024	Mining Safety	MQ Gas sensors	Wireless (RF/Wi-Fi)	Limited mobility in rough terrain
Pradnya Bhoye	2024	Automation (Review)	Multi-sensor systems	IoT	No practical implementation
Chandana R.	2020	Precision Agriculture	Soil, Plant health sensors	IoT	Limited scalability
G. Jhansi Rani	2020	Environmental Monitoring	Temperature, Humidity, Gas	IoT	No robotic mobility

5.Research Gaps and Challenges

The review of available IoT-based robotic systems reveals that all agricultural robots perform only crop and soil monitoring without gas sensing or intelligent navigation. Environmental monitoring robots are usually fixed or partially mobile, providing limited area coverage. Robots designed for mining and hazardous locations enhance safety by detecting gases, but their performance is constrained by poor mobility and high energy consumption. Multi-sensor and multi-robot systems increase the accuracy of monitoring, but at the cost of added complexity and a greater communication burden. Moreover, large-scale testing, real-time data processing, and adaptive decision-making are lacking in many of the systems.

6.Future Research Directions

The future work should pursue compact and low-cost robotic platforms capable of supporting multi-parameter sensing. Application of intelligent navigation should be done in a way to reduce human dependence and improve the operation efficiency. Energy-efficient communication technologies and hybrid architectures in IoT could enhance system reliability in an outdoor environment. The use of distributed data processing close to the source enables fast data analysis and timely decision-making. Another important emphasis shall be on real-world deployment and scalability of the proposed systems.

7.Conclusion

The review investigated recent IoT-based robotic monitoring systems applied in agriculture, environmental sensing, and safety applications. While current systems improve automation and accuracy of monitoring, limitations based on mobility, sensing capability, autonomy, and system complexity are not fully met. Comparative analysis shows that requirements such as integration, scalability, and energy efficiency are needed toward a robotic solution. Overcoming such system limitations can enhance performance and applicability by a big margin. In general, IoT-based robots should be developed for intelligent operation and practical deployment in future real-world scenarios.

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