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# The impacts of sensing robots in the Internet of Things

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**Abstract.** Sensing robots, autonomous robots capable of sensing, collecting and transmitting environmental data, play a key role in the development of the Internet of Things. The purpose of this paper is to discuss the role of sensor robots in the Internet of Things environment and what kind of impact it has on the Internet of Things, and discuss how sensor robots are changing people's lives and work. Finally, this paper emphasizes the key role of sensor robots in the Internet of Things, providing a strong support for the development of future intelligent Internet of Things systems. This research provides an in-depth theoretical basis for the application and development of sensing robots and has a wide range of application prospects. In general, sensing robots provide important data support for iot systems and promote the development of intelligent technology. They have broad application prospects and will continue to play an important role in various fields, bringing more convenience and innovation to people's life and work.

**Keywords:** sensing robots, Internet of Things, data

## 1. Introduction

The Internet of Things (IoT) is a very successful thing that has been developed to connect numerous devices, enable data-driven and decision-making across industries, and so on. At the same time, sensing robots are also developing rapidly, and the combination of the Internet of Things and sensing robots is also a very promising project at present. Sensing robots expand the scope and potential of IoT application environments. The rapid development of the Internet of Things combined with sensing robots has affected many industries. This revolutionary change in agriculture, for example, is changing current farming methods and creating new opportunities and challenges. This paper discusses the far-reaching impact of sensor robots on the Internet field and discusses how sensor robots enhance the data acquisition, processing, and utilization of the Internet of Things system, so as to improve efficiency, accuracy, and real-time response ability. At present, the Internet of Things sensor robots have been applied in many fields, and have brought great progress to people's work. Such as the medical field, agriculture, manufacturing, and other fields. The technical challenges and opportunities of sensor robots in the IoT ecosystem are also discussed, and there are still some developing issues between sensor robots and IoT, such as the existence of better solutions for resource allocation. As well as security-related issues, potential solutions to effectively address these challenges are presented.

Existing research shows growing interest in the intersection of sensor-equipped robots and the Internet of Things. Researchers and practitioners alike have recognized the potential of these robots to enhance data acquisition, monitor remote or hazardous environments, and optimize various processes.

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This paper provides a broader discussion of the future of the Internet of Things, not only discussing the advantages that sensor robots can bring to the use of the Internet of Things but also discussing some of the limitations of sensor robots.

## 2. Theory

### *2.1. The connotation of the Internet of Things*

The term “Internet of Things” has gained popularity due to the advancement of the information era. Its concept of an Internet-based connection between things has steadily become clearer. The category of "things" is expanding these days. A plethora of cutting-edge technologies have emerged as a result of the Internet of Things [1]. IoT is essentially a network of real-world items, machinery, cars, and even buildings that have been fitted with sensors, software, and networking features to allow them to gather and share data via the Internet. However, in order to face the challenges presented by the Internet of Things, it is necessary to examine the middleware’s key features, including service creation and discovery. The Internet of Things has several challenges, primarily related to its very vast scale, heterogeneity, and dynamics, which surpass those of the current Internet of Services. Furthermore, fresh difficulties concerning the IoT’s foundational physical world element also emerge [2].

The Internet of Things has several notable features. First, various communication technologies are used in IoT devices, such as Wi-Fi, Bluetooth, cellular networks, and even low-power remote networks. In this way, devices can communicate easily and seamlessly with each other and with centralized systems. Second, IoT devices are equipped with a variety of sensors, such as environmental sensors, motion detectors, and cameras, generating large amounts of data. This data is collected and processed to provide insights and support decision-making. Third, IoT devices often have the ability to operate autonomously and can also be operated under human supervision. For example, a smart thermostat can automatically adjust the temperature setting based on occupancy and weather conditions. In addition, the IoT ecosystem is designed to be interoperable, enabling devices from different manufacturers to work together seamlessly within the network. Finally, IoT technology can be extended from home automation systems to large-scale industrial applications, showing versatility and adaptability.

### *2.2. Robots equipped with sensors*

There are several different types of smart environments with sensors and actuators that use robots. These gadgets can offer useful data that a robot's onboard sensors are unable to perceive, or they can supply more actuators to enhance the robot's actuation capabilities [3]. Robots with sensors have made major advances in hardware and software. Initially, robots were mainly used in industrial areas, such as assembly and welding. But with the integration of sensors, they are making significant progress in various areas. These robots allow for real-time monitoring without putting humans at risk.

**Healthcare:** In healthcare, robots equipped with sensors are used for tasks such as patient monitoring, drug delivery, and surgery. They provide accurate and consistent data to enhance patient care. There are several different types of smart environments with sensors and actuators that use robots. These gadgets can offer useful data that a robot’s onboard sensors are unable to perceive, or they can supply more actuators to enhance the robot's actuation capabilities [4].

**Agriculture:** There has been a revolution in agriculture with sensor-equipped robots being used in precision farming. Sensor-equipped drones and ground-based robots monitor crop health, soil conditions, and irrigation needs to optimize resource utilization. An agricultural robot was designed using a three-dimensional sensing system comprising a lift and a laser scanner to obtain accurate exterior data. The lift shifted the laser scanner vertically in order to gather three-dimensional distance data surrounding the robots. In the studies, every tomato fruit in the same cluster was effectively discriminated using a color camera and a laser scanner. Furthermore, when infrared sensors were added to the sensing system, the system was able to detect movements from humans in addition to items around a robot [5].

**Smart Cities:** In urban environments, sensor robots are used for tasks such as traffic management, waste collection, and infrastructure inspection. They help build smarter, more efficient cities.

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### *2.3. The interaction between IoT and sensor robots*

The interplay between IoT and sensor-equipped robots. The Internet of Things provides a framework for connectivity and data exchange, while sensor robots aid in data collection and decision-making. These robots enhance IoT capabilities in several ways. First, they increase IoT's data pool through real-time data collection, especially in complex and dynamic environments. Second, they enable remote monitoring and control of physical processes and environments, expanding the scope of IoT applications. Third, sensor robots optimize processes, improve resource utilization, and reduce costs in various industries. Finally, they replace humans in dangerous or high-risk tasks, improving safety. Taken together, these robots provide innovative solutions for various fields and have a profound impact on the IoT ecosystem.

## 3. Sensing robot application scenario analysis

Sensing robots are equipped with a wide range of sensors and autonomous capabilities and have different applications in various fields. This section will delve into the application scenarios of sensor robots in agriculture, manufacturing, and healthcare.

### *3.1. Agricultural application*

#### *3.1.1. Precision agriculture*

Because precision farming has the ability to boost productivity and lighten the labor burden in the agriculture sector, it is a topic that is gaining popularity. It is anticipated that automation using mobile robots will completely transform the sector [6]. Robots equipped with sensors are used to collect basic data such as crop health, soil state, and weather patterns, including multispectral cameras and soil moisture detectors. They travel through the fields, capturing real-time information and processing the collected data to identify areas that need attention. For example, multispectral images can show crop stress or pest situations, allowing targeted interventions.

In addition, sensor robots help in the precise application of resources such as water and fertilizer. They provide resources based on data, reducing waste and environmental impact.

With autonomous navigation and autonomous operation capabilities, the robot can work around the clock, ensuring timely data collection and necessary interventions.

#### *3.1.2. Benefits of sensing robots in agriculture*

Precision agriculture helps make labor more productive, and automation using mobile robots could revolutionize the industry [7].

By providing accurate and timely data, sensor robots support the optimization of agricultural practices, helping to increase crop yields. They can deliver inputs where they are needed most, reduce water use, and reduce chemical waste.

Sensor robots promote precision farming practices, minimize the environmental impact of agriculture, and contribute to the development of sustainable agriculture.

### *3.2. Applications in manufacturing*

#### *3.2.1. Automation and quality control*

Automation is a driving force behind the introduction of more sophisticated concepts and quality engineering methods to the manufacturing sector. Contrary to popular belief, the very nature of automated manufacturing necessitates an even greater application of quality control methodologies: not only must final product inspection and in-process statistical control be applied, but total quality control must be applied more actively [8]. The global manufacturing industry is increasingly adopting sensor robots to improve production efficiency and product quality. These robots play a key role in all aspects of manufacturing.

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Production line automation Sensor robots equipped with vision systems and robotic arms can perform tasks on the production line, such as picking up and placing items, assembling parts, and conducting quality checks.

Quality control Robots equipped with advanced sensors can accurately detect product defects, reducing human error and ensuring consistent product quality.

Workplace safety Sensor-equipped collaborative robots (cobots) are able to work safely alongside humans. Sensors enable robots to detect and react to the presence of humans, reducing the risk of accidents.

Inventory management: Autonomous robots equipped with radio frequency identification (RFID) sensors manage and monitor inventory levels and optimize supply chain operations.

#### *3.2.2. Benefits of sensing robots in manufacturing*

Sensing robots can increase production speed and reduce downtime, thereby increasing productivity. Using robots in quality control can make product quality more reliable and consistent, reducing defects and rework. Automation reduces labor costs and minimizes material waste, helping to save costs.

### *3.3. Application in medical treatment*

The development of novel medical ingestible robots has been made possible by the rapid advancements in electronics, robotics, nanotechnology, and material sciences since the introduction of ingestible temperature sensors and capsule endoscopes. The entire gastrointestinal (GI) tract can be directly and non-invasively accessed by the untethered robots. Moreover, a wide range of biomarkers for gut health and disease are present in the tissues, gases, and fluids of the gastrointestinal lumen. Advanced imaging and sensing techniques combined with edible medical robots can improve the pathophysiological understanding of gastrointestinal disorders and facilitate disease diagnosis and monitoring. Furthermore, a variety of macro- and microscale robotic actuation mechanisms can be used to achieve improved drug delivery and surgical interventions for the treatment of illnesses [9]. All facets of medicine, including targeted therapy, hospital automation, and surgical intervention, are about to change as a result of medical robotics [10].

## 4. Development tendency

The latest research and innovation in the field of the Internet of Things (IoT) and sensing robots are constantly driving the development and application of technology. Here are some of the latest trends and innovations in IoT and sensing robots.

Advances in edge computing technology enable sensor data to be processed and analyzed locally on iot devices, reducing the need for data transfer to the cloud. The emergence of smart sensors improves the efficiency and accuracy of data acquisition, which helps to monitor and respond to environmental changes in real time.

Sensing robots combined with augmented and virtual reality technologies can provide users with richer, more immersive experiences. This integration can be used for training, remote operations, and data collection and analysis in simulated environments.

These research and innovations are driving advances in the Internet of Things and sensing robotics, opening up broader possibilities for intelligent applications and systems in the future. As these technologies continue to evolve, it is expected to see more intelligent solutions based on the Internet of Things and sensing robots applied in various fields, bringing more convenience and innovation to society and industry.

## 5. Conclusion

This paper explores the development and impact of sensing robots in the Internet of Things (IoT). Through literature review, case study, and data analysis, the wide application of sensing robots in many fields is deeply discussed. Sensing robots have made significant progress in recent years, thanks to developments in areas such as sensor technology, machine learning, and cloud computing. These

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advances enable sensing robots to more accurately and intelligently perceive their environment and make autonomous decisions. Case studies of sensor robots in fields such as agriculture, industrial automation, healthcare, and urban planning demonstrate their diversity and flexibility. These robots are widely recognized for not only increasing efficiency and reducing costs but also improving the quality of life.

Data analysis indicates that the application of sensing robots in the Internet of Things will continue to grow. This growth is driven by both technological advances and market demand. Sensing robots are expected to play an important role in areas such as smart homes, smart cities, and industrial and agricultural automation. They will become an important part of IoT systems, offering more possibilities for data acquisition and analysis.

Overall, the development of sensing robots in the Internet of Things brings new opportunities and challenges. Their wide application in various fields has already had a positive impact and will continue to drive technological innovation and business development. In the future, the potential of sensing robots should be further tapped to meet the growing demand for the Internet of Things and shape a smarter, more connected future.

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