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APPLICATIONS OF SERVICE ROBOTS

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ABSTRACT

Service robots are non-industrial robots built to assist humans in residential, commercial, healthcare, hospitality, educational and agricultural environments. Unlike factory robots that work in fixed structured zones, service robots operate directly around people where the environment is dynamic and unpredictable. They can clean homes, deliver food, help patients walk, guide customers in hotels and even harvest crops in farms. Rapid enhancements in artificial intelligence (AI), sensor technology and autonomous navigation have pushed service robots into practical daily use. This research paper explores the major categories of service robots, their architecture, market developments, real-world case studies, benefits, current challenges and expected future advancements. The objective of this report is to provide a complete technical and real-world overview for students and researchers, while also highlighting ethical, social and safety aspects for sustainable deployment. The study concludes that service robots will become an essential part of human life within the next decade, improving productivity and quality of life globally.

INTRODUCTION

Robots are intelligent machines capable of sensing their environment, analyzing data and performing tasks with minimal human control. Service robots belong to a special category of robotics where the main focus is not manufacturing, but helping people in everyday life and service-based industries. As global labour cost increases and demand for automation rises, service robots have become an efficient substitute for repetitive, risky and time-consuming tasks.

The need for contactless service during the COVID-19 period boosted robotic deployment in hospitals and hotels. They delivered medicine, disinfected rooms, managed reception desk work, and served meals to reduce human exposure. In agriculture, service robots are used for precision spraying, fruit picking and field monitoring. Domestic robots like vacuum cleaners and lawn mowers have already become common in many smart homes.

Service robots rely on technologies such as machine learning, computer vision, SLAM-based navigation, obstacle detection, grasping mechanisms and natural language communication. These systems allow robots to understand surroundings, move safely, interact with humans and make decisions in real time.

This research paper presents a detailed discussion on the different application areas of service robots, working principles, hardware architecture, advantages, limitations and future research possibilities. Real case studies are included to highlight how companies and industries are adopting these robots successfully in the real world.

2. TYPES & APPLICATIONS OF SERVICE ROBOTS

Service robots are broadly classified into the following domains:

Domestic and Personal Service Robots

These robots assist inside homes assisting with cleaning, cooking support, caregiving and security surveillance.
Examples include robot vacuum cleaners, smart home companion robots, floor-mopping robots, pet-feeding robots and elderly-care robots. Robots like iRobot Roomba can map rooms, detect furniture, avoid obstacles and clean automatically. Elderly-care robots remind patients about medicine and help them move using voice commands.

Benefits:

- Saves time and reduces physical burden
- Enhances home safety through monitoring and sensors
- Helpful for senior citizens and people with disabilities

Healthcare and Rehabilitation Service Robots

Hospitals use robots for surgery assistance, delivering medical supplies, assisting in rehabilitation therapy, monitoring patients using sensors and providing tele-interaction between doctors and patients. Rehabilitation robots like robotic exoskeletons help stroke or spinal-injury patients walk again by supporting limb movement.

Telepresence robots allow doctors to consult patients remotely through a mobile robot equipped with a camera and display. Hospital delivery robots navigate elevators and corridors autonomously using LiDAR and SLAM.

Hospitality & Commercial Service Robots

Hotels, restaurants and malls use robots for welcoming guests, showing directions, carrying luggage and delivering food items. Many restaurants in Japan and China use robot waiters powered by AI and navigation sensors. These robots improve service speed and operate 24/7 without fatigue.

Advantages:

Reduces labour load
Enhances customer attraction
Maintains hygiene and safe contactless service

Agricultural Service Robots

Agricultural robots play a major role in modern smart farming. Robots perform seed planting, soil moisture monitoring, pesticide spraying and fruit picking. Drones capture aerial images to measure crop health and detect disease early.
Fruit-picking robots use computer vision for color recognition and robotic arms to pluck without damage. This reduces labour shortage and increases harvesting efficiency.

ARCHITECTURE & WOKGING OF SERVICE ROBOTS

A typical service robot consists of:

Component Function

Sensors Camera, LiDAR, ultrasonic - environment perception
Locomotion System Wheels/legs -movement & navigation
Power Source Battery, charging dock,solar for agriculture
Controllers Microcontrollers/SoC for processing
Communication Wi-Fi/Bluetooth/IoT for cloud connectivity
Manipulator & End-effector For gripping, holding, delivering objects
Software & AI Navigation, obstacle avoidance, voice recognition

Working Process

1. Perception — Sensors capture environmental data
2. Mapping — SLAM or GPS creates a map
3. Localization — Robot identifies its position
4. Decision-Making — AI selects next action
5. Motion Control — Motors move robot safely
6. Task Execution — Delivery/Cleaning/Interaction

REAL -WORLD CASE STUDIES

Case Study 1: Hotel Robot Deployment

During the pandemic, several hotels adopted room-delivery robots for hygiene and staff reduction. Tasks included delivering towels, food and amenities. Customer satisfaction increased due to quick service, though elderly customers sometimes preferred human interaction.

Case Study 2: Exoskeleton Rehabilitation in Hospitals

Patients recovering from stroke injuries trained using robotic exoskeleton suits. Clinical reports showed better recovery speed and low physical strain on therapists. Hospitals saved manpower as one therapist could monitor multiple patients.

Case Study 3: Autonomous Farming Robots

ssFruit-harvesting robots in orchards identify ripe fruits using cameras and harvest them without damage. This solved labour shortage during peak seasons and increased productivity significantly.

CHALLENGES & LIMITATIONS

1. High Cost – Advanced sensors and motors make robots expensive.
2. User Acceptance – Some customers feel uncomfortable interacting with robots initially.
3. Battery and Power Issues – Long working hours require fast charging & efficient power use.
4. Reliability – Robots must operate safely around people without collisions.
5. Legal & Ethical Issues – Privacy during video recording, job displacement concerns.
6. Environment Sensitivity – Rain, uneven surfaces and lighting affect performance.

FUTURE SCOPE

The next generation of service robots will be more intelligent, emotion-aware and capable of learning from experience using deep learning. Integration with IoT and cloud computing will allow robots to update software automatically and share data globally. Domestic robots may evolve into fully automated personal assistants that cook food, manage schedules and monitor elderly health conditions.

In healthcare, robotic nurses might assist surgeons in real-time operations using AR-based control. Agriculture will witness fully autonomous farms with robots performing seeding to harvesting without human intervention. Furthermore, humanoid service robots may engage in social companionship to reduce loneliness in elderly communities.

CONLUSION

Service robots are transforming everyday living by taking over repetitive, risky and labour-intensive tasks across homes, hospitals, hotels and farmlands. With advancements in AI, sensing and mobility, robots are becoming smarter, faster and more reliable. Although cost, maintenance and social acceptance remain challenges, research and industrial developments indicate a promising future where robots and humans co-exist as collaborative partners. A well-planned approach focusing on safety, ethics and user-friendly design will accelerate global adoption.

Service robots will not replace humans entirely, but rather support and enhance human capabilities, improving productivity and living standards worldwide.

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