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Domestic Household Multi-purpose robot

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ABSTRACT :

The emergence of domestic household robots represents a paradigm shift in the way individuals manage their daily lives. These robots, designed to operate within the confines of a home environment, aim to enhance convenience, efficiency, and overall quality of life. Equipped with advanced sensors, artificial intelligence, and robotic capabilities, domestic robots can perform a myriad of tasks, ranging from routine chores to complex assistance.

Key functionalities of domestic household robots include automated cleaning through robotic vacuum cleaners, mopping bots, and window cleaners. These devices streamline household maintenance, allowing occupants to delegate mundane tasks and allocate time to more meaningful activities. Additionally, robotic companions and entertainment devices have entered the market, providing social interaction and leisure experiences.

The integration of voice recognition and smart home technology enables seamless communication and integration with other household devices. Users can now control lighting, thermostats, and security systems through voice commands, creating a cohesive and interconnected living space.

While the prospect of domestic robots holds promise for improved efficiency and convenience, it also prompts considerations regarding privacy, security, and the ethical implications of entrusting tasks to autonomous machines. Arresting a balance between the benefits and potential challenges is essential as these robots become more prevalent in households, reshaping the dynamics of domestic life in the process. As technology continues to evolve, the role of domestic household robots is likely to expand, prompting a revaluation of societal norms and expectations in the context of human-robot cohabitation.

INTRODUCTION:

Introduction of Cleaning Robots: Revolutionizing Maintenance Practices

Technological Advancements in Cleaning Robotics

Sensor Technology: Cleaning robots are equipped with advanced sensor technologies including infrared sensors, ultrasonic sensors, and cameras. These sensors permit robots to detect obstacles, map environments, and navigate autonomously.

Artificial Intelligence (AI) and Machine Learning: AI algorithms allow robots to absorb and adjust to different environments over time. Machine education assistance robots improve efficiency by optimizing cleaning routes and adapting cleaning patterns based on the layout of the space.

Integration of Automation and Internet of Things (IoT): Many cleaning robots are IoT-enabled, allowing remote monitoring, scheduling, and control via smartphone apps or centralized management systems. This connectivity enhances user convenience and operational efficiency.

Benefits of Cleaning Robots

Efficiency and Consistency: Cleaning robots can operate continuously without breaks, delivering consistent cleaning performance. This efficiency saves time and enhances overall productivity.

Autonomous Navigation: Robots can circumnavigate multifaceted environments autonomously, ducking obstacles and optimizing cleaning routes. This autonomy reduces the need for human intrusion during cleaning operations.

Precision and Effectiveness: Cleaning robots are planned for specific tasks like vacuuming, mopping, or scrubbing floors with precision. Some robots include specialized attachments for tasks like window cleaningor outdoor maintenance.

Improved Hygiene and Safety: By reducing human exposure to hazardous cleaning chemicals and environments, cleaning robots contribute to improved hygiene and safety. They also minimize the risk ofaccidents associated with manual cleaning activities.

Resource Conservation: Cleaning robots consume fewer resources such as water and cleaning agents compared to traditional cleaning methods, promoting sustainability in facility management.

Applications of Cleaning Robots

Residential Use: Cleaning robots like robotic vacuum cleaners have become popular in households, providing convenient and efficient floor-cleaning solutions.

Commercial and Industrial Settings: Cleaning robots are widely adopted in commercial spaces, offices, hospitals, and industrial facilities to maintain cleanliness efficiently and consistently.
Public Spaces: Cleaning robots are used in airports, shopping malls, and other public areas to handle routine cleaning tasks and ensure cleanliness throughout the day.

Specialized Environments: Some cleaning robots are planned for specific environments such as outdoor spaces, swimming pools, or hazardous areas where manual cleaning is challenging or risky.

Challenges and Considerations

Initial Costs: The upfront investment in cleaning robots can be significant, especially for larger facilities orspecialized cleaning needs.

Maintenance Requirements: Regular maintenance and servicing are essential to ensure optimal performanceand longevity of cleaning robots.

Technological Limitations: Despite advancements, cleaning robots may still face challenges in handling certain surfaces, navigating complex environments, or adapting to unforeseen obstacles.

Human-Labor Displacement: The increasing adoption of cleaning robots may lead to concerns about job displacement for human cleaners, requiring proactive measures for reskilling and workforce adaptation.

Future Trends and Implications

Continued Technological Innovation: Future advancements in robotics, AI, and sensor technologies will further enhance the capabilities and effectiveness of cleaning robots.

Customization and Specialization: Cleaning robots will likely become more specialized and customizable to meet specific cleaning needs across different industries and environments.

Integration with Smart Building Systems: Cleaning robots will be integrated into broader smart building ecosystems, enabling seamless coordination with other IoT devices and systems for optimized facility management.

Economic and Environmental Impact: The widespread adoption of cleaning robots will have economic implications in terms of cost savings and productivity gains. It will also contribute to environmental sustainability by reducing resource consumption and waste generation.

Research Objective:

The primary objective of this study is to enhance the efficiency, adaptability, and user experience ofDomestic Household Multi-Purpose robots through innovative advancements in robotics, artificial intelligence, and sensor technologies. Specifically, this research aims to:

1. Optimize Navigation and Mapping: Develop advanced navigation algorithms to improve the robot's ability to map environments accurately, navigate complex spaces efficiently, and avoid obstacles seamlessly during cleaning operations.

2. Enhance Cleaning Performance: Investigate novel cleaning techniques and mechanisms to enhance the robot's vacuuming and mopping capabilities, ensuring superior cleaning results across various floorsurfaces and environments.

3. Integrate Smart Home Connectivity: Explore seamless combination with smart home ecosystems, enabling enhanced control options, scheduling flexibility, and interoperability with other connecteddevices for a more streamlined user experience.

4. Implement Adaptive AI Algorithms: Implement adaptive AI algorithms to enable the robot to learn from user preferences and environmental factors, optimizing cleaning patterns, and improving overallresponsiveness to changing cleaning needs.

5. Evaluate User Interaction Design: Conduct user-centric studies to evaluate and refine the robot's interface design, focusing on intuitive controls, informative feedback, and user-friendly features toenhance usability and satisfaction.

6. Assess Sustainability and Resource Efficiency: Investigate strategies to improve the robot's energy efficiency, resource conservation, and eco-friendly design elements to align with sustainable practicesin household robotics and robotics.

Literature Review & Problem Identification

Construction of a Cost Design and -Oriented Mobile Robot forDomestic Assistance
Brayan S. Pallares O. * Tatiana A. Rozo M. * Edgar C. Camacho * Jose Guillermo Guarnizo
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This paper presents the design and development of a cost-oriented mobile robot for domestic assistance. The design of the mechanics, electronics, and software necessary for the operation of the robot is detailed, as well as the tests carried out to ensure its correct operation. Concluding that the controllers, kinematics, and odometry work correctly providing a measurement that is close to the real one. The developed robot can be easily equipped with multiple actuators to make it useful in different social tasks, such as elderly supervision robot, medicine supply robot, companion robot for dependent people, a n d telecare robot, among others. The robot design is focused on allowing its easy replication to be freely used in a large number of domestic applications. In future work, the development of a SLAM algorithm that allows the robot to operate autonomously is proposed.

RESEARCH GAP

Research on multipurpose household robots has made significant strides in recent years, but several notable gaps persist, warranting further investigation. Identifying and addressing these research gaps is crucial for the development and implementation of efficient, user-friendly, and socially acceptable multipurpose household robots. Here are some key research gaps in this domain:

1. 1. Human-Robot Interaction (HRI): Multipurpose household robots aim to assist with various
2. tasks, there is a need for more research into improving the naturalness and intuitiveness of human-robot interactions. This includes understanding user preferences, developing adaptive communication strategies, and ensuring that users can easily convey complex instructions to the robot.
3. Task Adaptability and Learning: Current multipurpose household robots often struggle with adapting to dynamic and unstructured environments. Research is needed to enhance the ability of these robots to learn and adapt to new tasks, objects, and changes in the home environment over time. This involves developing advanced machine learning algorithms that allow robots to acquire new skills efficiently.
4. Safety and Reliability: Ensuring the safety of users and their belongings is paramount. There is are search gap in developing robust safety mechanisms, collision detection, and avoidance strategies for multipurpose household robots. Additionally, there is a need to address reliability concerns, minimizing the risk of malfunctions or errors, especially in situations where the robot operates autonomously.
5. Energy Efficiency: Multipurpose household robots often rely on batteries, and energy efficiency is a critical concern. Research is needed to develop more energy-efficient components, explore innovative power sources, and optimize the overall energy consumption of these robots to extend their operational time between charges.
6. Customization and Personalization: Household environments and user preferences vary widely. Research is needed to develop customizable and adaptable robot systems that can be tailored to individual household needs and preferences. This includes the ability to configure tasks, appearance, and interaction styles to suit diverse user requirements.

Long-Term User Acceptance: Understanding the long-term acceptance of multipurpose household robots in real-world settings is crucial. Research should focus on user studies that assess the long-term impact of these robots on users' daily lives, considering factors such as user satisfaction, trust, and the psychological aspects of human-robot cohabitation.

Methodology

The multi-purpose household robot is designed to perform a variety of tasks and functions to assist with daily activities in a home environment. This robot is equipped with various sensors, cameras, and intelligent software to navigate and interact with their surroundings and achieve tasks that can vary from cleaning to entertainment to home security.

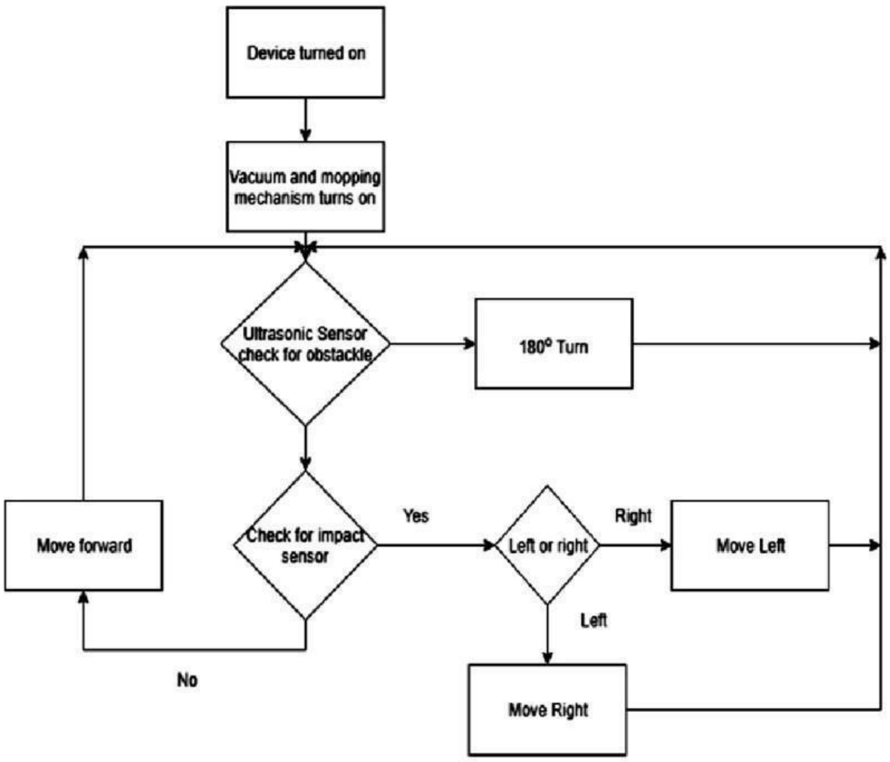

Fig 1:- Line Diagram of working of Domestic House-Robot

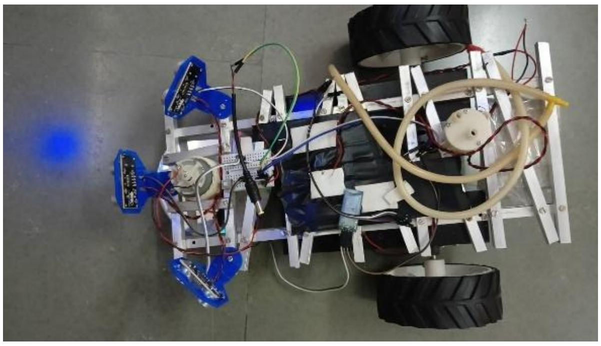

Fig 2:- Domestic Household Multi-purpose robot top view

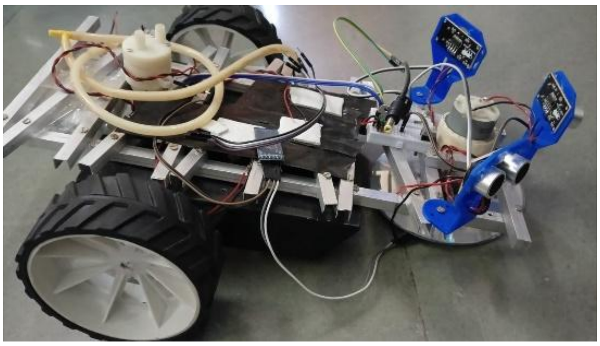

Fig 3:- Domestic Household Multi-purpose robot right view

Fig 4:- Domestic Household Multi-purpose robot back view

Component Used

- Arduino Uno:
- HC-05 Bluetooth Module
- Ultrasonic Sensor:
- 12Volt Geared Motor:
- 12Volt Diaphragm pump
- L298 Motor Driver:
- BMS System
- Jumper wires
- Bread Board
- Aluminum frame
- 12Volt Dc Geared Motor

Features of the robot

- **Obstacle Detection:** House cleaning robots use sensors to detect obstacles andavoid them while cleaning
- **Mobile Phone Control:** House cleaning robots can be controlled using a mobilephone, allowing for remote operation and monitoring
- **Reduce Efforts for Mobbing:** House cleaning robots can reduce the physical effortrequired for cleaning, such as bending and reaching, by moving around autonomously
- **Less Water Consumption:** House cleaning robots can help decrease water feeding by cleaning efficiently without the essential for manual water usage

Experimental Setup

Setup used for testing:

Test Environment: We have taken the area of 10 feet x 10 feet area for testing.

Equipment: Our Multipurpose Household robot, Stopwatch, and Beaker for measuring the water consumed incleaning 100Sqft Area.

Procedure:

In the first step, we took a bucket, filled it with water (8 Litre water with floor cleaning solution), and used a microfiber cloth mob with it to clean the area of 100Sqft and record the time within the stopwatch to get the time required to clean that Area.
In the next step, measure the water left in a bucket to get the value of water consumed in mobbing by subtracting it from the initial value of the water used (8 Litre).
Now we have ready the Robot for cleaning the same amount of area, filled 1-litre water in reservoir by adding floor-cleaning solution, and attached a mob attachment with it.
Now we have connected the robot with the mobile phone for cleaning and starting the stopwatch.
After cleaning the sample area of 100Sqft, time is noted in the stopwatch at last and the water left after cleansing is also measured which has to be subtracted from the initial water used to find the water consumption.

Measurements and Readings

Manual Mobbing: By doing manual Mobbing we find slight stains of water to be present on the floor, which take a few minutes to completely dry up & more water is used in a bucket to completely wet up the mob which increases the water consumption for cleaning the small area, and also much manual efforts are needed to take water from a bucket, So it becomes heavy and more force is required to handle the wetted mob.
Mobbing with Robot: The floor dries up instantly without any stain, it uses less amount of water to clean the same amount of floor, reduces human efforts, and saves time.
Time Taken:
Time required for cleaning 10x10Sqft area:

By Manual Mobbing:

Time taken in Manual Mobbing: 4.8 Minutes

By Robot Mobbing:

Time taken: 5 Minutes
Wheel Size of Robot: 6 Inches; Circumference: 18.85 Inches.Max Speed/RPM: 60 RPM
Distance Covered = 18.85 Inches/Sec
Width coverage of robot while mobbing = 12-14 Inches
Total rounds required by a robot to cover the whole area = 10Length of each round: 10 x 12 = 120 Inch.
Total distance covered by a robot: 120 x 10 = 1200 Inch Theoretical time taken by the robot to cover the whole area: 1200/18.85 = 63.66 Seconds or 1.06 Minutes

Time Noted in a Stopwatch: 2.1 Minutes considering delays in turning and object detection.
Water Usage: The amount of water used by each method.

Manual:

Initial Water Filled = 8 Litre
After mobbing water left in a bucket = 4.5 LitreWater Consumed = 8 – 4.5 = 3.5 Litre

Robot:

Initial Water Filled = 1 Litre Remaining water left = 50 mlWater Consumed = 950 ml
Difference in water consumption: 3.5Litre – 0.95 Litre = 2.55 Litre

Physical effort required for each method:

Manual Mobbing: Requires manual efforts to wet the mob by dipping it into the bucket and after that it absorbs the water, after that it becomes heavy for the human body to work with it, and one has to carry a heavy bucket of water along with it.

Robot Mobbing: It uses an advanced water distribution system with nozzles, which evenly spread the water throughout the area reducing the effort of carrying a heavy bucket with the advanced water distribution spraying system less water is consumed while mobbing and it reduces the pain of having heavymob which absorbs the water and get heavy while mobbing.

Task	Manual	Robot
Initial Water Filled	8 Litre	1 Litre
After mobbing water left in a bucket	4.5 Litre	50 ml
Water Consumed	8 – 4.5 = 3.5 Litre	950 ml
Time required for cleaning 10x10Sqft area	4.8 Minutes	5 Minutes
Water saving by the robot		2.55 Litre

Table 1:- Measurements and Readings

Result & Discussion

Cleaning Efficiency Comparison: The cleaning efficiency of the robot is found to be more effective as looking forward, manual mobbing uses microfiber clothes which absorb the water and get heavy due to which more water is used for mobbing as well as we find the marks of mob on the floor by seeing it in detail, andalso sometimes we can find the threads of mob lying into the floor.
Our robot uses foam pad technology for mobbing, and for water distribution, it uses a high-pressure pump with nozzles to evenly distribute water on a floor.

Time Comparison: By using our robot, we can save time up to 50 Percent on mobbing.

Water Usage Comparison: The difference between the usage of water between manual and robot is 2.55 Liter, which means you can save water up to 30 Percent.
Labor Effort: Reduces the efforts of a person as we can control the robot by sitting in one place

Benefits of using Robot instead of Manual Mobbing

Using robots for cleaning instead of manual mopping offers several significant benefits:

1. **Efficiency:** Robots can clean floors more efficiently and consistently compared to manual mopping. It follows predefined paths or it can use advanced navigation to cover entire areas without missing spots or requiring rework.
2. **Time Savings**: Cleaning robots can operate autonomously, allowing users to concentrate on other tasks while the robot handles cleaning. This saves appreciated time, particularly in large or busy environments.
3. **Consistency in Cleaning Quality**: Robots perform cleaning tasks with consistent quality every time, regardless of the operator's skill level. This ensures a uniformly clean surface without human error or fatigue affecting performance.
4. **Labor Cost Reduction:** Employing cleaning robots can reduce labor costs associated with manual cleaning. Once purchased, robots can operate for extended periods with minimal ongoing costs compared to hiring and training human cleaners.
5. **Health and Safety Benefits:** Using robots for cleaning reduces the physical strain and potential injuries associated with manual mopping, such as back pain or slips and falls. This contributes to a safer and healthier working environment.
6. **24/7 Cleaning Capability:** Cleaning robots can be programmed to operate at any time, including after-hours or during periods of low occupancy. This ensures continuous cleaning without disrupting daily operations.

Advantages of Manual Cleaning:

- Save Time
- Reduce Human Efforts
- Best Cleaning Results
- No dependency on worker

Future Work:

The future of cleaning robots holds exciting possibilities driven by advancements in technology and artificial intelligence. Here are some potential developments we might see:

1. **Advanced Navigation and Mapping**: Future cleaning robots will have more sophisticated navigation capabilities, allowing them to efficiently map and clean complex environments like multi-story homes or office buildings without human intervention. These robots could use advanced sensors, such as LIDAR andhigh-resolution cameras, to create detailed maps and avoid obstacles.
2. **AI-Powered Cleaning Algorithms:** Cleaning robots will leverage AI to adapt their cleaning strategies based on real-time data. They could learn from past cleaning experiences and adjust their techniques to optimize efficiency and effectiveness for different surfaces and environments.
3. **Increased Autonomy:** Future cleaning robots will be more autonomous, requiring minimal human interaction. They could recharge themselves, empty their dustbins, and schedule cleaning tasks independently based on observed usage patterns.
4. **Integration with Smart Home Ecosystems:** Cleaning robots will become integral parts of smart home ecosystems. They will seamlessly integrate with other smart devices, allowing users to control them via voice commands or smartphone apps. For example, they could organize cleaning schedules with HVAC systems or automatically adjust cleaning patterns based on occupancy data.
5. **Enhanced Cleaning Capabilities:** Cleaning robots will be equipped with more versatile cleaning tools and capabilities. This might include advanced vacuuming, mopping, disinfection using UV-C light, and even more specialized tasks like cleaning windows or high surfaces.
6. **Environmental Awareness**: Future cleaning robots will be designed with environmental sustainability in mind. They could use eco-friendly cleaning solutions, consume less power, and be built with recyclable materials.
7. **Robotic Swarms**: Instead of individual cleaning robots, we might see fleets or swarms of smaller specialized robots working together to clean large areas more efficiently. These robots could communicate and collaborate to cover extensive spaces quickly.
8. **Personalized Cleaning Preferences:** Cleaning robots will be able to adapt to individual preferences. They could learn user habits, such as preferred cleaning schedules or areas that require more attention, and adjust their operations accordingly.
9. **Maintenance and Self-Repair:** Future cleaning robots might incorporate self-diagnostic features and self-repair capabilities. They could detect and address minor issues autonomously, reducing the need for human maintenance.
10. **Augmented Reality Interfaces:** Cleaning robots could use augmented reality (AR) interfaces to provide users with real-time feedback on cleaning progress or suggestions for optimizing cleaning routines.

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