



Autonomous Cleaning Changes the Game for the Future of Smart Vacuums

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IDC Opinion

- Smart home devices are evolving from existing in silos, they are becoming part of connected ecosystems. Greater interoperability makes smart homes a holistic solution, with, for instance, the connection between smart lighting and smart speakers adding value to the service and devices than if they were separate. This enriches the consumer experience, making it an important market trend developing in the direction of being scenario-specific.
- Housecleaning is an important part of the daily routine in a smart home, where ease of setup and ease of use are a priority. In such scenarios, smart vacuums have a key role to play in changing the way housecleaning is done, leading the way to a future where housecleaning can be performed by autonomous vacuum cleaning devices.
- For smart vacuums to be autonomous, they must have improved cleaning and moving capabilities, along with smarter interactions with users, thus improving product functionality and optimizing the user experience.



- Upgrading the cleaning and moving abilities of smart vacuums — by using artificial intelligence (AI), for instance — will enable better market penetration, and also serve as a model for other smart home devices.
- Al technologies and Internet of Things (IoT) interoperability will accelerate the evolution of interaction between consumers and smart vacuums from passive interactions, where users give instructions to devices, to autonomous interactions where devices can detect and anticipate users' needs. The teamwork between a camera and a smart vacuum would be a use case to start with, where the camera spots the dirt and activates the smart vacuum to have it cleaned.



1. Situation Overview

Smart Home Market

IDC's 2023–2027 global smart home device market forecast predicts that the worldwide smart home market size will continue to increase, driven by the demand for convenience, energy efficiency, and security. Consumers everywhere are looking for ways to streamline their daily routines and make their homes more comfortable and secure.



IDC predicts that the worldwide smart home market volume will exceed 1 billion by 2027, with a compound annual growth rate (CAGR) of 5.6%. North America will continue to be a major market, while significant growth will take place in Europe and Asia/Pacific.



FIGURE 1 IDC Global Smart Home Devices Forecast



Source: IDC, 2023

The smart home market consists of devices such as digital media adapters, cameras, door locks, lighting, TVs, and the penetration rate varies among categories. The market penetration rate of home entertainment devices has grown to be the highest, with smart TVs and set-top boxes becoming quite commonplace. With consumers becoming familiar with these devices, they have set the scene for the future evolution of the smart home ecosystem. Next in terms of market penetration are smart speakers which have entertainment as their main feature, but also play the functional role of personal assistant, and their usage may also extend to other scenarios as the smart home ecosystem develops. Monitoring and security devices, enhanced by visionary AI technology, come next, helping keep families safe in their neighborhoods. Smart vacuum cleaners that can clean autonomously and communicate bidirectionally via various network protocols have the potential to achieve similar market penetration rates.



FIGURE 2 Household Penetration of Smart Home Devices



Source: IDC's 2023 Worldwide Consumer Pulse Home & Entertainment Survey; n = 13,007 (WW) adult consumers who own a PC, tablet, or phone for personal use; US: 2,028; UK: 2,007; Germany: 2,029; Brazil: 2,042; Turkey: 870; China: 2,013. Samples of countries not considered in this white paper have been excluded.

Though North America and Europe are economically well-developed regions, the market penetration rates of smart vacuums there are comparatively low, making them potential growth targets for vendors.



The comfort level inside a house is determined by very concrete elements, like sufficient lighting during nighttime, or a livable temperature in winter and summer. And to ensure a better quality of life, it is crucial that the room is free from dust, dirt, and allergens that can trigger respiratory issues and other health problems. In the past, human labor played a major role in maintaining comfortable home spaces, but with the significant market potential of smart home devices, autonomous appliances such as smart vacuums are set to enjoy great popularity in the coming years.

Use of AI will add more value to smart home devices.

Large-scale models and autonomous mobility will reshape smart home service attributes to create the next growth curve of the smart home market. Advances in Al-driven technology have completely transformed the interactivity, connectivity, and mobility of smart home devices, making them smarter and enabling selfmanagement, hence optimizing users' engaging experience. And the development of scenario-specific solutions has made the benefits of smart home devices more persuasive.

Fueled by advancements in technology such as IoT and AI, smart home devices have made it easier for consumers to integrate and control multiple devices in their homes. The smart-home industry is developing in the direction of holistic housekeeping solutions, where the user-device interaction is becoming more and more autonomous. Users no longer need to "learn" how to use devices. Instead, the devices learn about their users, making it easier for them to act upon the users' orders.

Smart vacuums will play a leading role in the future development of the smart home.

Autonomous cleaning, as the goal of smart vacuums, also sets the future direction for the smart home, and defines the smart development of the industry. The mobility of the smart vacuum can also help to extend the area of coverage for other connected devices in a smart home ecosystem. The integrated docking feature enables the vacuum cleaner to return to the dock to re-charge or clean itself, thus reducing human intervention in household chores. And improvements in sensory capability will help not only the smart vacuum, but also other smart home devices in detecting the environment of the house and the living habits of users, hence enabling them to work in a more customized, human-like, self-aware way.



Smart Vacuums Market

IDC defines a smart vacuum as a vacuum cleaner that can clean autonomously and communicate bidirectionally via various network protocols. It can clean (sweep/vacuum/mop) the floor autonomously by combining the ability to move, plan, and compute, and it can be controlled by or communicate with a remote user. Smart vacuums play a key role in housecleaning, along with air purifiers, window cleaners, and other devices that refresh the living environment.

FIGURE 3 Development of Smart Vacuum Market



	Stage 1	Stage 2	Stage 3
	Nascent	Adoptive	Proliferation
Product features	 Sweeping only. Random cleaning path. Station for charging only. 	 Various cleaning modes. Precise navigation and obstacle avoidance. Self-cleaning dock. 	 Autonomous cleaning functions. All-room and all-time path planning. All-in-one dock.



	Stage 1 Nascent	Stage 2 Adoptive	Stage 3 Proliferation
Scenarios	 Floor sweeping/ vacuuming. 	Floor cleaning.Pet monitoring.	 House cleaning. Monitoring and security. Intelligent assistant.
User analysis	 "Buy for its novelty" mentality prevails. Most are first-time buyers. Price is generally high at first and declines gradually. 	 Pay for its functionality. First-time buyers dominate, but repeat customers increase. Price differentiation occurs, with entry- level prices falling and high-end product prices increasing. 	 Lifestyle-driven demand. First-time buyers and repeat customers contribute to market growth. The price gradient becomes diversified, with prices within each tier decreasing.
Regional features	 Consumers are mainly from highly developed regions. 	 Primarily focused on developed regions, gradually expanding into developing areas. 	 Developing regions become the main growth drivers, and consumers in developed areas focus on upgrading.

Source: IDC, 2023

Many early adopters bought smart vacuums for their novelty, with their ability to move autonomously being a major plus point. With breakthroughs in navigation technology, as well as further optimization of vacuuming and mopping solutions, smart vacuums are beginning to be accepted among a broader range of consumers. The market for smart vacuums has developed to the stage where consumers see the device as a serious cleaning tool.

A smart vacuum's cleaning ability is measured by how completely it frees humans from the labor of cleaning.

As the smart home ecosystem develops, consumers begin to expect more features from next-generation devices, especially with regard to convenience and their own health. For smart vacuums, this means smarter self-management of cleaning schedules and task areas. Once it learns the family's daily routine, the smart vacuum can plan how and when to set about cleaning the home. And the synergy with other smart home devices will create a joint sensor and processing system throughout the house. This means that the vacuum cleaner's radar and camera, along with its mapping ability, may be shared by other devices, and vice versa — this applies not only for sensors, but also computing resources.





IDC predicts that by 2027, the market volume of smart vacuums will grow to 23.2 million worldwide.

Product functionality improvement and the expansion of use scenarios will drive the growth of the smart vacuum market.

The smart vacuum market, with higher year over year (YoY) growth rates than the overall smart home market, contributes positively to the democratization of the industry. And for the year 2024, the Asia/Pacific market will continue to be the largest, while North America and Europe, also with large market sizes, will see steady growth as well. At the same time, the markets in Latin America, the Middle East, and Africa will also gain momentum.

FIGURE 4 IDC Global Smart Vacuum Shipment Forecast



Source: IDC, 2023



2. Challenges: A Consumer Perspective

Consumers use smart vacuums, as well as other smart home devices, to streamline and simplify daily tasks, improve efficiency, and enhance overall convenience in their lives. These devices offer the ability to automate various functions within the home, such as controlling lighting, temperature, security systems, and entertainment, ultimately leading to a more comfortable and convenient living environment. Therefore, consumer demand is the guiding principle of market development, and deviation from these goals may reduce consumers' satisfaction with relevant products.

Smart Home in General

Based on IDC's survey, 71% of consumers are satisfied with smart home devices. The satisfaction rate for specific use cases, including home monitoring and security, home automation (including smart vacuums), and networked entertainment, is higher than the overall satisfaction rate, reaching 77%, 74%, 74% respectively.



FIGURE 5 Smart Home Device Customer Satisfaction Rate

71%	77%	74%	74%
Overall Smart Home Satisfaction	Home Monitoring and Security	Home Automation	Networked Entertainment
Overall satisfaction is lower than that of each individual area, indicating that consumers expect more from smart home devices on an overall level.	Security devices rank highest in user satisfaction, as they primarily fulfill the essential need for safety in such contexts. Meeting this fundamental requirement significantly boosts satisfaction with the product.	There is significant potential for improvement from the perspective of automation, reducing the level of involvement required from users so they can save time and effort.	Satisfaction levels for entertainment are lower than those for security because of the diverse needs. The varying expectations of users make it challenging to attain a high rate of satisfaction.

Devices included in the category of **home monitoring and security** are motion detector, window sensor, door sensor, doorbell, carbon monoxide/smoke detector, video monitoring camera and flood/freeze sensor.

Devices included in the category of **home automation** are smart speaker, smart home display, major appliance, small appliance, thermostat, garage door opener, and vacuum and mop.

Devices included in the category of networked entertainment are smart TV, set-top box and streaming stick.

IDC works with a broad definition of the smart home which includes home monitoring and security, home automation and networked entertainment.

Source: IDC research survey data in Consumer Pulse Worldwide, n = 10,474

Consumers expect smart home devices to meet their core need of making their lives more convenient. Their demands are much clearer and more specific when it comes to individual areas of home monitoring and security, networked entertainment, and home automation, and are therefore easier to implement.

Market potential lies in functionality, data security, and simplicity.

Functionality is crucial as consumers seek devices that can effectively perform the tasks they are designed for, whether it is controlling lighting, managing security, or regulating home temperature. The devices must offer practical and valuable features that enhance the overall living experience.



Note:

Consumers are vigilant about privacy policies and data security measures implemented by smart home device manufacturers. They seek transparent information about how their data is collected, stored, and used, as well as assurances that their right to privacy is respected.

Simplicity is equally important, as consumers prefer intuitive interfaces and easy-to-use systems. They want smart home devices that are user-friendly and straightforward to set up and operate. A simple and uncomplicated user experience is highly valued, as it reduces the learning curve and frustration associated with complex technology.

FIGURE 6

Room for Improvement for Smart Home Devices

Failed expectations/promiseOngoing service cost too high

Privacy/security concerns
 Lack of good tech support

Too complicated/confusing
 Desire for better interoperability



Source: IDC research survey data in Consumer Pulse Worldwide, n = 2,314



Zoom Into the Smart Vacuum Market

Consumer satisfaction in the smart vacuum market shows a similar pattern to the overall smart home market. Buyers want a smart vacuum that can clean effectively and efficiently, with strong suction power and the ability to reach tight spaces and corners. At the same time, they do not want the controls and maintenance of the machine to be complicated, and they don't want it to disturb their daily activities or sleep.

Cleaning results and operational processes are key challenges for the smart vacuum industry.

Consumers' needs can be characterized as having different layers — on the first level, the cleaning results of a smart vacuum decide whether the user still needs to get their hands dirty. What a consumer wants is to strike off housecleaning from the list of daily chores, so that their attention can be given to tasks that they consider to be more demanding and important.

Imperfect cleaning results and efficiency

Need of manual intervention/maintenance

Cleaning corners and under furniture

"Smart vacuums often can't properly clean corners, around and under furniture, which makes the overall cleaning unsatisfactory, and more often than not I need to do some manual work."

Need to remove of subjects on the cleaning path

"Before the smart vacuums start to work, I need to move household items to prevent it from colliding or getting entangled. For instance, I need to move chairs for under-table cleaning and organize cables to avoid tangling."

Hard/tough stains

"Smart vacuums can't remove **stubborn stains** such as yogurt and juice well, so the cleaning results are not satisfactory. If you want to thoroughly clean these stains, you still need to clean on your own."

Helping the smart vacuum when it is stuck

"The smart vacuum can get trapped by various obstacles like chairs and low-lying furniture. Manually assisting the smart vacuum becomes necessary, which is troublesome when there are no people at home, because the smart vacuum can't get out of trouble itself, leading to incomplete cleaning."

Low cleaning efficiency and disturbance to routine

"It is quite time-consuming for the smart vacuum to do extensive cleaning and its movement and noise are a disturbance to daily life."

Daily/routine maintenance

"Routine maintenance work such as emptying the dust bag, refilling the water tank, and adding cleaning agents, which, although minor, still require time and effort, which doesn't meet my expectations from an ideal automation product."

Source: IDC, 2023





Cleaning efficiency:

- There are always corners and under-furniture areas in a house, where dust, dirt, and debris often accumulate. Full coverage of such areas is the first step in accomplishing a thorough cleaning job. Should a smart vacuum fail to reach these corners and below-furniture areas on its own, the user will have to do the job.
- Spilled coffee or tea leaves stains that, if ignored, can dry up and become difficult to remove. Such stubborn stains may require repeated cleaning. In such situations, even if the smart vacuum cleans up 99% of the stain, it is still a job undone, because the user must pick up a mop and do the cleaning manually.
- A smart vacuum moving around a room doing its tasks means that that particular room cannot be used — to minimize this inconvenience to the homeowner, the device should be efficient enough to reduce cleaning time. It should also be intelligent enough to schedule its tasks to those times when the room is not being used, because the noise of the vacuum cleaner can be a disturbance.



Operating process:

- Early smart vacuums needed a lot of help users had to follow them to clear objects in their path or rescue them if they got trapped between objects. This meant that users could not be hands-off when it came to housecleaning chores, especially those which required high levels of maneuverability on the part of the vacuum cleaner.
- While the smart vacuum frees the user from the direct labor of floor cleaning, it
 may create new daily maintenance chores such as emptying the dust bag, brush
 cleaning, sensor dusting. These chores can be no less demanding than the
 actual cleaning work, defeating the purpose of having a smart vacuum in the
 first place. So it is crucial for a smart vacuum to be capable of self-maintenance
 to a certain extent.

Interoperation, technical support, and customization are crucial for the advancement of smart vacuums, especially to cater to the specific demands of niche market segments.

The level of satisfaction also differs among various user demographics. Gen Z (aged 18–26), which has shown increasing potential in smart home device purchases, is more demanding, especially in home automation, where smart vacuums can take over the cleaning chores. Their greater familiarity with technology leads Gen Z to have higher expectations from smart home devices compared with other groups.





FIGURE 7 Satisfaction by Generation

Source: IDC, 2023

Better Wi-Fi connections and technical support are areas where there is potential for service providers. Gen Z consumers expect more on these points compared with other generations, and they want smoother connections between devices.

FIGURE 8 Room for Improvement by Age



Source: IDC, 2023



Gen Z and younger millennials value more on interoperability and technical support.

Gen Z and young Millennials desire better interoperability, which refers to interoperation of a smart device with other smart home devices, and how easily it can work with smart assistants. They look for superior interoperability from a smart vacuum, meaning better integration with other smart home devices, and user-friendliness. Their current dissatisfaction stems from the limited range of cooperation and operational functions between smart vacuums and voice assistants, with many vacuums compatible with only select assistants and restricted command options, leaving several custom needs unaddressed.

These younger users also call for robust technical support, particularly in maintaining stable Wi-Fi connections and efficient troubleshooting, to ensure a seamless experience. A consistent network connection is fundamental for the comprehensive operation and remote management of smart vacuums. The device's connectivity module performance, alongside home network quality, is pivotal. This demand elevates the service standards required in the smart vacuum sector, with young consumers expecting more technical assistance during setup and use, and prompt manufacturer responses to issues like equipment malfunctions and wear and tear.

Families with children or pets have higher requirements for child- or pet- friendly functions, cleaning capabilities, and health factors.

Families with children or pets tend to want customized solutions that take into consideration their children or pets and provide added safety and convenience. Pet hair and waste, children's scattered toys, and the need for disinfecting spaces frequented by pets and children significantly test the cleaning efficiency of smart vacuums. The degree to which these specific concerns are addressed greatly influences these users' interest in smart vacuums.

Features specifically designed to accommodate children and pets may include tangle-free brush rolls to prevent hair and fur from getting entangled, as well as sensors and safety mechanisms to avoid accidents involving children or pets. These families require strong suction power and effective cleaning capabilities in smart vacuums to handle the messes and litter often associated with pets and young children. They prioritize health-related features, such as advanced filtration systems to capture allergens, and place a premium on such features.

The key to increasing market receptivity for smart vacuums lies in improving their cleaning efficacy and control features. Concurrently, focusing on technology enhancements and comprehensive service support tailored to specific segments like young individuals, pet owners, and families with children is crucial for the market's comprehensive growth.



3. Cutting-Edge Technology

What Is autonomous Cleaning?

Autonomous cleaning encompasses smart sensors and technology that enables the device to adapt to its environment and adjust its cleaning patterns without requiring manual adjustments. Being autonomous starts with the chassis-andtechnical-based moving ability of smart vacuums, which also defines "mobile" for the smart home industry and leads the trend for smart home ecosystems. One step further is an integrated solution enabled by continuous improvements of the docking function. At a deeper level is the interaction mechanism, with the smart vacuum becoming more proactive, managing itself in a more customized, humanlike, self-aware way, upon detection of the house environment and user behaviors.

FIGURE 9 Explanation of Autonomous Cleaning



Source: IDC, 2023



Autonomous cleaning aims to provide a seamless and straightforward user experience, allowing individuals to clean their living spaces efficiently and effectively with minimal effort and hassle. It sets the direction not only for smart vacuums, but also for smart homes, by defining the value proposition of smart development for the industry.



Autonomous Floor Cleaning

Floor cleaning is mainly about vacuuming, sweeping, and mopping. Vacuuming solutions have been advancing to deal with problematic objects on the floor, such as long hair. Besides the increasing vacuuming power in general, smart vacuums on the market have developed multiple approaches in the pursuit of higher cleaning capabilities.

As far as autonomous vacuum cleaning is concerned, it is important to design the system to make its operation easy to understand and without the need for extensive instructions or training.



• Hard stain cleaning: Technologies that enhance mopping include pre-heated mop-washing water, auto-usage of cleaning agent, mop vibration, etc., ensuring the removal of hard stains by all possible means. The most advanced devices can detect how dirty the water is after washing the mop, to decide if the smart vacuum needs to be sent out again to re-clean the area that has just been cleaned.



Corner and edge cleaning: Smart-vacuum cleaner manufacturers have made creative use of mechanical engineering and material science to enable their products to reach corners and edges. Intelligent control of a mechanical arm that extends out has been an important solution, along with usage of flexible materials to clean hard edges.



 Recognition of floor materials: Advanced smart vacuums may be equipped with sensors that can detect changes in floor surfaces. These sensors can identify transitions between carpeted areas and hard floors, prompting the vacuum to adjust its cleaning mode accordingly. Advanced algorithms upon camera and 3D structured light can be utilized to analyze the texture and composition of the floor surface, and adjust the suction power, mopping intensity, and cleaning patterns accordingly.



1 - 1

 Integrated self-cleaning dock: To minimize human involvement, the smart vacuum must be able to clean and maintain itself. This means that the dock must not only serve as a charging station, but also enable the functions of water selfcirculation for mop washing (with hot water)/drying and auto tank refilling, as well as automatic dust bag emptying, UV-C sterilization, etc. And as an integrated solution, the dock may also serve as a charging hub for other smart devices.

An autonomous cleaning experience is one that feels natural and user-friendly, allowing individuals to operate the cleaning equipment easily and effectively without encountering complexity or confusion. It minimizes the involvement of users in the cleaning process, allowing them to enjoy a cleaner home with minimal effort. And for users, the benefit is that they can set it and forget it, allowing the vacuum to clean on its own without needing manual intervention.

Autonomous Navigation and Avoidance System

Autonomous navigation and avoidance system allows the vacuum to autonomously navigate through the cleaning area while avoiding obstacles and hazards. There have been various stages in the evolution of such systems for smart vacuums.

Tech evolution of navigation and avoidance capabilities in smart vacuum — a multimodal navigation system:





Inertial navigation works well in environments with limited external references, such as featureless or open spaces, but faces difficulty in complex environments such as inside a house, which led to the VSLAM stage. The later laser navigation utilizes "light detection and ranging" (LIDAR) sensors to create a detailed map of the smart vacuum's surroundings. It provides highly accurate mapping and obstacle detection, allowing for precise navigation and obstacle avoidance. And with the integration of LDS and visual recognition, it was combined the capabilities of laser-based navigation with visual recognition technology to enhance the navigation and perception abilities of robots or autonomous systems, so the accurate detection of small objects can help with the smart vacuum's perception of the surroundings.



Full navigational capability: Advanced navigation and mapping features enable smart vacuums to navigate through indoor spaces autonomously and effectively, ensuring comprehensive cleaning coverage.

- Fast and accurate mapping and path planning: Smart vacuums use sensors, cameras, and laser-based systems to create a map of the cleaning area and determine their precise location within the space. This mapping capability enables the vacuum cleaner to efficiently navigate and clean the entire area without missing spots.
- LIDAR-based real-time dynamic navigation: With the help of LIDAR, the smart vacuum's sensors detect obstacles such as furniture, walls, and other objects in the cleaning path. It then uses this information to plan its route and avoid collisions while cleaning.



Accurate obstacle avoidance capability: This enables smart vacuums to navigate through indoor spaces while effectively detecting and avoiding obstacles.

- Object recognition and path optimization: When an obstacle is detected, the smart vacuum's navigation system dynamically adjusts its path to navigate around the obstacle, ensuring that it can continue cleaning without getting stuck.
- Pet identification and protection: This enables the vacuum cleaner to recognize and accommodate pets during the cleaning process, as well as safeguard pets from potential harm. The smart vacuum cleaner adapts its cleaning patterns to avoid disturbing or colliding with pets upon detection of their presence.

An autonomous navigation and avoidance system enables smart vacuums to operate autonomously, efficiently navigate complex environments, and provide thorough cleaning while minimizing the need for user intervention.



Autonomous User-Device Interactions

Smart vacuums can be designed with simple and easy-to-use interfaces that allow users to control the device with minimal effort or technical knowledge. This approach aims to simplify the user experience and reduce the cognitive load required to operate the device.

FIGURE 10 Evolution of User-Device Interactions



Source: IDC, 2023

By proactively addressing user needs and environmental conditions, smart vacuums can enhance user convenience, improve cleaning efficiency, and reduce the need for manual intervention. The transition from traditional button control to multimodal interaction represents the shift in how users interact with smart vacuums. Traditional button control typically involves physical buttons or switches on the device, while multimodal interaction involves the use of multiple input modalities, such as voice commands, gestures, touch interfaces. This change expands the range of input options and enhances the user experience by providing more natural, accessible, and intuitive ways to interact with smart vacuums.

The shift from passive to proactive behavior in the context of smart vacuums refers to a transition from simply responding to user commands or manual inputs to actively anticipating and addressing user needs without explicit direction.



 Screen-based remote control: Screen-based remote control refers to the use of a visual interface, typically displayed on a screen such as a smartphone, tablet, or computer, to remotely control and interact with a device. In the context of smart vacuums, screen-based remote control allows users to access and manage various functions and settings of the vacuum cleaner through a digital interface.

• **Evolving voice control:** Voice-activated features and capabilities have been evolving, leveraging natural language processing and artificial intelligence to enhance the user experience. It involves natural language understanding and contextual understanding and may also evolve to support a wider range of commands and functions, including the ability to query the vacuum cleaner's status, schedule cleaning sessions, adjust cleaning modes, and even provide feedback or guidance on maintenance and troubleshooting.



 Cross-scenario visual interactions: This is the ability to visually interact with and adapt to different environmental and situational contexts. It involves leveraging visual information to recognize and respond to various scenarios, leading to more intelligent and adaptable cleaning behaviors. At the same time, by using their cameras for pet care and home security monitoring, the push to expand the scope of smart vacuums from traditional cleaning scenarios to security monitoring scenarios is underway.

Manufacturers are actively ensuring compliance and addressing user concerns about potential privacy and security risks associated with cameras and microphones. Privacy protection is of crucial concern across the industry, since any interaction needs to be with the users' consent, and should not invade their privacy.



4. Smart Vacuums Outlook

FIGURE 11 Smart Vacuums Outlook



Source: IDC, 2023

Smart Cleaning Technology Boosts Market Awareness

The evolution of smart vacuums has developed technology which can be adapted by other cleaning devices in the smart cleaning ecosystem. Besides the



The penetration of smart vacuums will reshape consumers' attitudes toward smart housecleaning and boost the development of this market. technologies of water pre-heating, mop vibration, and automatic water drilling, etc., current intelligence has enabled the detection of post-cleaning water, providing the smart vacuum much more information about cleaning conditions. It expands the decision-making scale for the smart vacuum, where it can decide on its own how to proceed with the cleaning process.

Improved experiences due to automation and AI can greatly drive the growth of the smart home cleaning market, boosting consumers' interest in smart devices like washer-dryers and wet-dry vacuum cleaners.

Bringing Robots Home

The mobility and mechanical motion capabilities of robots will be utilized in a wider range of smart home devices, hastening the advancement of household robots to meet consumer demands for an intelligent assistant capable of not only answering their questions but also solving problems for them.

- The ability of self-driving will be particularly useful for escorting robots or monitoring robots.
- Controlling a mechanical arm via sensors can help to grab and hold of objects, which are key functions of robots used for clothes hanging or object organizing.

As-a-service Model Will Provide Customized, Long-Term Support to Smart Home Ecosystem

A smart home ecosystem will have solutions in place to address interoperability issues, integrating smart vacuums with devices like smart cameras and smart phones, to execute tasks such as detecting dirt spots, map sharing etc.

- With smart home devices: Smart vacuums execute tasks based on the stains spotted by cameras.
- With screen-embedded equipment: By sharing the home map with other smart home devices, the smart vacuum can help improve the interface of screenbased devices to be clearer and more autonomous.
- With devices outside the home: Smart vacuums can interoperate with smartphones, wearables, or cars, to add convenience to the user's life, in scenarios like speeding up the cleaning task when the user is on the way home.



Customized solutions for different family members and situations.

• The smart vacuum can prove different family members with customized cleaning plans for their own space, allowing users to designate cleaning zones for individual family members.

The user experience can be improved by providing software, applications, and innovative service with a broader subscription-based model for diverse and long-term user support.

- Cloud storage for the users' children's or pets' video clips allows them to store and access video clips and other media files of their children or pets from any internet-connected device, with AI selecting the most memorable and meaningful moments.
- Home monitoring alerts and advanced visual recognition skills are likely to be characterized by increasingly sophisticated and intelligent systems that offer advanced visual recognition, behavioral analysis, personalized alerts, and other features.
- Smart vacuums can support health management services with the analysis of waste from attributes like hair volume, bacteria category, etc., and provide more thorough bio-cleaning solutions.



5. Roborock: Pioneering Excellence in Autonomous Cleaning

As one of the leading players in the industry, Roborock is committed to a 'customer-centric' philosophy, dedicated to providing autonomous cleaning solutions for home maintenance. Roborock focuses on delivering seamless and efficient cleaning experiences, tailored to the needs and preferences of its users.

Autonomous Cleaning for a Virtually Intervention-Free Experience

Elevating Edge and Corner Cleaning to New Heights

FlexiArm Design[™] Side Brush & Extra Edge Mopping System

In the area of home maintenance, traditional solutions often leave hard-to-reach areas like corners and edges inadequately cleaned. This defeats the purpose of autonomous cleaning. The Roborock S8 MaxV Ultra smart vacuum cleaner addresses this issue through its FlexiArm Design[™] Side Brush and Extra Edge Mopping System.



The FlexiArm Design[™], rooted in biomimetic engineering principles, includes a mechanical arm that automatically extends a side brush upon sensing corners or gaps beneath furniture, thus achieving comprehensive cleaning in previously neglected areas. This advanced technology extends the vacuum's reach and effectiveness, thereby increasing the autonomy of the cleaning process.

The Extra Edge Mopping System, featuring a soft edge mop, complements this by efficiently cleaning edges while avoiding damage to furniture. The edge mop employs sophisticated algorithms to better clean convex corners.

Seamless Cleaning: From Hard Floors to Carpets

DuoRoller Riser[™] Brush & Carpet Boost+ System[™] Technology

Apart from edge and corner cleaning, hard floors and carpets are also important. The Roborock S8 MaxV Ultra, with its DuoRoller Riser[™] Brush system, excels in carpet cleaning. Its dual rubber brushes improve hair cleaning efficiency on carpets by 30% compared to the previous single-roller models. This enhancement enables users to trust the smart vacuum, making the process more intuitive and less laborious.

Additionally, the Carpet Boost+ System[™] also contributes to improved carpet cleaning. Upon detecting a carpet with ultrasonic sensors, the device automatically raises its mopping module and increases suction power. Moreover, this system can perform a second round of much deeper cleaning in a checkerboard pattern. If "Vacuum Carpet First" option is enabled, the smart vacuum conducts carpet vacuuming before mopping to further clean carpets.

VibraRise[®] 3.0 Mopping System

The VibraRise[®] 3.0 Mopping System exemplifies the convergence of vacuuming and mopping processes into a single, cohesive operation. The smart vacuum lifts the mopping module by up to 20mm when a carpet is detected, preventing any unwanted dampness. This innovation eliminates the need for users to first vacuum the entire house and then set carpets as no-go zones for mopping. With this feature, the smart vacuum efficiently completes both vacuuming and mopping in a single pass.

Additionally, a dual vibration module further elevates its cleaning prowess. It is designed to tackle stubborn stains. This feature enables the mop to perform 4,000 strokes per minute. This innovative approach provides a level of cleanliness that mirrors the care and attention of a hand-washed floor, delivering a hassle-free cleaning experience.



Efficient Navigation and Precision in Obstacle Avoidance

PreciSense® LIDAR Navigation

Navigation and obstacle avoidance are foundational capabilities underpinning the autonomous cleaning process. Roborock was an early adopter of LIDAR navigation since 2016. All models currently available from Roborock are equipped with the PreciSense[®] LIDAR Navigation system, which utilizes lasers to create highly detailed 3D maps during scans. It can create as many as four floors of mapping. By precisely mapping its environment, the Roborock sets a new standard in intelligent, efficient robotic cleaning.

Reactive AI 2.0 Obstacle Recognition

Obstacle avoidance plays a crucial role in ensuring a worry-free cleaning process. The Roborock S8 MaxV Ultra's Reactive AI 2.0 Obstacle Recognition system, equipped with 3D structured light and an RGB camera, can identify up to 73 types of common household objects. Moreover, it intelligently suggests no-go zones, such as stairs and areas where the vacuum could get trapped. Importantly, upon detecting pets, the system not only stops the main brush to avoid contact but also increases suction power around areas where pet supplies are stored to ensure thorough cleaning. This level of detailed obstacle management highlights Roborock S8 MaxV Ultra's commitment to an intuitive, efficient, and thoughtful cleaning experience.

Minimal Manual Upkeep, Effortless Operation

"Hello Rocky" Intelligent Voice Assistant

Ease of use is as crucial as high cleaning efficiency. The S8 MaxV Ultra's built-in voice assistant, "Hello Rocky" brings convenience to the user experience. Whether the user is engrossed in desk work, preparing dinner, or simply wanting to relax without reaching for the phone, "Hello Rocky" can effortlessly handle cleaning commands. It can also direct the vacuum to clean specific rooms or adjust the cleaning modes. "Hello Rocky" is also accessible offline, meaning that even in instances when there is a loss of network connectivity in the home, "Rocky" will still be readily available.



Roborock App

The Roborock App also provides an effortless interaction experience. With the Roborock SmartPlan[™], the user simply selects the area that needs cleaning, and the smart vacuum takes care of the rest. This intelligent system autonomously determines the optimal cleaning method based on the environment. Whether it is routine vacuuming or over a targeted area, the S8 MaxV Ultra adapts its cleaning strategy to the user's home layout and surfaces, utilizing the most innovative smart cleaning technology.

The S8 MaxV Ultra also understands that life can be unpredictable, which is why it is equipped with the innovative "Temp Cleaning" function. This feature is designed to swiftly address sudden spills or messes without disrupting the current cleaning schedule. Additionally, the "Temp Skip" option allows the user to temporarily exclude certain areas from the cleaning path. Furthermore, the S8 MaxV Ultra excels in cleaning along the direction of the floor, ensuring that even the seams and crevices are spotlessly cleaned.

8-in-1 RockDock® Ultra

While smart vacuums take care of home cleaning, the post-cleaning maintenance of their docks still leaves users often yearning for a more hands-off experience. Addressing this, Roborock's innovative 8-in-1 RockDock[®] Ultra provides users with "set and forget" convenience.

The Hot Water Mop Washing system utilizes water heated up to 60°C to dissolve stubborn and greasy stains on the mop. Its Dirt Detection for Re-Wash and Re-Mop continuously detects and adjusts the duration of washing based on the mop's dirtiness. In heavily soiled areas, the smart vacuum will automatically re-mop that area. The Auto Detergent Dispenser simplifies the need for manual refills. The 580ml detergent tank needs filling only once every three months. Furthermore, the Dock Self-Cleaning function and the Heated Air Drying system use 60°C hot air to dry the mop, preventing mold and odors. The Auto Dust Emptying feature supports automatic dust disposal during and after cleanups. The Auto Tank Refilling feature ensures that the smart vacuum's water tank is always ready, enhancing the efficiency for homes with heavy cleaning needs.

Moreover, the RockDock[®] Ultra is available in two versions. For the version with Refill & Drainage System, the dock autonomously refills clean water and empties dirty water during mop washing and tank refilling, offering a hands-free experience.



O IDC Custom Solutions

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