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# Cultural Design of Domestic Robots: A Study of User Expectations in Korea and the United States

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*Abstract*— **In this paper, we describe the results of a comparative analysis of user-created designs for future domestic robots made by participants in Korea and the US. We identify their culturally variable expectations and preferences. We use a generative design methodology, which includes users visualizing their designs followed by semi-structured interviews. We describe our results in four areas of design: the look and feel of the robot, interaction mode, social role, and desired task. We identify variable cultural models relating to robotic technology and the cultural meaning of the domestic context as central factors. Finally, we discuss the design implications of our findings to culturally situated robot design.**

## I. Introduction

The development of robots for use in homes and other everyday contexts is seen as a rising trend [1] not only in the United States and Japan [2], but across Asia and Europe [3]. As domestic robots are developed for diverse national markets, we can expect that nationally variable cultural factors—the socially learned, transmitted, and shared language, knowledge, values, norms, behaviors, material objects, and physical environment—in user perceptions of domestic robots should be an important focus of study in robot design. However, little research has been conducted on cultural variability in users' needs and expectations from robotic technologies. To address this emerging agenda, we present a comparative study of user expectations and needs relating to domestic robot design in the United States and South Korea. We investigate user expectations from domestic robots by asking participants to visually represent their ideal home robot (Fig 1), using a methodology inspired by a design elicitation technique called generative design study [4].

This study confirms the existence of cultural differences in the way potential users in the US and Korea imagine living with robots in the home. We present the results of our analysis in four categories of user expectations and needs: Look and Feel, Interaction Mode, Social Features, and Desired Tasks. Based on these results, we suggest that designers and researchers should attend to: 1) cultural models of robotic technology, and 2) the different cultural meanings attributed to the domestic context as salient factors in designing culturally appropriate robots. We also provide possible design implications regarding these two factors.

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Figure 1. Examples of participant drawings from Korea (top) and the US (bottom).

## II. Related Work

The use of robots in everyday contexts has gained international acceptance. Consequently, researchers have started investigating cultural factors relating to user perceptions and reactions to robots particularly around three questions: *1) Do cultural differences exist in user attitudes towards robots?*, *2) Which cultural factors generate these differences?*, and *3) What are the design implications of cultural variability in user attitudes and perceptions?* We describe research to date for each question below and discuss how our study adds to this body of existing work.

### A. Do cultural differences exist toward robots?

Existing studies agree that cultural context is a significant influence on people's perceptions of and behaviors toward robots, but they do not agree on the nature of these differences, as shown in the following examples. Scholars use the Negative Attitude towards Robots Scale (NARS) to measure cultural variability in user attitudes towards robots among Dutch, German, Chinese, Japanese, American and Mexican participants [5]. Their results show that US participants have the most positive attitude toward robots, particularly in terms of being willing to interact with everyday robots, while Mexican participants were the most negative, with Japanese participants in between. MacDorman et al. compared the incidence of pleasant and threatening associations with robots made by participants in the US and Japan and found more similarities than differences in Japanese and US participants' attitudes toward robots [6]. Nomura et al., on the other hand, indicated people in the US have a more ambivalent attitude towards robots when compared to participants from Japan and Korea [7]. These divergent results suggest various contextual factors may underlie professed cultural differences.

### B. *What generate cultural differences in robot perception?*

Scholars have attempted to identify particular cultural factors that might lead to differences in user perceptions of robots. Scholars note religion as one influential attribute [8, 9], suggesting that animistic beliefs and Buddhism affect the public's acceptance of robots in Japan. Researchers argue that believing all living and non-living creatures have soul allows the Japanese to put humans and robots on a more equal footing [8]. In contrast, the strong Christian influence in Western cultures, which strictly distinguishes humans as the only being with a soul, is seen as influencing users to be less accepting of human-like machines [10]. Yamamoto hypothesizes that Confucianism might also have had an influence on a relatively positive outlook on robots in Japan [5, 11]. In addition to religion, exposure to differing media portrayals of robots has also been identified as a possible influence on variable perceptions of robots [5]. According to this literature, Japanese animations and films often depict robots as superheroes [5] that help and live alongside humans (e.g. Astro Boy). In Western films and literature, on the other hand, robots are often portrayed as trying to take over the world or replace humans (e.g. the Terminator) [10]. While both religious beliefs and the media are used to explain cultural differences in attitudes toward robots, their effect on daily human-robot interaction is largely unsubstantiated.

### C. *Implications of cultural differences for robot design*

Human-robot interaction researchers have also investigated cultural differences in user preferences for various robot design factors by relating cultural norms to participants' interactions with robots. For example, Chinese participants living in a high context culture were found to prefer implicit verbal communication (e.g., the robot saying "Are you sure?" to express disagreement), while US and German participants living in low context cultures preferred explicit communication (e.g., robot saying "I think this choice is not correct") [2, 12, 13]. While experimental studies have verified the effects of specific cultural mechanisms on user interactions with robots, few studies provide an everyday context that would be familiar to users. Rather, they propose unusual situations or do not specify the context; e.g., one study asked participants to imagine they were astronauts assisted by a robot [2]. Another [12] asked participants to design a chicken cooperative with the robot.

Researchers have yet to investigate cultural differences and design opportunities for culturally appropriate robots by asking users directly about their perceived expectations and needs regarding these technologies. Our study focuses specifically on investigating how users envision robots in their daily lives and how they define the potential contexts of use and the place of robots in them, and compares these narratives across participants from the US and Korea.

## III. METHOD AND PARTICIPANTS

This study uses a generative design approach to collect data. Participants were asked to create visual representations of their ideal domestic robot and then explained their designs to researchers. While allowing users to share their insights through an active process of "doing" [14], this descriptive and unstructured process helps participants reveal needs that may be difficult to express in words [4] and supports their ideation of future domestic robots. It does require or evaluate participants' skills in creating the visualizations.

At the beginning of the study, each participant was given a large 24"x18" sheet of blank paper and a range of generative tools (colored paper, pens, etc.), and asked to visualize their ideal robot for home without considering any technological limits. US participants used materials from technology-related and family/living related magazines to create collages expressing their visions of future domestic robots, such as using the image of a circuit board to indicate the high intellect technology (Fig. 1, bottom). Korean participants envisioned their robots through drawings, without using collage materials like magazines (Fig 1, top).

After creating these visual representations, we asked the participants about the concept and motivation for their robot designs. Then, we turned to detailed descriptions of form, interaction modes, sociability, function, and other design factors suggested by their visualizations. We audio- and video-recorded the interviews. The interviews were transcribed and analyzed using qualitative methods. Initial open coding of the transcripts yielded 244 discrete design options (e.g., 50cm height, verbal recognition, friendly personality) mentioned by Korean participants and 221 by American participants. We grouped these design options using an affinity diagram technique, a form of inductive analysis that categorizes similar key points to identify overarching themes in a given context [15]. We continued this inductive process until we had identified four broad categories of design factors: Look and Feel, Interaction Mode, Social Roles, and Desired Task. Two researchers independently coded the transcripts and Cohen's Kappa was calculated. The reliability was sufficiently high ($\kappa$ =.754).

The initial sample of US participants contained 48 people (as reported in [16], from which we randomly selected 20 (10 men and 10 women, mean age=43.4, single= 9 and married = 11, with children = 10 and without children = 10) to use in this study. We compared their answers to those of 20 South Korean participants (9 men and 11 women, mean age=39, single= 8 and married = 12, with children = 12 and without children = 8). The participants held a variety of occupations including restaurant owner, nurse, professional cleaner, homemaker, and pharmacist. All participants were living locally in the US and South Korea at the time of the study.

## IV. RESULTS

Participants imagined aspects of the robot from appearance to interaction style, which we discuss through four main themes: Look and Feel, Interaction Mode, Social Roles, and Desired Tasks. "Look and Feel" describes the main concept of the robot drawing and their relation to various form factors (e.g., gender, material, and size). "Interaction Mode" involves the participants' vision of how a robot physically interacts with a human (e.g., interface design, interaction modality and level of autonomy/control). "Social Roles" refers to participants' expectations about the social position of the robot (e.g., whom to interact with) and "Desired Tasks" includes functions that participants expect the robot to perform. We found that Korean and US participants had similar responses regarding Desired Tasks and more varied responses in the other categories.

### *A. Look and Feel*

The "Look and Feel" category indicates the main design concept and form of the robot, including its shape (e.g., abstract, anthropomorphic), gender, materials, and size.

A majority of Korean participants depicted human-like robots with a "warm, friendly, and tender" feel. Robots are preferably female gender, related to Korean's understanding of the needs of the household and the importance of interpersonal relations in the family. US participants, on the other hand, focused more on abstract notions of futuristic and modern style. The robot's task-based functionality was the main determinants of its design. Several American participants (US15F, US21M, US22F) even said that look and feel did not matter if their robots functioned properly.

*Main design themes: Warm vs. modern*

A predominant theme in descriptions by Korean participants (n=11, 55%) was the robot as "tender, friendly, and warm" (부드러운, 상냥한, 따뜻한), which they identified as essential for the home environment. Korean participants compared "warm and tender" robots to family members, saying they were "mother-like" or "like my son," and visualized such robots using anthropomorphic and curved shapes (Fig. 2). US participants focused on the notion of modern, functional robots (n=17, 85%); 7 US participants mentioned "modern and stylish" robots would be the best fit for their home. US participants visualized this concept using rectilinear shapes and concrete or metal materials. One US participant (US17M, 30, student) described his robot as follows (Fig. 2, bottom right):

*"I really like the* ***concrete*** *feeling…* ***metal*** *surfaces … And these wheels because they have this very* ***modern feel.****"*

Another US participant (US23M, 29, engineer/designer) described how his robot should fit a futuristic house design (Fig. 2, bottom left):

*"It needs to be* ***modern and stylish****, represented by what I think is a really cool house. Futuristic stuff… It should have a very cool aesthetic."*

*Gender preferences*

Among the Korean participants who assigned a gender to their robot (n=9), six wanted their robots to be female, explaining that the female form best represents the concept of "warm and tender" (Fig. 2, top left and middle). The other three chose a male robot. One participant (KR06F , 42, hairdresser) relates the notion of "tenderness or softness" (부드러움) to "mother-like" (엄마 같은) qualities, which would help the robot fit into the home:

*"I think* ***tenderness*** *is the most important thing both for family relationships and for the home. If a robot has mother-like, feminine features, I think my children could feel comfort and be emotionally stable even though there are no parents in the home. That's why I concentrated on drawing a* ***soft and feminine-looking robot*** *wearing a skirt, earrings, and accessories."*

When assigning gender to robots, US participants (n= 6) showed a preference for male robots (n=5), while one participant wanted the robot to change genders according to its function (n=1). US participants described the robot's gender as related to the tasks they performed. For example, one participant (US9M, 56, VP of aviation company) drew a robot that resembles Darth Vader, a cyborg male character in Star Wars, when functioning as a security robot, and Nicole Kidman, an attractive female actress, when it is entertaining.

*Size preferences*

The average size of robots specified by Korean participants (n=17) was at 4.7ft, slightly shorter than the average height of a Korean adult female (5.1ft). The size of robots designed by US participants was quite variable and largely determined by their function. In some cases it was compact "to be stored and to be portable," while in other it was "huge" to be able to include various appliances such as a dishwasher and a refrigerator.

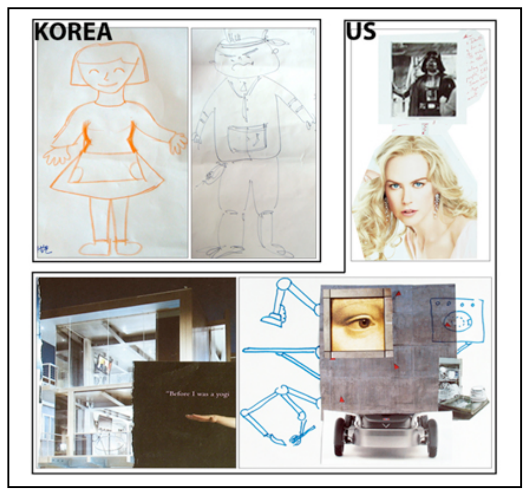


Figure 2. Top left, middle: Mother-like and son-like robots designed by Korean participants, Top right: US participant's robot changes its gender depending on task; Bottom left: A futuristic house fits the US notion of modern and stylish, Bottom right: US participant's modern robot.

### *B. Interaction Mode*

"Interaction Mode" in our study includes interface design, modality (e.g. speech, gesture), and level of robot autonomy/user control.

*Korean robot: Limited autonomy*

Korean participants often mentioned wanting to control their robots rather than giving them full autonomy. Some Korean participants (n=8, F = 2, M = 6) desired to control their robots by limiting its verbal abilities. Korean participants said they only wanted their robots to be able to reply to the owners' questions or commands by answering with a simple 'yes' or 'no,' or to inform the owners of the status of tasks they were performing, but not to initiate conversations. In the words of one participant (KR4F, 45 years old, homemaker):

*"The robot does not need to talk like me. I just want the robot to say simple things, such as that the floor-cleaning routine has started, like the lady's voice in the subway saying the next stop is Seoul station."*

Besides limiting their verbal abilities, Korean participants (n = 6, F = 6) expressed their preference for an increased level of control over their robots by drawing buttons on the robots' torso (Fig. 3, left) and remote controllers (n = 5, female = 2, male = 3) to manage robots from a distance (Fig. 3, right). Such buttons and controllers represent unidirectional communication that allows robots to perform only in response to the actions of their owners.

*US robot: Full autonomy*

In contrast to Korean participants, US participants emphasized the autonomy of their robots and described them as being able to interact without any restrictions on verbal ability. Only two US participants (F = 1, M= 1) out of 20 designed buttons and remote controllers for their robots. Furthermore, some US participants (n = 5) suggested that their robots should have the ability to learn the participants' habits, daily routines, and preferences. Their drawings also indicated that robots should adapt to new situations and environments by learning the structure of the house and the location of objects. US participants talked about the learning function as a way to increase the utility of their robots and their ability to operate without the user's input.

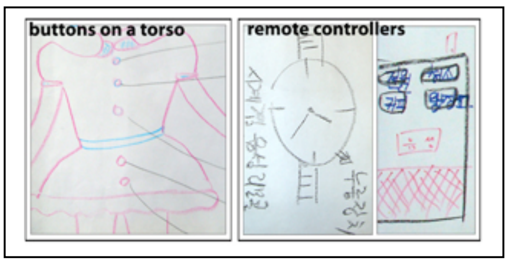


Figure 4. Supplementary control interfaces drawn by Korean participants

### *C. Social Roles*

The notion of a robot's "Social Role" refers to the expected social position of a robot as an agent. Social Roles are related to sociability, defined as the robot's ability to behave according to socially accepted norms. Social behaviors are particularly important for robot adoption where people tend to treat them as social agents [17, 18].

*Robot as an assistant*

Although a similar proportion of US and Korean participants reported having children (Korean = 12, US = 11), 9 of the Korean participants (45%) discussed robots tutoring or taking care of their children while only one US participant (5%) mentioned childcare as a desired application. Korean participants wanted robots to educate children as a private teacher (KR7M, 46, salary man), to discipline children when the participant is not home (KR17F, 40, teacher), and to give dating tips to children (KR6F, 42, hairdresser).

US participants expected robots to act as personal assistants (n = 7), and to give them expert advice in various domains, including physical training (US5F, US11F), fashion (US11F, US1F), finance (US10F), and legal (US9M).

*Robot as a friend*

When discussing the robots as companions, US participants described robots as interacting with every family member in their home, including visitors (n = 4). US9M (36, computer engineer) drew his robot going hiking and camping with him, US23M (39, designer/engineer) drew himself and his robot engaged in conversation, and US3F (40, landscape designer) drew the robot as a member of her family. Korean participants, however, allowed robots to form friendships only with children (n = 4). When interacting with Korean adults, robots were expected to just follow commands. KR6F (42, hairdresser) defines interaction with robots according to the user's age:

*"The robot could be a friend of my daughter. It can play with her and cheer her up when she is sad. And it can also read her mind and have deep and emotional conversations with her… It is only able to do some task oriented works that I command."*

*Robot as an entertainer*

Both Korean (n=9) and American (n=4) participants drew a robot as an entertainer. However, Korean robots were used to reinforce existing social dynamics by acting in the background rather than interacting with others directly. KR18F (25, graduate student) describes her robot:

*"I want my robot to provide me karaoke when I want to dance and sing. You know, it is hard to play when you are alone … Also, I want my robot to provide me a sitting cushion or flower if I feel gloomy or sad. A sitting cushion means comfort and coziness to me." (Fig. 4, left)*

In contrast, US participants wanted robots to be actively and directly involved in social activities. Participants danced, sang songs (US9F, 55, chef), and played games (US23M, 39, engineer/designer) with their robots. US23M illustrated the active role a robot could take entertaining his family:

*"It should be entertaining, either for me or for guests or keeping kids... It could play games, it could engage you in conversation."*

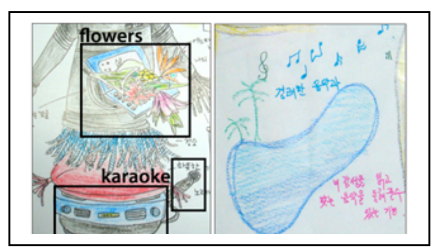


Figure 3. Korean robots as an entertainer acting in the background

### *D. Desired Tasks*

Desired Tasks indicate the expectations regarding function and task that could be done without an agent. Both Korean and American participants list similar desired tasks, as shown in Table 1 below.

Many participants drew robots cleaning the home: vacuuming (KR = 2, US = 3), washing dishes (KR = 4, US = 1), organizing (KR = 2, US = 3), and making a bed (KR = 1, US = 1). Participants also designed their robots to cook and prepare drinks such as coffee and martinis. Some robots were expected to perform information technology related functions, such as tracking objects in the pantry, constructing shopping lists, finding information from the Internet. In general, both US and Korean participants want robots to perform tasks that need practical and hands-on solutions, which matches US participants' expectations found in a previous online survey study [19].

TABLE I. BREAKDOWN AND QUANTITIES OF TASKS KOREAN AND US PARTICIPANTS DESIRED ROBOTS TO PERFORM IN THE HOME

| Types of Tasks | Korea (n=20) | US (n=20) |
|---|---|---|
| Cleaning | 16 | 12 |
| Cooking | 11 | 7 |
| Environmental Control | 6 | 1 |
| IT-Related Functions[a] | 4 | 6 |
| Security | 2 | 4 |
| Fetch and Carry | 2 | 3 |
| Health-Related Functions[b] | 1 | 2 |
| Gardening | 0 | 4 |
| Miscellaneous | 7 | 5 |

a. Connection to Internet, USB access etc./ b. Message function and health monitoring.

*Culturally variable task performance*

Despite the nominal similarity of the tasks described by participants in the US and Korea, there was cultural variation in how they imagined the tasks being performed. For example, Korean and US participants depicted security robots quite differently. Robots drawn by US participants were part of a house security system (US4F, US9F) and were allowed to use a gun (US4F) (Fig. 5, right), which is illegal in Korea. The robots in Korean's drawing performed security tasks for children rather than for the house as a whole (Fig. 5, left). In Korea, home security systems are not common, since most people live in apartment buildings with security guards. The appearances of robots designed by Korean participants are also friendly so that they can guard children. US security robots (US04F, US09M) were more threatening and machine-like (US02M, US07M).

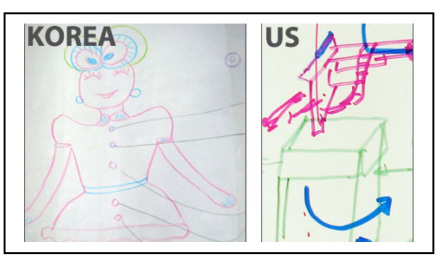


Figure 5. Left: Korean security robot for children, Right: US security robot with gun as a part of home security system.

*Culturally specific tasks*

Participants described certain culturally specific tasks. Only US participants mentioned gardening and landscaping (US1F, US3F, US9F, US21F). People in Korean living in apartments do not have a yard and therefor may have not thought to add landscaping or gardening tasks in their robot design. In addition, only US participants (US9F, US9M) expected their robot to drive a car, which did not appear in designs of Korean participants, who are less dependent on cars. Many Korean participants (n=6), on the other hand, wanted robots to control the domestic environment, including dust sensing, air purifying, sanitizing, fire detection, temperature control, and humidifying, while only one US participant expected the robot to control lighting and heating.

## V. DISCUSSION

In this paper, we provided a comparative analysis of the expectations and desires of potential users of domestic robots in Korea and the US. From our analysis, we extrapolate two cultural factors that should be taken into account to design more culturally appropriate domestic robots in the future.

### *A. Relational/interdependent and utilitarian/independent robotic technology*

Participants in our study designed robots that varied widely in terms of their look and feel—from human-like to mechanical—and interaction mode—from remote controlled to fully autonomous. We might expect participants to want more human-like robots to be more autonomous. However, the results of our study showed that this is not necessarily the case. Rather than directly mimicking humans and objects, participants espoused different cultural models of robotic technologies: a relational and interdependent view of robots in Korea and a utilitarian and independent view in the US.

Korean participants visualized their robot in terms of relationships to family members and their effects on interfamily dynamics. They determined the theme and appearance of a robot by referring to their similarity to family members ("mother like" or "like my son"), their relationships with children, and their role in supporting the daily life of the family. While envisioning very humanlike robots, Korean participants expected them to have low levels of autonomy, and maintain interdependence with other members of the household by distributing their control to family members through various interfaces.

Unlike Korean participants, US participants held a utilitarian view of their robots, defining robots primarily according to their function. For example, one human-like US robot was expected to change its gender depending on its task. Some US participants did not even care about the appearance of their robots as long as they functioned properly. US participants, at the same time, expected their robots to have high levels of autonomy, and to perform tasks independently of direct human intervention.

The relational view of Korean and utilitarian view of US can be related to the current visions of a robotic market in the two countries. In Korea, service robots dominate the market, which includes elder-care and educational robots. In the US, functional robots such as those working in inhospitable environments, underwater robots, and space exploration robots are widely developed and studied [21]. Different expectations of robot autonomy can also be related to the notions of the interdependent self predominant in Korean culture and the independent self predominant in the US, whereby the robot designs mirror cultural norms relating to the construal of the self [20]. The robots' human-likeness, roles, and capabilities are contextualized within these particular domestic market models and cultural norms. The two models of robotics offer design implications regarding the appearance of robots and their level of autonomy.

### B. *Culturally situated meanings of the home*

Our findings also suggest that understanding the cultural meaning of the home context plays an important role. In our study, we found both Korean and American participants drew robots that fit their culturally defined notion of the mood and meaning of the home. Korean participants emphasized the *"warm and tender"* feeling of the home, while American participants described the home as "*modern and stylish*." Those themes relate to the different meanings of home in each culture. For Koreans, home is a place where family members can rest [22], rather than a space for strangers such as visitors. In Western culture, home represents an essential aspect of self-expression and personal identity of the individual, rather than just being a space for family members [23]. The culturally situated meaning of home suggests three possible design implications for domestic robot design: 1) material and color of robot (pastel colors and fabric for "warm and tender" versus achromatic colors and metal for "modern and stylish"), 2) shape of robot (curved shape versus rectangular shape), 3) personality of robot (calm and passive v. assertive and active).

The culturally different meanings of the domestic context could explain the contradictory findings that came out from previous survey studies, as described in the section on Related Work. For example, when participants were asked the same questions (e.g., possible social interaction with robots in their homes), they would imagine very different robots in very different contexts. Our study suggests that an exploratory qualitative approach, such as detailed interviews and generative design studies, enables researchers to uncover some of these more subtle differences. This approach should be more commonly used for developing culturally adaptive robot designs and the development of human-robot interaction.

Our study was limited by the use of different visual materials presented to participants in the US and Korea. The limitation may have led to differing sources of design inspiration for the two groups. Nevertheless, we found robust repeating cultural themes in the responses of both groups of participants. The cultural themes were not related to the specific contents of the magazines used (e.g., level of robot autonomy, robot appearance).

## VI. CONCLUSION

Few existing studies have shed light on the importance of culture in users' expectations and preferences from future domestic robots using qualitative data, such as the work presented in this paper. We investigated user expectations using a generative design methodology. As a result, we found relevant factors to be 1) cultural models, such as relational and utilitarian views of robots and interdependent and independent notions of self, and 2) culturally variable meanings of the domestic context for robot design. Our study contributes empirically, conceptually, and practically to the design of culturally adaptive and appropriate robots by focusing on the perspectives and desires of users. Also, we hope our study provides HRI researchers with new methods to explore future domestic robots.


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