DESIGN OF A ROOM-SERVICE ROBOT

DESIGNING HUMAN-AGENT COLLABORATIONS

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INTRO

Initial Question:
What are the motivations for using robots in room service for both hotels and guests?
What considerations should be taken into account when implementing this?

With the rapid development of technology, artificial intelligence has gradually penetrated all walks of life, and the hotel industry is no exception. In this digital era, hoteliers must constantly seek innovation to meet the growing needs and expectations of guests and improve guest experience and service efficiency. Against this background, robots, as an emerging technology, have brought unprecedented opportunities and challenges to the hotel industry.

Room service is a vital part of the hotel industry and directly affects guests' stay experience and satisfaction [1,2]. There are already many types of room service robots on the market, each with its characteristics, but all are committed to providing smarter and more efficient services.

For example, some robots can assist guests with check-in and provide navigation services to help guests find their rooms quickly. Once in the room, the robots can perform housekeeping services, including making beds, changing bedding, and cleaning bathrooms, while delivering drinks, snacks, and other items in the room [2]. More intelligent robots even support voice control. Guests can request services or obtain information through voice commands, which greatly improves the user experience.

Hotel service

In addition to providing basic room service, some robots also have certain entertainment and educational functions. They can introduce the hotel's facilities and services to guests, provide recommendations for surrounding attractions, and even provide guests with language learning or cultural exchange services, adding more fun and value to the guest's stay experience.

I chose to design a room service robot myself. This robot will be placed inside the room. When the guest enters the room for the first time (automatically activated through the Internet after the room card is inserted), the robot will briefly introduce its functions and ask the guests if they need to use it (voice interaction system). Its main functions include monitoring the environmental parameters inside the room and adjusting them according to guest preferences; intelligently controlling lighting, curtains, air conditioning, and other equipments; simply cleaning and transporting garbage in the room, and collecting items ordered by guests (such as toothbrushes, toothpaste, food, etc.).

1. 4 Easy Ways to Simplify the Hotel Check-In Process for Customers
2. Hotel Robots: An Overview of Different Robots Used in Hotel

COMMITMENT TO JOINT ACTIVITIES

The first question to consider is “Are the agent's intentions and agreements visible to the user”? We can understand commitment as participants taking appropriate actions as required by the joint task and trusting that the other will do the same [1]. However, in the case of room service, we can only control and modify the robot's behavior to take into account its expectations in the interaction with the user. This can be challenging, especially given the user's familiarity with the robot or their different backgrounds. On the one hand, the robot needs to manage the execution of its actions, while also considering and managing the user's expectations of its behavior. Bots, on the other hand, need to monitor user behavior and signal when their expectations are not met.

Secondly, what tasks does the agent want to perform? Room service robots should be designed to support human decision-making and actions and undertake specific tasks when necessary, rather than replacing human roles. This means that when designing robots, the responsibilities and decision-making rights between humans and robots need to be clearly defined and ensure that the robot's behavior does not take away the user's autonomy [1].

DESIGN IMPLICATIONS FOR THE CASE:

Transparency and Visibility:

Robots should communicate their intentions and action plans to users. Before interacting with the user, the robot first provides concise and clear instructions, explains the task it is about to perform, and asks for an interaction method consistent with the user's expectations. For example, when adjusting room environment parameters, the robot will notify the guest of its action intentions through voice or screen display, and allow the user to confirm or adjust the adjustment.

Skill Augmentation:

The bot's functionality is designed to enhance the user's quality of life and experience while not replacing the skills of hotel staff. For example, the robot can collect the goods ordered by the guests, making it easier for the guests to enjoy their stay. However, for the guest's full freedom and the professional experience of the hotel staff, after placing the order, a voice prompt will be given to the guest to choose whether manual delivery is required or robots pick up the goods. If you choose manual delivery, a voice announcement will be made when the staff is about to arrive; if you choose a robot to pick up the goods, an in-room phone call will be made through Wi-Fi induction to announce their arrival.

1. Cila, N. (2022, April). Designing human-agent collaborations: Commitment, responsiveness, and support. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-18).

AUTONOMY & CONTROL

Proactive behavior is spontaneous and attempts to solve problems before they occur [1]. It involves taking action in advance of future situations, rather than reacting. Proactive behavior means taking control of the situation and making changes early, rather than adapting to the situation or waiting for events to develop.

Most human-robot collaboration involves hybrid proactive control, which allows for the integration of humans into complex control domains in a way that is often desired by humans, who can take charge and sense but do not need to issue every command [2]. When planning a task, breaking it down along meaning, plan, and action primitives can help determine which components are assigned to agents and which to people.

DESIGN IMPLICATIONS FOR THE CASE:

Environmental Monitoring and Active Adjustment:
The robot can actively monitor the environmental parameters in the room, such as temperature, humidity, etc., analyze the local average parameters, and spontaneously adjust the equipment to adapt to ensure guest comfort. It will also record the guest's behavior of actively adjusting environmental parameters, analyze their preferences, and make adaptive adjustments in subsequent services.

Intelligent Control Equipment:
The robot can autonomously control the lighting, curtains, and other equipment in the room to meet the needs of guests. For example, when a guest enters the room, the robot will automatically adjust the lights and curtains based on the time and external weather conditions (check the local weather online).

Processing Items:
When the guest requests to clean up garbage, the robot can identify and process the garbage in the room and centrally process and transport it. The robot will also determine the guest's intention to throw away garbage, analyze the guest's behavioral preferences, and ask whether it needs to be cleaned up at specific times every day. When guests place an order for goods, they will be proactively asked whether they need to collect the goods or need hotel staff to provide door-to-door service. If the latter is required, the front desk will be prompted through the networked system.

Respect User Control:
Although the robot has a certain degree of autonomy, it also respects the user's control. Only when the robot adjusts environmental parameters, it will not be explained to the guest in advance. All other functions will first obtain the guest's consent.

1. Luria, M., Zheng, R., Huffman, B., Huang, S., Zimmerman, J., & Forlizzi, J. (2020, April). Social boundaries for personal agents in the interpersonal space of the home. In Proceedings of the 2020 CHI conference on human factors in computing systems (pp. 1-12).
2. Cila, N. (2022, April). Designing human-agent collaborations: Commitment, responsiveness, and support. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-18).

MORALITY

In the design of robots, given the advancements in technologies, Moral concerns are of great importance, especially in three aspects[1] within the current context. Firstly, in terms of safety and errors, it mainly involves the issue of whether the software is complex. Then in the realm of law and ethics, the focus lies on user privacy. Lastly, it concerns social impact.

In this case, as the room service robot will directly interact with human users and carry out various tasks within the guest room environment, ethics become especially crucial. I choose to stand on the side of the Ethic of Care, emphasizing the relationships, emotions, and care between people. The room service robot should be seen as a tool to serve and support users rather than just task executors. Their design should consider the feelings and needs of users, respecting their privacy and personal space.

DESIGN IMPLICATIONS FOR THE CASE:

Human-Robot Interaction:
Emphasize friendly, caring, and respectful interaction with users. The language and behavior of the robot will reflect care and understanding to enhance user comfort and satisfaction. Voice interaction will possess human-like characteristics, adopting voices from animated movies corresponding to animal shapes. For example, a rabbit-shaped robot may use the voice of Judy the rabbit from Zootopia to increase guest affinity and trust. The design will avoid any behaviors that might make guests feel uncomfortable or disrespected, such as indifferent or intrusive tones.

Privacy:
The robot will respect the privacy and personal space of users while performing tasks. Upon the user's first entry into the room, the system will initiate a voice prompt, briefly introducing its functions, and guiding users to choose whether to activate the robot. Users will be informed about data collection and storage, including environmental parameters of the room such as temperature, humidity, air quality, etc. Users can choose to issue a sleep command at any time. Additionally, the robot will have strict data security measures. When the user checks out, the user's preferences and personal information will be automatically deleted through Wi-Fi networking to protect the user’s sensitive information.

Self-Protection:
Besides considering the robot's protection of user privacy, we also need to avoid ethical issues that may arise from user interactions. Therefore, the robot's voice recognition system includes self-protection functionality. When the user has used insulting, sexually suggestive, or violent instructions, it will warn the user that inappropriate information has been detected. The system will then shut down for 5 minutes automatically, and an alert will be stored in the hotel system. If the alert is triggered three times during the same user's stay, use permission will be temporarily blocked, and you need to apply to the hotel front desk before you start it again. The above content will be explained by the front desk during check-in and mentioned in the usage guide in the room.

1. Lin, P., Abney, K., & Bekey, G. (2011). Robot ethics: Mapping the issues for a mechanized world. Artificial intelligence, 175(5-6), 942-949.

COMMON GROUND

In interpersonal communication, common ground of experience plays an important role in promoting mutual understanding and effective communication [1]. In collaboration, all participants need to understand the situation of other parties in addition to their situation [2]. The performance of robotic systems depends on the common ground they share with their human partners, and robotic systems need to be intelligent and communicative.

Room service robots should read guests' intentions and needs through multiple methods, including verbal commands, sight lines, gestures, etc., and the robot's status and intentions should also be communicated to guests through various communication methods to establish common ground and promote effective communication.

DESIGN IMPLICATIONS FOR THE CASE:

Multi-modal Perception:
Robots have multiple perception methods, including voice recognition, visual recognition, and motion tracking, so that they can sense the users' intentions and needs. For example, when guests use verbal commands, the robot will be able to recognize and perform corresponding operations; when guests indicate through gestures or gazes, the robot also can understand and respond.

Intelligent Inference:
Robotic systems can infer users' intentions and needs by analyzing their behavior and expressions. For example, when a guest looks at the curtains, the robot can infer that the guest wants to adjust the curtains, and then ask and perform the appropriate action.

Natural Communication:
The robot can communicate naturally with users using friendly language, facial expressions, and gestures. When the robot understands the guest's intention, it can confirm its intention to the guest through simple verbal prompts or body movements.

Real-time Feedback:
The robot can communicate its status and intentions to users promptly. For example, when a robot is cleaning garbage, its current status will be displayed through voice prompts or a display screen to let guests understand the ongoing operations of the robot, and they can make timely requests for modifications or additions.

1. Stubbs, K., Hinds, P. J., & Wettergreen, D. (2007). Autonomy and common ground in human-robot interaction: A field study. IEEE Intelligent Systems, 22(2), 42-50.
2. Cila, N. (2022, April). Designing human-agent collaborations: Commitment, responsiveness, and support. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-18).

COMMITMENT TO MUTUAL SUPPORT

Humans can take proactive action. Imagine the following scenario: When people see a person looking around with trash, they tend to point out where the trash can is because they recognize the person's intention to throw away the trash. This requires all parties to provide support to each other when necessary. This includes actions such as providing guidance, advice, or warnings and asking for help.

Designing a robot to help requires considering two aspects: when the robot will help and how it will help [1]. One way is to recognize human intentions and take action to fulfill them, like opening the door you are about to walk through. Another approach is to reason about possible future threats or opportunities and take action to prevent or promote them.

Robots should be able to recognize and reason about human intentions; infer the current and predicted states of the environment; understand which states may be better than others; and anticipate problems that humans may face.

At the same time, the agent will also need to request help [2]. Imagine how anxious you would feel when a robot tried to clean your room, but spent a lot of time not knowing that the plastic bags you piled in the corner were the only trash that needed to be transported. Wouldn't it be great if they could preemptively seek help instead of just failing?

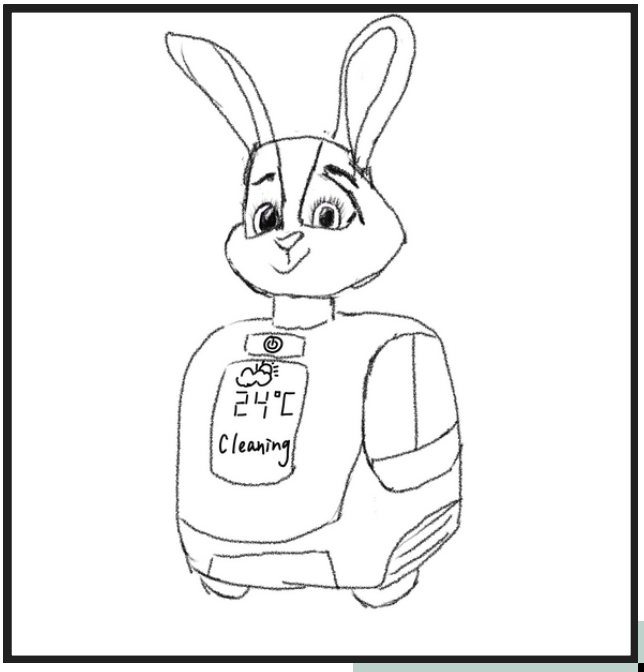
DESIGN IMPLICATIONS FOR THE CASE:

Intelligent Help Provision: Bots will proactively provide help when they sense that the user needs help, rather than waiting for the user to explicitly request it. For example, when the robot detects that the guest has left the room but forgot to turn off the air conditioner, it will proactively remind and perform corresponding actions. When the robot detects that the guest is looking around with garbage, it will proactively ask if cleaning and garbage delivery services are needed and will record the time the user performed this behavior, analyze their preferences, and combine the time the guest threw garbage into subsequent services.

Polite Request for Help: When the robot encounters a problem that cannot be solved, it will ask for user help positively and politely. This approach helps reduce user dissatisfaction with robots and makes it easier to get support and cooperation from users. At the same time, the display screen always shows a friendly smile and thanks for help while working. For example, when the robot cannot identify whether an item in the room is trash, it will politely ask the guest for additional information or assistance. At the same time, because we want the robot to be as small and cute as possible which leads to not having arms, a storage space will pop up from the body side when picking up goods and garbage, and request staff and guests to help place items.

1. Cila, N. (2022, April). Designing human-agent collaborations: Commitment, responsiveness, and support. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-18).
2. We Need Robots That Are Smart Enough to Ask for Help

VISION OF ROBOT

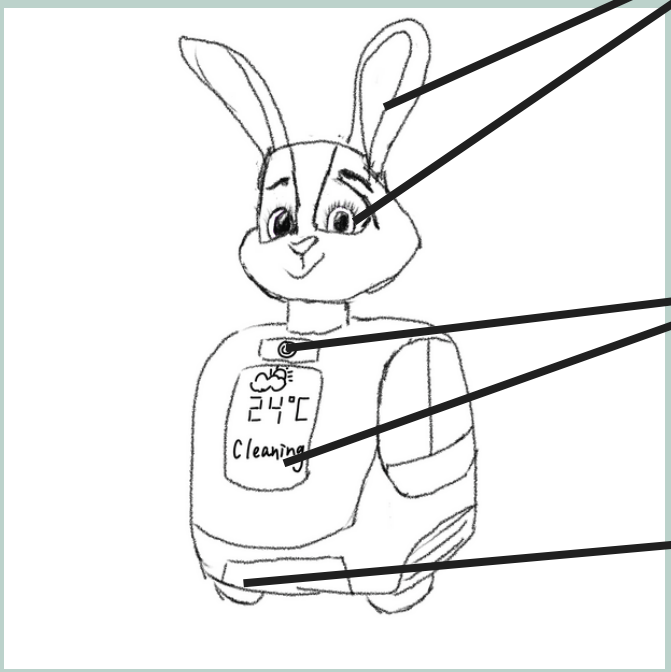


I first drew my imagination of the robot in my mind, using Procreate on iPad.

Then I tried the AI painting program [1] and generated such a picture based on the following command: Design an animal-shaped hotel room service robot. Its main functions include monitoring the environmental parameters inside the room and adjusting them according to guest preferences; intelligently controlling lighting, curtains, air conditioning, and other equipment; simply cleaning and transporting garbage in the room, and collecting guests' items ordered.

1. Image-generator

VISION OF ROBOT



There are cameras in the eyes and the ears are actually radios.

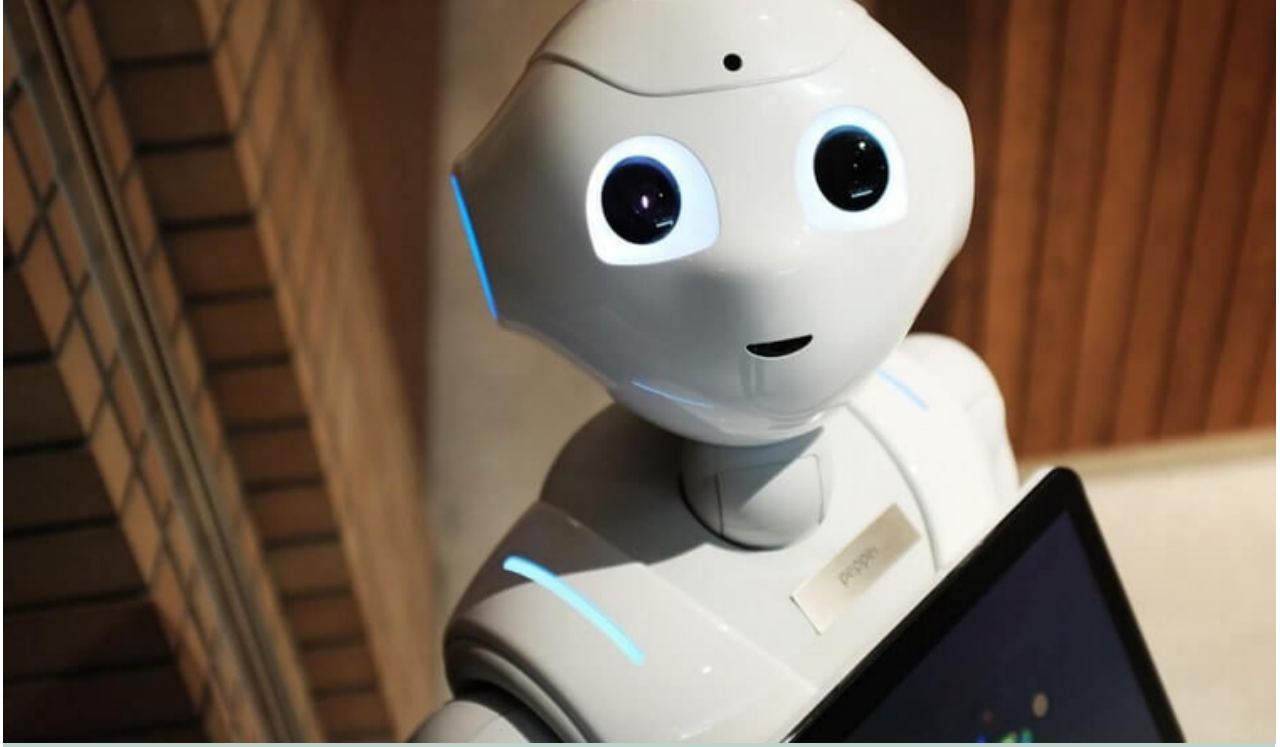
There is a manual switch button here.

The electronic display screen will display the current indoor environmental parameters, interactive systems, and the working status of the robot in real time.

The robot will collect trash from this location near the bottom.

This is the storage space on the side of the robot. When picking up items, everything will be placed in this space.

The robot uses wheels to move.



CONCLUSION

The traditional room service model often has problems such as low efficiency and unstable service. The introduction of robots can effectively solve these problems and improve the quality and efficiency of room service. Robots generally do not need to rest and can work around the clock if necessary. This means they can cover more shifts and free up staff to perform other tasks. Labor costs are significantly reduced. For guests, the benefits are mostly related to convenience. Having robots that can collect food and amenities and deliver them to guest rooms eliminates the need to wait in line at the front desk or interact with other people. At the same time, the robot can also help intelligently monitor environmental factors inside the room, help clean up garbage, and provide guests with comfortable and considerate services.

Since equipping every room with one such robot, the biggest issue is cost. Although I was full of enthusiasm and motivation when designing, I deeply realized that the money and technical support required to actually implement such a service in a hotel would be huge. Not to mention the complex internal sophisticated technologies such as voice recognition, data analysis, and route planning. Maybe I could consider putting it into practice in VIP suites. In addition to this, guest privacy is also a factor worthy of concern.