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## **A13 Robotic Design and Ethical Analysis Project (My Robotics Project: The "Maestro" Restaurant Robot)**

### **Introduction**

For my robotic design project, I chose the **restaurant entertainment** application domain. The restaurant industry is always looking for new ways to create memorable experiences for customers. People go out to eat not just for food, but for the atmosphere and social experience. My idea is to use robotics and AI to add a new layer of wonder and personalized fun to the dining experience.

This report details my design for a robot called "The Maestro." I designed it to be an autonomous entertainment host that visits tables in a restaurant. It can perform small shows, interact with guests, and help make special occasions feel even more special. I will first describe my robot's design, what it looks like, and its unique features. Then, I will explain how it uses artificial intelligence, including its sensors and how it thinks and acts. Finally, I will do a deep ethical analysis of my robot. I will look at the serious problems it might create, like issues of privacy, safety, and job displacement. I will use the research materials from our course to guide my analysis and to propose solutions for these ethical challenges.

### **My Robot's Design and Features**

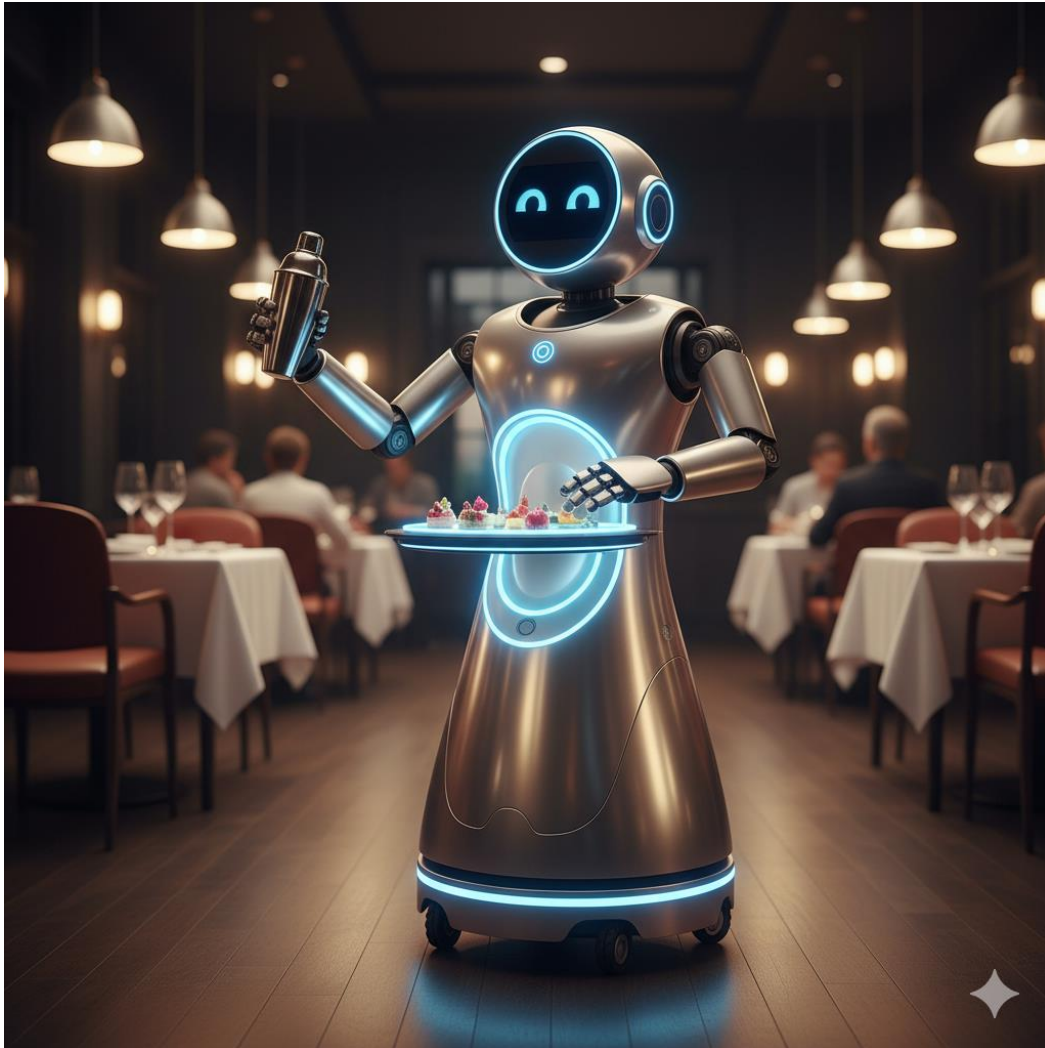
#### **Robot Description**

I call my robot "**The Maestro.**" It is designed to be a high-end, interactive entertainment robot for use in restaurants. It is not a server; it does not replace the human waitstaff. Instead, it's only job is to provide short, personalized entertainment experiences at a diner's table.

Here are the main details of its physical design:

- **Appearance:** The Maestro stands about 5 feet tall. Its body is very sleek and modern, with a pearl-white or brushed metal finish. I designed it to look elegant and futuristic, not "cartoony."
- **Head:** Its head has a smooth, digital screen for a "face." It does not try to look like a human. Instead, it shows simple, animated eyes to show emotion (like curiosity or happiness) and to show where its attention is.
- **Arms:** It has two articulated arms. These arms are designed for performance, not heavy lifting. One arm is a "utility" arm that can hold and use special tools, like a drink mixer or a dessert decorator. The other arm is a "performance" arm that is very graceful. It can use gestures to tell a story or perform simple magic tricks.
- **Body:** The main torso has a built-in "performance tray." This is a stable, well-lit tray where it can mix a drink, decorate a cupcake, or show a magic prop.

- **Movement:** It glides silently on an omnidirectional wheelbase. This allows it to move in any direction and turn in place. This is very important for navigating a crowded restaurant floor without being clumsy.



### Unique Features

I designed The Maestro with three unique features that are all powered by its AI.

1. **Dynamic Entertainment Menu:** The robot is not just on a fixed loop. Diners at a table can ask for a specific performance. For example, they could say, "We have a birthday!" and the robot could perform a special "sparkler" and song routine. Or kids could ask it to "tell us a story," and the AI would use generative AI to create a unique, 2-minute story, letting the kids choose what happens next.
2. **Adaptive Social AI:** This is the robot's most complex feature. It uses its microphones and cameras to sense the "mood" of a table. If the table is very loud and celebratory, The Maestro will adopt a more energetic and boisterous personality. If it senses a quiet, romantic dinner, it will either stay away or, if called over, speak softly and perform a very subtle, graceful action (like presenting a single rose).

3. **Tableside "Show":** The robot is designed to create a "spotlight" moment. It can mix a non-alcoholic "flair" drink for kids, with lights and sounds. It can also use its utility arm to do "dessert art," like drawing a picture with chocolate sauce on a plate.



## How The Maestro Uses AI

My design for The Maestro's AI system is based on the fundamental model I learned about in my research. This model says that a robot's AI must have three parts: Perception, Cognition, and Action.

### 1. Perception (How it Senses)

This is how the robot understands its surroundings.

- **Cameras:** It uses multiple cameras to see the world. These let it recognize tables, chairs, and people. It also uses them to watch for obstacles, like a child running past. The cameras also provide input for the Adaptive Social AI by looking at table activity.

- **Microphones:** An array of microphones allows it to hear voice commands from diners, even in a noisy restaurant. The microphones also listen to the tone and volume of a table to help the AI understand the social mood.
- **Sensors:** It uses LiDAR and proximity sensors to build a 3D map of the room. This is what allows it to navigate safely and avoid bumping into anything.

## 2. Cognition (How it Thinks)

This is the robot's "brain" and where the AI does its main work.

- **Natural Language Processing (NLP):** This AI allows the robot to understand what a diner is saying. It can understand requests, answer simple questions, and "hear" the choices for its interactive stories.
- **Machine Learning (ML):** This is what powers the Adaptive Social AI. The ML model has been trained to recognize patterns in sound, volume, and motion and connect them to a "mood." It then decides which personality and entertainment routine is the best fit.
- **Planning:** The AI must constantly plan its actions. This includes planning the safest and most efficient path to get from its charging station to a table. It also has to plan its arm movements to perform its tricks or mix its drinks without spilling.

## 3. Action (How it Acts)

This is how the robot physically interacts with the world based on its thoughts.

- **Manipulation:** The robot acts by using its articulated arms. It can grip a mixer, gesture for a story, or gently place a dessert on the table.
- **Navigation:** The robot acts by moving its mobile base. It can glide smoothly between tables and spin in place to "face" its audience.
- **Communication:** The robot acts by speaking with its voice synthesizer. It also acts by showing expressions on its digital face, which gives humans clear, visual feedback.

## Ethical Analysis

Building a robot like The Maestro brings up many serious ethical questions. A robot in a public space that records people is very complicated. My analysis is guided by the core ethical principles I researched, such as privacy, safety, fairness, and accountability.

### Privacy

- **The Problem:** This is the biggest ethical issue. The Maestro uses cameras and microphones to do its job. This means it is actively recording video and audio of diners' private conversations. People go to restaurants to talk privately, and they would be very uncomfortable if they knew they were being recorded.
- **My Mitigation Strategy:** I would propose several strict rules. First, all AI processing must happen on **the robot itself**. No video or audio of a table of conversation should ever be sent to the cloud or stored. The AI should only "listen" for its wake-word, and all other audios should be instantly deleted. Second, the robot must have a very clear visual signal,

like a bright light, that shows exactly when its microphone is active, so users are not in doubt.

## Safety

- **The Problem:** The robot is a 5-foot-tall, moving piece of metal and plastic. It operates in a crowded, dark, and unpredictable environment with running children and busy staff. It could malfunction and run into someone, or its arm could accidentally hit a guest. This is a failure of the "non-maleficence" principle (does no harm).
- **My Mitigation Strategy:** Safety must be the number one priority. The robot navigation AI must be based on a reactive, "safety-first" model. If its sensors detect any uncertainty, its first action is to stop completely. The arms must also be equipped with force-torque sensors, which means they will stop moving the instant they feel any resistance. This prevents injury. Finally, it must undergo thousands of hours of testing.

## Job Displacement

- **The Problem:** A robot like this could take jobs away from humans. Restaurants hire magicians, musicians, or even "flair bartenders" to entertain guests. The Maestro could replace all of them, leading to job loss for human performers.
- **My Mitigation Strategy:** My design is for The Maestro to be an attraction, not a replacement for human staff. It is a special "add-on" that a restaurant might pay to be unique. A restaurant would still hire human musicians or hosts for the main atmosphere. In fact, this robot might even create new jobs. The restaurant would need to hire a "Robot Technician" or "Performance Manager" to maintain the robots and program new shows.

## Bias and Fairness

- **The Problem:** The AI in my robot could be biased. What if the voice recognition AI works better for high-pitched voices than low-pitched ones? Or what if it understands certain accents better than others? This would lead to a frustrating and unfair experience for some diners.
- **My Mitigation Strategy:** The only way to fight this is with data. The AI models must be trained in huge, **diverse, and representative datasets**. This means we need to train it with voices and accents from all over the world. We must also constantly audit the robot's performance logs to find and correct any biases that appear.

## Accountability and Transparency

- **The Problem:** If the robot does cause harm (like knocking a person over) or damage (like breaking an expensive camera), who is responsible? Is it the restaurant? The company that made the robot? The programmer who wrote the AI code? This is a huge challenge in AI ethics.
- **My Mitigation Strategy:** First, we need **transparency**. The robot's actions should be as clear as possible. It should "announce" its intentions, like saying, "I am now going to mix a 'Starlight' drink!". Second, for **accountability**, the robot must have a secure "black box" data logger. This log would record all sensor data and AI decisions. If an accident

happens, this log can be used to see exactly what went wrong and determine who is responsible.

## Application of My Research

My research was the foundation for this entire project.

- **AI and Robotics Fundamentals (Murphy):** This research gave me the "Perception-Cognition-Action" model. I used this as the blueprint for my "How the Maestro Uses AI" section. It helped me understand that a robot is not just one thing; it is a system of sensors, a brain, and a body working together.
- **Ethical Considerations (Nature & UNESCO):** These sources provided the list of ethical issues I needed to analyze. The five core principles (transparency, justice, non-maleficence, responsibility, and privacy) from the Nature article were the direct basis for my ethical analysis. The UNESCO article's focus on human rights is what made me focus on privacy and safety as the most important issues.
- **Recent Developments (ArXiv):** The ArXiv review confirmed that the principles I found were the correct ones. It also pointed out that a big challenge is that these principles are "vague." This is what pushed me to not just name the ethical problems, but to propose a specific, practical mitigation strategy for every single one.

## Conclusion

The Maestro robot is my design concept for applying AI and robotics to the restaurant entertainment world. It is intended to create a fun, magical, and personalized experience for diners. By combining generative AI for stories, complex AI for social adaptation, and a safe, sleek physical body, it could become a major attraction. However, as I discovered in my research, building this robot is more than just a technical challenge. It is a major ethical challenge. The risks of guest privacy, physical safety, and fairness are very real. Before a robot like this could ever be used, we would need to be extremely confident in the mitigation strategies I have proposed. By addressing ethics from the very beginning of the design, I believe we can create amazing new technologies that are also responsible, safe, and respectful of people.

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