Towards Embedding Dynamic Personas in Interactive Robots: Masquerading Amimated Social Kinematic (MASK)

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Project Page

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Introduction

Motivation

Robots in interactive environments often lack the expressive depth needed to form meaningful connections with users. By equipping robots with dynamic, character-like personas conveyed through non-verbal behaviors, it becomes possible to create interactions that are more engaging, interpretable, and emotionally resonant. Drawing from both personality traits and fictional characters, we explore how persona-driven behavior can improve the clarity and memorability of human-robot interactions.

Hypothesis

We hypothesize that conditioning a robot's non-verbal behavior on observed human cues and a predefined persona allows users to recognize and engage with distinct personality or character traits in the robot.

Methodology

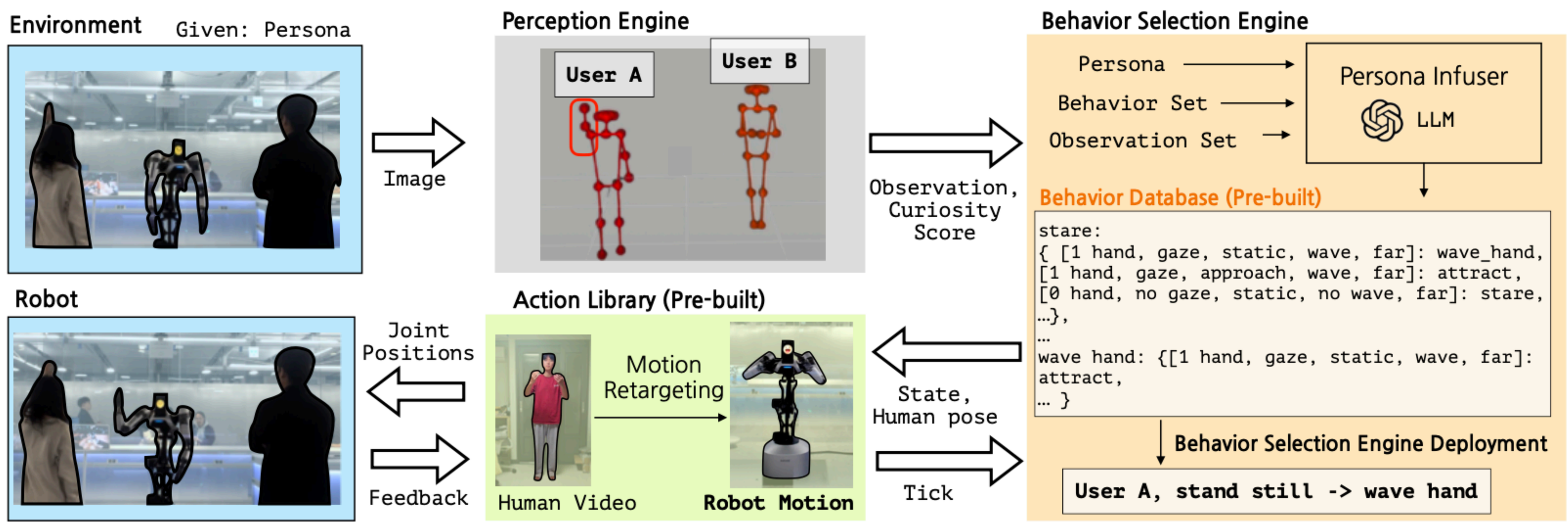

Fig 1. *Overall pipeline of proposed method*

A. System Overview

We introduce **MASK (Masquerading Animated Social Kinematic)**, a framework for embedding dynamic personas into robots using non-verbal behavior.

Perception Engine: Extracts 3D human pose data from an RGB-D camera and computes discrete observations, such as hand gestures, gaze direction, distance, and approach behavior. These observations define the interaction context.

Behavior Selection Engine: Implements a finite-state machine where the robot's next behavior is selected based on (1) current robot state, (2) perceived human observation, and (3) an assigned persona. Transitions between states are guided by a precomputed behavior database.

Action Library: Contains 91 retargeted motion trajectories and facial expressions mapped to each behavior state. Motions are pre-recorded and adjusted with yaw variants to face users naturally.

B. Persona-Infused Behavior Generation (Finite State Machine)

To reduce manual effort in behavior design, we use a large language model (GPT-4) to generate persona-specific behavior rules:

Motion Selection: Chooses motions that align with a target persona.

Expression Integration: Matches selected motions with fitting facial expressions.

Transition Estimation: Predicts the next state based on persona, current state, and observed human behavior.

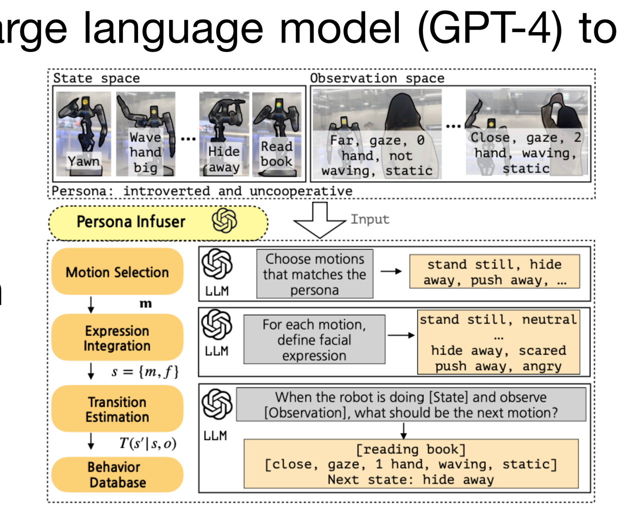

Fig 2. *Persona-Infuser*

C. Interaction Flow

At runtime, the robot selects the most engaged user using a **curiosity score** based on gaze, proximity, hand motion, and approach. The **behavior engine** then selects the next gesture and facial expression using a **persona-conditioned transition table**, given the robot's state and user observation. The selected behavior is executed through **motion retargeting**, aligning with the user's position. This cycle repeats in real time, enabling fluid, persona-driven non-verbal interaction.

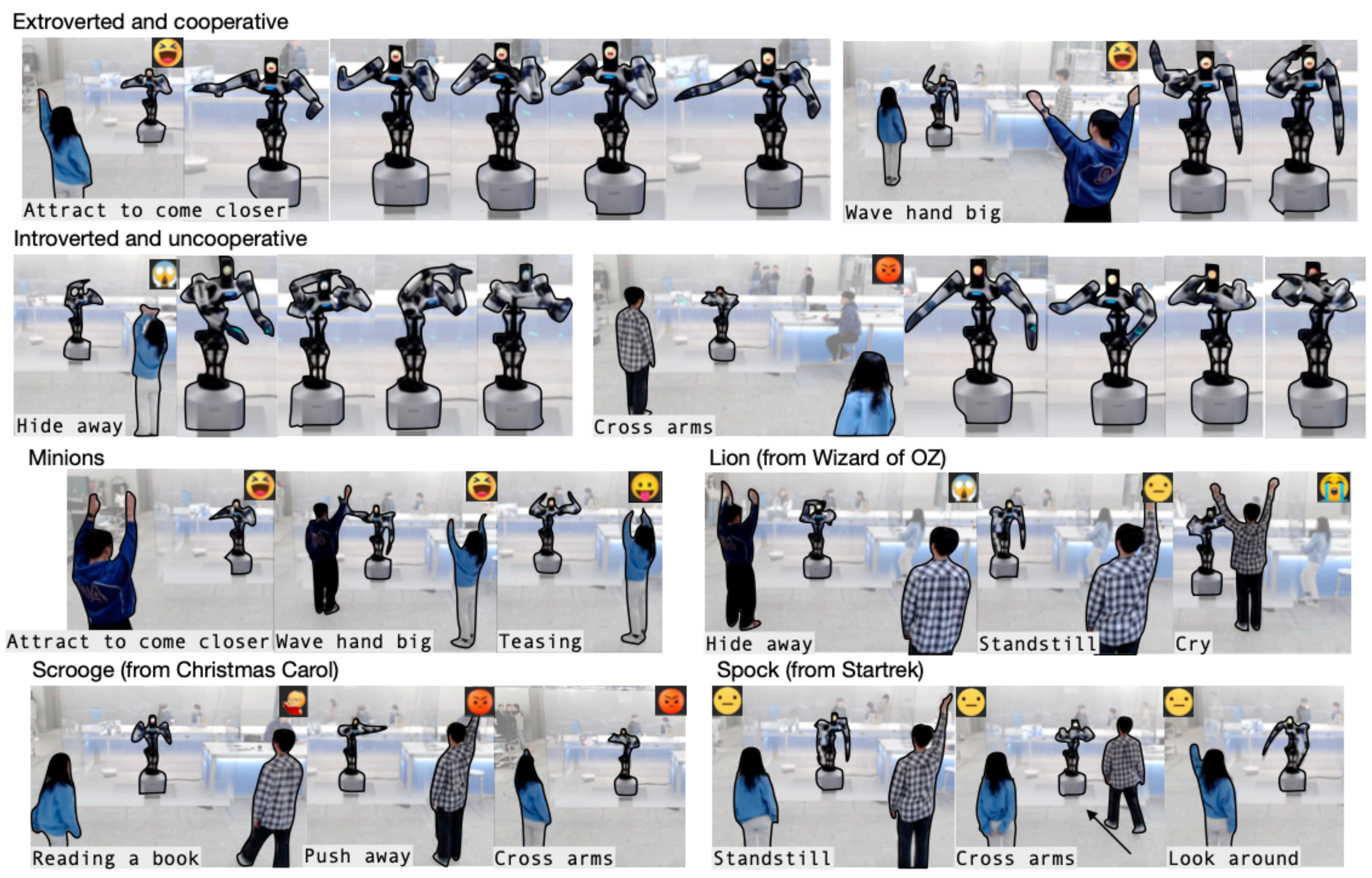

Fig 3. *Demonstration of the proposed system*

Experiments

A. Personality Based Persona

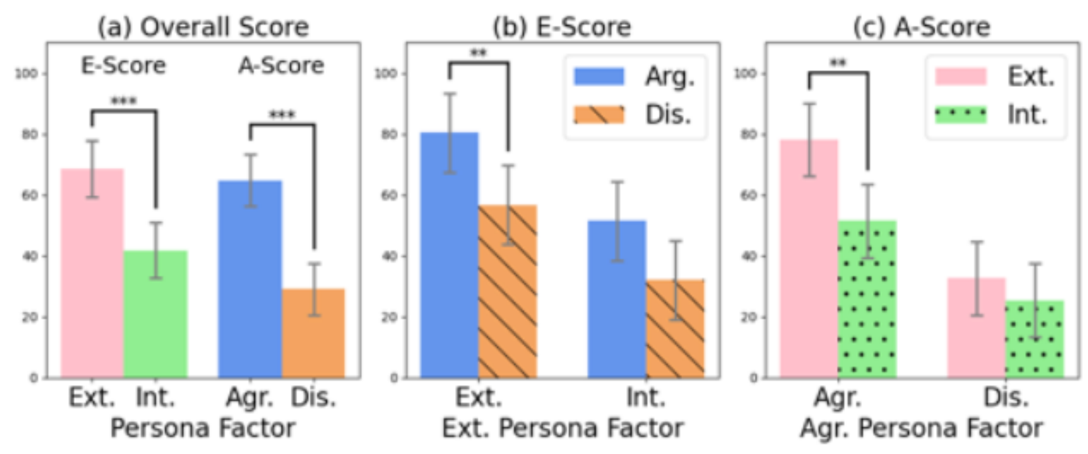

Fig 4. *Results from user study. (a) E-score of extroverted factor and A-score of agreeable factor. (b) E-score of extroverted persona with agreeable persona. (c) A-score of agreeable persona with extroverted persona. Agr., Dis., Ext., and Int. denote agreeable, disagreeable, extroverted, and introverted personas, respectively.*

Participants: 52 (26M / 26F, ages 21–57)

H1: Robots with different levels of **extroversion** (introverted vs. extroverted) are perceived differently by users.
→ Users significantly distinguished extroverted robots from introverted ones ($p < 0.001$).

H2: Robots with different levels of **agreeableness** (agreeable vs. disagreeable) are perceived differently.
→ Agreeable robots were rated significantly more likable ($p < 0.001$) and led to higher satisfaction.

Key Findings:

- Users reliably recognized **extroversion** and **agreeableness** in robot behavior.
- **Agreeable personas** received higher satisfaction scores.
- Extroverted behavior was perceived as more agreeable.
- Facial expressions helped users interpret gestures more clearly.

B. Character Based Persona

Participants: 108 (47M / 63F, ages 20–53)

H3: Users can correctly identify a robot's **fictional character persona** (e.g., Minion, Scrooge, Spock, Cowardly Lion).

→ 76.7% classification accuracy, far above the 16.7% random chance baseline.

Key Findings:

- **Minion, Scrooge**, and **Cowardly Lion** were easily recognized.
- **Spock** was often confused with **Scrooge** due to similarly blunt behavior.
- Participant keywords aligned with target personas (e.g., "shy", "playful", "angry").
- Users actively interpreted behaviors, often assigning narrative meaning to actions.

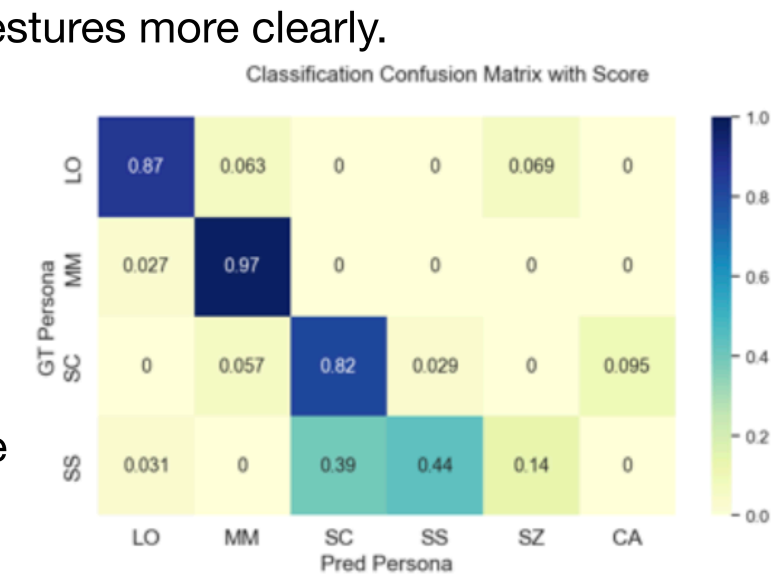

Fig 5. Classification Confusion Matrix for the character- based persona representing the characters *Cowardly Lion (LO), Minion (MM), Scrooge (SC), Spock (SS), Sloth (SZ), and Captain America (CA), respectively.*

Discussions

User Expectations Matter
Users tended to expect robots to be warm and responsive. Disagreeable or static personas (e.g., Spock) led to confusion or reduced satisfaction, highlighting a gap between intended design and user assumptions.

Anthropomorphism Enhances Engagement
Many participants assigned human-like intentions to robot behaviors—creating narratives (e.g., "the robot was scared of me")—which enriched their experience and emotional connection.

Design Trade-offs
While the finite-state machine enabled clear persona transitions, its limited state diversity caused repetitive behavior in longer interactions. Expanding the behavior space or using a more flexible policy could improve long-term engagement.

Group Interaction Limitations
In multi-user settings, slow responsiveness and one-user-at-a-time interaction caused curiosity decay and disengagement. A more advanced turn-taking mechanism is needed.

Character Fit Challenges
Discrepancies between the robot's physical form and the visual identity of fictional characters (e.g., Minion) occasionally broke immersion, suggesting a need for appearance-motion alignment.

Conclusion

We present **MASK**, a framework that enables robots to express dynamic personas through non-verbal behavior. By combining a perception engine, LLM-driven behavior generation, and an action library, MASK allows robots to convincingly portray both personality traits and fictional characters.

Through large-scale user studies, we show that users can accurately recognize the intended persona, and that persona-driven behavior improves engagement and interpretability. Despite current limitations in behavior diversity and group interaction, our results highlight the potential of persona-infused robots in social and entertainment settings.

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