Robot Continuity across Embodiments: Portability, Identity and Migration of Robotic Systems

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***Abstract*— This paper explores the elements that are needed to facilitate the seamless transfer of a robotic agent's "persona" between various embodiments. It addresses the challenges in maintaining the robot identity, user trust, and engagement during transitions into other robot embodiments. Through a literature review, we propose a framework for decomposing and reconstructing a robot's persona across embodiments, integrating visual, audial, and behavioral identity signals. By leveraging insights from robot interaction studies, this research contributes to the design of transferable and adaptable robot companions, with applications in eldercare and assistive technologies. The findings have broader implications for advancing human-robot interaction and fostering sustainable, user-centered robotic systems.**

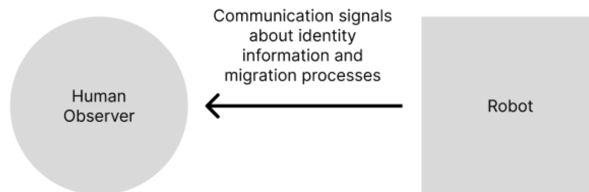

Fig. 1. Signals are intentional communications.

I. Introduction

A robot seamlessly changing embodiments means providing continuous and personalized assistance for robot users. It also addresses concerns that robot hardware has a shorter lifespan than the affordance of long-term human-robot interactions [1]. By enabling robots to maintain their identity across diverse embodiments, this work aims to meet practical demands for flexibility, adaptability, and cost-effective solutions in social and dynamic robot systems.

Prior work has acknowledged the challenges in assessing what modalities people use and prefer when interacting with robots [2]. This challenge aligns with robotic mind migration, which requires identifying and maintaining consistent signals across embodiments to ensure intuitive and seamless user interaction (see Figure 1). Another challenge concerns robot signals and how they can be described and modeled [3]. This is crucial when discussing how identity and behavioral signals can be preserved and communicated during migration. It underlines the importance of distinguishing between deliberate and consequential signals and ensuring clarity in communication, which are core to the success of robot mind migration. Building on these works, this paper aims to synthesize the practical challenges of preserving a robot's identity across multiple embodiments and leverages insights into modality preferences and signal design.

This paper reviews the current body of literature, identifies challenges and opportunities to address this gap. It investigates a robot "mind transfer" between both embodied and non-embodied agents, enabling the creation of hybrid companions that can seamlessly transition between virtual and physical forms, or migrate between distinct physical robot embodiments. Currently, robot companions have been shown to take on roles as companions to humans and to help with feelings of loneliness [4]–[6]. Portable robot companions that have a hybrid presence would be capable of preserving their unique identity as virtual non-embodied agents. Robot companions that can assume a new body would be capable of preserving their unique identity and functionality across various embodiments. The successful implementation of this migration has the potential to enhance user acceptance, trust, and engagement while providing a more sustainable and impactful solution for robot continuity.

Critical insights from cognitive science are essential for addressing robot continuity. For example, temporal binding theory suggests users perceive closely timed events as connected, implying that minimal delays in migration enhance perceived continuity [7]. Event segmentation theory indicates that clearly signaled, well-timed migrations prevent disruptions in users' mental models of continuous robot identity [8]. Further, incorporating insights from cognitive load and automation trust models can also inform how identity migration should be managed to maintain user trust and ease of interaction [9].

The issue of a seamless transfer of a robot's persona between different robot embodiments is unique. The ability to transfer a robot to a new body while ensuring continuity is not a concept easily available to humans and is currently not broadly addressed in literature, yet it has far-reaching practical needs. To realize such implementations, empirical studies that systematically evaluate the mechanisms and implications of interactive companion identity and migration signals during embodiment transitions are needed. However, we were unable to find systematic studies or structured frameworks that describe how robot continuity can effectively and efficiently be achieved in applied robots. This paper seeks to address this critical research gap by conducting a literature review and comprehensive evaluation of identity and migration signals in multi-embodied robots

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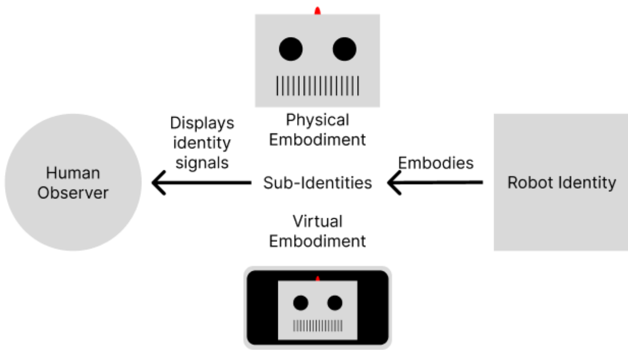

Fig. 2. Identity signals are managed by the identity but displayed by the embodiment.

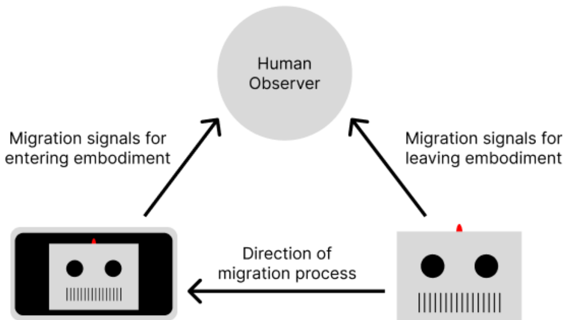

Fig. 3. Migration signals are displayed by both the leaving and entering embodiments, and could also be managed by the identity itself.

and proposes a structured theoretical framework to set the stage for systematic empirical validation in future studies.

II. Methodology

The signals we refer to in this paper refer to the intentional communication of information from the robot embodiment to any human observer, as seen in Figure 1. When a robot identity and embodiment have the ability to support re-embodiment, there is an issue of accurate portrayal of identity across these embodiments. Typically, these signals are associated with the identity itself, but are portrayed through the robot that embodies the identity, as seen in Figure 2.

Again, when dealing with the ability to re-embody, migration signals are communication signals about the process of migration. While not strictly about a one-to-one identity-embodiment relationship, we typically see migration signals for leaving and entering embodiments. Figure 3 displays how human observers view migration signals.

This work and methodology were inspired by a previous literature review on multi-embodied agents that identified several notable research gaps and included a systematic analysis of both identity and migration signals [10]. This work aims to address the following two knowledge gaps identified from [10]. Please note with the above and for consistency, we continue to use the terms *signal* as defined above whereas the original quote uses the term *cue*:

(1) "Although many types of *identity signals* have been proposed and used, there is a need for a systematic analysis of the effectiveness of these [signals] for enabling user recognition of agent identity" [10], and

(2) "Many different types of *migration signals* are proposed in the literature, but a systematic examination of the effectiveness of each [signal] is yet to be conducted" [10].

In order to conduct systematic analyses on *identity signals* and *migration signals* we identified the need to compile a list of works with regards to identity and migration signals and derive a set of possible interactive signals that show the identity of an agent, what signals are not mentioned in the literature, and how a migration of an identity can be initiated and conducted. First, we gathered all related works where they have performed work validating signals. The initial literature review yielded 11 articles on migration signals and 7 on identity signals from [10]. We used the resulting 18 papers with Google Scholar's "cited by" functionality to identify any new articles as well as the Publish or Perish software with Google Scholar-based review search performed by [10]. All new articles were restricted to be published after 2020 under the assumption that any significant articles published before that are covered by [10]. This yielded a total of 213 results and was reduced to 136 results after removing duplicates. A manual evaluation of the article's title, publish date, authors, abstract, and tags regarding the relevance to portability, identity, migration, and signals (also referred to, but in human-relevant literature referred to as *cues*) reduced the list of articles to 25. The last 25 articles we thoroughly reviewed for any analysis performed on identity or migration signals between embodiments or migration events, which left 2 additional contributions after Bransky et al.'s review.

In the following sections, we list and analyze the found works for identity and migration signals by their type (see Table I and further uncover gaps left out by the literature.

Identity Signal Type	Reference
behavioral	[11] [12] [13] [14] [15] [16]
audial	[15] [14] [17]
visual	[18] [14] [15]
Migration Signal Type	**Reference**
conceptual	[19] [20]
behavioral	[21] [22]
audial	[14] [23] [24] [25] [26]
visual	[27] [23] [24] [25] [26]
triggers	[28] [26]

TABLE I

All scholarly articles containing analysis on speculation in regards to identity and migration signals. Last full search performed in March of 2025.

III. Identity Signals

In human interaction, identity signals help one human identify who another human is. In the case of a robot, identity signals refer to non-referential communication signals [3] that help humans identify who or what (someone or something) a robot is. Identity signals help distinguish one identity from other identities and include but are not limited to visual signals (e.g. appearance), audial signals (e.g. pitch), props (e.g. clothing), kinesthetic signals (e.g. movement speeds) or behavioral signals (e.g. daily routines). For robots, it might be the case that an identity moves to the same or a different embodiment. Good identity signals help users easily identify and differentiate the embodied identity from other entities, even across diverse embodiments. Poor identity signals can cause users to think that two different identities are the same identity, and conversely, two embodiments of the same identity are different identities.

The concept of identity signals was first introduced in embodied literature by the Agent Chameleons project [18]. This project uses several signals (features, class of object, markings, and color) to distinguish their virtual avatars from other possible avatars. The avatar was built using the object's class as the general shape and outline, and then features, markings, and colors were added on top to create unique avatars. Participants would select the most similar avatar from the lineup, showing that any of the signals they provided performed better than no signals at all.

Both identity and migration signals rely on the physical abilities of the embodied device itself. Most modern devices and robots are equipped with the basic functionalities required by many of these signals, such as microphones, speakers, cameras, and a dynamic appearance. However, they likely also require device-specific programming per device that wishes to embody and employ such signals.

A. Visual Identity Signal

Visual identity signals are one of the most immediate and powerful means of recognizing an entity, whether human, artificial, or robotic [29]. When humans distinguish individuals, visual features such as appearance, facial features, clothing and movement patterns play a critical role [30]. Despite the well-established role of visual signals in identity recognition, robot migration presents unique challenges. Unlike human identities that are tied to a single physical form, robot identity must be (re)constructed across diverse embodiments and is crucial for ensuring continuity in user perception where the user visually identifies a migrated entity as the same entity despite having transitioned into a new embodiment, reducing cognitive load allowing the use to track identity with minimal mental effort, and building trust and user engagement where a visually coherent entity fosters a sense of familiarity.

Several studies have explored visual attributes that contribute to identity continuity across different embodiments.

1) Shape and Object Class: The general body structure or shape of a robot could serve as an identity signal, similar to how humans recognize body silhouettes. However, robots may need to switch between drastically different form factors (e.g. humanoid robot to a wheeled platform, a mechanical robot to a screen-based avatar). Furthermore, many robots do not have custom hardware to at least make a structural similarity possible. The likely outcome is that the user might be less likely to associate a robot shape with the same identity if its shape changes drastically with a migration, meaning robot shape alone is an inferior identity signal. It has been shown that visual signals for virtual agents like object class (e.g. outline of an object, shape) improved identity recognition [18], however, these findings are yet to be extended to physical robots.

2) Color and Texture: Studies on avatars suggest that consistent color schemes improve identity recognition [18]. However, the exterior of robots often lacks dynamic color-changing capabilities, making color-based identity impractical. Furthermore, color-based signals may be culturally or contextually dependent (e.g. different lighting conditions distort color perception).

3) Features, Accessories, and Props: Adding distinguishing elements like clothing, accessories, or markings can reinforce identity. For example, it was shown that in virtual avatars features (e.g. hat or gloves) and markings (e.g. similar to tattoos or birthmarks) can increase identity recognition and outperform the use of colors [18]. Another study used the robot owner's first initial in the current residing embodiment to show identification [14], but this information was only understood by 11 of 36 participants. Participants did not remember their character's name and did not make the connection to the letter display. For robots, accessories and props could serve identity continuation if the accessories or props can be displayed in all embodiments (e.g. badge, LED pattern). However, no systematic research that tested how well robotic accessories support long-term identity tracking has been identified in our literature review.

4) Screens, Virtual Avatars and Facial Displays: Research has considered robots that use screens to display a consistent virtual face or a nameplate across embodiments [14]. While screen-based avatars can retain the same screen across embodiments, the application to physical robots is limited as not all robots have screens, it is unclear if a virtual face is tied to a physical embodiment thus it is unclear if this would support continuity, and users might respond differently to a robot with an avatar on screen vs. a robot with a physical face structure.

Although facial identity cues are among the strongest identity markers in human recognition, few robots have consistent facial features [31]. Robots that do have consistent facial features are often human-like or humanoid robots that abstract human faces, yet that consistency might be interrupted when the robot migrates to an embodiment that does not facilitate human-like facial features. An alternative would be to reduce the face to eyes and gaze behaviors, however, research on this is limited.

B. Audial Identity Signals

Audial signals, such as sound or voice are another category to maintain identity in a robot. For humans, audial signals include voice tone and intonation as a means to recognize identity [29]. In our literature review, we found only a few examples of audial identity signals. One example is voice consistency, where the same voice for a robot's virtual and physical form is being used and a unique "Doppler-effect"-like sounds for a particular robot identity [14]. This indicates that voice consistency and the use of signature sounds could be effective audial signals for robot identity. However, research in this area appears to be incomplete, and not all audial signals are explored for robots. Missing elements include for example a robot's speech style, accent, or catchphrases that serve as identity markers. Also, the roles of non-verbal sounds such as musical tones or chimes beyond the Doppler sounds example seem to be not explored for robot identity.

C. Behavioral Identity Signals

Behavioral Identity Signals would be consistent patterns in how a robot moves or acts. This has been shown to be an indicator of identity continuity in a study where multiple identities shared identical embodiments, and users were asked to identify their robots in a video [12]. Users were able to distinguish their robots from other robots by behavior alone. Even when robots had very different embodiments [32] or lacked common communication abilities [11], users matched them by behavioral "personality" signals after an off-screen migration. This underscores that unique motion styles or interactive behaviors (e.g. movement patterns, mannerisms) can signal identity. It was also noted that for artificial agents, the concept of familiar behavioral patterns over time contributed to identity [15].

Aside from movement, having behaviors that show the memory of specific details and previous conversations could be an additional behavioral identity signal, albeit a signal that might not be able to be perceived immediately. It has been shown that for dialogue across multiple interfaces in long-term interactions, consideration of conversation history scores higher compared to lower memory conditions [16].

D. Other Identity Signals

We acknowledge that identity signals are not limited to visual, audial, or behavioral and that some of these signals can overlap with each other. We also acknowledge that the literature review conducted does not elaborate deeper on categories like props (e.g. clothing), kinesthetic (e.g. body language) or conceptual (e.g. self-identification). For example, props like wearing a distinctive badge could be a simple visual marker of identity. However, beyond the Agent Chameleons study [18] that idea is not discussed in the robot context even though dressing robots in clothes has been explored [33]. Kinesthetic signals likely overlap with behavioral signals, however, research so far does not seem to explicitly explore robot body language specifics like gait or posture and how that could be recognizably carried into a new embodiment. We also could not identify research in the area of conceptual identity signals, for example, the use of explicit self-identification by name and status (e.g. "It's me, Ro-Bob, I am in a new body now"). Also, absent from the current discourse are social or narrative identity signals by referencing shared previous interactions and memories. While we do not expect these signals to be a single crucial factor of robot identity, it is expected that, in combination with other signals, identity could be significantly reinforced.

IV. Migration Signals

Migration signals help a human user identify and register the robot identity migration process. These signals may happen on either the origin embodiment, ambient devices like apps or charging stations, the target embodiment, or a combination thereof and indicate the identity of leaving the current or possessing the new embodiment.

Poor migration signals can lead to confusion about what the embodiments or identities are doing and further confusion about the resulting embodiment-identity assignments. Good migration signals communicate the process and resulting embodiment-identity effectively, even to most novel users.

While the identity signals had some human social equivalent, migration signals are unique to robots, given their ability to reembody in other host embodiments and our desire to maintain the identity through that transition.

A. Stages of Migration

Four phases of the migration process, each with its own signals, were identified in a workshop [26]. The phases are in order going from connect, connecting, robot connected, and robot appearing. They propose signals from these, which are discussed alongside other findings from literature in the following sections.

B. Visual Migration Signals

Visual indicators of migration were used to show a robot's transfer from one body to another visually. For example, a virtual avatar leaves or joins a screen to signify the agent moving in or out of a robot [14]. Another study tested graphics like a "moving progress bar," flashing lights, and a moving face icon to visualize the transfer process from one robot to another [27]. The moving bar filled up on the robot becoming embodied, and emptied on the robot it was leaving. The flashing lights on the first embodiment start flashing slowly and get faster until stopping entirely, and then the target embodiment's lights flash quickly and then slow down until the process is complete. The moving face moved up off of the screen of the departing platform and came in from the top of the screen on the incoming embodiment. The moving face was to be determined as the best-understood migration signal by new users in this study, whereas the other signals seemed to be perceived as mostly communication between the robots.

These findings are somewhat limited to screen-based or light-based signals. Our literature review did not show other possible visual migration signals that were studied, for example, robots using their embodiment to perform body movements or distinctive gestures to indicate the departure or arrival in the new embodiment. We also could not identify research on environmental or ambient visual signals similar to base stations lights during the migration or transfer process, nor could we identify work on a combination of multiple visual signals for redundancy and enhancing clarity. The studies found did not address how the visual signal would scale with different robot embodiment types.

In most of the migration phases visual migration signals that would help indicate the process are highlighted [26]. For the connect phase, they want status indicators showing the status of the current embodiment. In the connecting phase, users requested ”some connection visual” with such examples as a phone call or moving progress bar. It should be noted that ”no visual at all” is also included in the group feedback. Upon reaching the ”robot appears” phase, all but one response notes that there should be a visual representation of the new embodiment. While no responses under phase 3 were included, the indicators from phase one might already be assumed to exist, and phase 4 does highlight the importance of visual representation after the process is completed.

C. Audial Migration Signals

Auditory signals accompanying a migration event were mentioned in researching an agent with a virtual and physical embodiment [14]. A unique Doppler-like sound was used whenever the agent switched embodiments. Since this sound was also unique to the identity of the robot, it was also mentioned as an identity signal.

Our literature review did not reveal other audial migration signals beyond this example. Additional audial signals that could indicate a transfer, like a particular melody, a tone sequence, or a verbal announcement of the migration, seemed to not have been used in robot migration research. Generally, the variety of audial signals that could be used and the reliability and design of them seem to be a gap in the literature. We also could not uncover assessments on how effective the audial signals are compared to other signals, like visual or behavioral signals. In particular, it seems like there is no answer to the research question if a user were to recognize a migration just by hearing the audial migration signal. Challenges to audial migration signals, like being missed by the user in noisy environments, being misinterpreted, or startling the user, have not been found in our literature review.

In most of the phases identified by [26], they highlight audial migration signals that would help indicate the process. In the connecting phase, users requested both audial feedback and ”no audio at all”. For the robot-connected phase, all of the responses in this category are audial and include short phrases or a ”chime sound”. Upon reaching the ”robot appears” phase, the only audial response suggests the embodiment uses the new identity’s voice.

D. Behavioral Migration Signals

Behavioral changes in a robot can also signal migration. For example, a robot’s eyes moving from a “down” position to an “up” position when an identity enters that embodiment, and dropping down when it leaves [14]. Another study on artificial pets used a migration with no explicit signals, the stopping of all behaviors in one embodiment and the starting of all behaviors in another embodiment for the migration, leaving it to the user to infer what happened [21].

Although robot behavioral migration signals are an important factor, the range of behavioral signals discussed in research is very narrow. Apart from the eye movement, other possible behaviors like waving hello or goodbye, changing postures, or performing a short routing potentially including audial and visual signals were not found. Robot migration mostly likely were to benefit from considering a wider spectrum of behavioral signals, potentially making use of metaphor-like concepts [34] or animation techniques [35]. Moreover, an analysis of universal usability for the users, and an assessment of the robustness and clarity of how the migration is communicated seems adequate [3], especially when considering that the user’s attention might be elsewhere. The reviewed studies also do not show how behavior consistency in the migration process can be linked to an agent’s identity.

E. Conceptual Migration Signals

Conceptional signals refer to the narrative or cognitive indicators (i.e. how users form a mental link that two different embodiments are the “same” agent beyond just seeing or hearing signals of a migration event) and are signals that are not tied to a physical sensory output (i.e. visual, audial, behavioral), but rather are tied to the robot’s communication or the user’s understanding. For example, the robot could provide a verbal explanation about it moving to another body, how that will look like, and what the resulting capabilities in the new embodiment are. The robot also could use a consistent persona narrative that carries through the migration shaping the user’s understanding of being the same persona in a different embodiment, sometimes referred to as mutation between agent embodiments [19] or a ”blended character” [20] when the agent identities are largely overlapping between embodiment types. Other research [28] has relied on the power of explicit explanation or storytelling for robots showing that direct communication can be used as a migration signal.

F. Migration Triggers

A migration trigger is a signal with which a migration can be initiated, depending on the agent’s degree of autonomy [36]. This includes implicit migration, where users infer a migration based on robot behavior, a system-initiated migration, where the robot system decides to migrate, and user-initiated migration, where a user directly commands the migration.

There is some limited research highlighting the importance of migration triggers. The concept of implied migration was used to migrate across similar and dissimilar embodiments [11], [12], resulting in users being able to successfully conclude which identity belongs to which embodiment. System-initiated migration was used to assess whether children would understand what had happened during the migration of an artificial pet [21] and found that 43% of children saw one dino while 40% saw two dinos. In a study on implementing a migration architecture, the agent itself is able to plan and trigger migration [15], but no evaluation on this was done. User-initiated migration, where an avatar only migrates when given an explicit command, was used to evaluate users' perspectives on identity migration topics [14].

In the connect phase of migration there are signals or triggers that users identified in conversation [26]. In summary, they noted connect buttons, contact lists, and voice and hand gestures. These results seem to suggest that users want to have part in the process of this migration, but this could be scenario-specific.

Migration triggers currently do not have a model that best explains how users understand cause-and-effect in robot migration. Furthermore, it remains unclear how different triggers affect user understanding, mental effort, and user agency [14] [21] [10]. It also is not clear how robots can communicate intent before migration. For example, in human interactions, handover tasks [37], [38] or walking away [39] both involve social signals. However, humans do not switch embodiments and therefore there is a need to assess how robots can successfully employ social signalling of migration triggers.

G. Migration Timing

It also seems that the timing of the entire migration process plays a role. For example, it was shown that for children playing with robotic pets, an overlapping migration (where both embodiments are active at once) creates a perception of separate identities, while a delay between deactivation and reactivation supports identity continuity [22]. The timing of robot migration is likely related to the psychological concept of how the brain links events based on time intervals (temporal binding [7], [40]), however seems not to have been further researched when it comes to robot migrations.

H. User Perception of Migration

Throughout this section on migration signals, we implicitly recognized the importance of user understanding - describing that poor migration signals would cause confusion about what an embodiment is doing and which identity it houses. Our literature review revealed only limited insights into the user's perspective on robot migration, but several missing considerations. For example, the studies cited here use either children or adults in their evaluations and it is unclear how these two different populations perceive and understand migration. It is also not clear how well a robot swapping bodies is understood by naive vs. more tech-savvy users. Additionally, the literature review does not go into depth about the user mental models, where it explores what users believe is happening during migration and how migration signals shape those beliefs. What is further absent from the scientific discourse is whether a migrated robot identity retains the same levels of user trust as the identity in the previous different embodiment, and what the emotional impact of a migration is, especially when a user is attached to a robot [41]. It is expected that considering users' perspectives - how users subjectively experience a migration event, what misunderstandings or assumptions they have, and how signals might alleviate anxiety or scepticism - will significantly contribute to a comprehensive understanding and successful migration of robot identities.

I. Validation and Experimental Approaches for Migration

This section highlights that the empirical validation of migration signals is still in early stages. We did not uncover a unified experiment or series of experiments that test migration signals across conditions along standardized evaluations metrics across studies measuring for example task performance, response times to recognize identity, user confidence, user behaviors and qualitative measures giving insights into users' mental models.

V. Discussion

This review explores how robots can maintain continuity across different embodiments through identity and migration signals. Our review suggests that certain identity and migration signals are more effective than others in maintaining continuity across embodiments. The analysis identifies behavioral signals (e.g., movement patterns, memory-based interactions) and audial signals (consistent voice and sound patterns) as the most effective identity signals. Visual signals, while useful in virtual avatars, could be less reliable in physical robots due to embodiment constraints; however, they have not been systematically evaluated in the literature. Conceptual signals, such as self-identification statements and narrative continuity, show promise but remain underexplored.

For migration signals, behavioral indicators like departure and arrival routines improve user understanding. Visual signals (e.g., progress bars, animated face transitions) could aid tracking but might depend on familiarity, observability and user understanding. For migration signals, timing also plays a role as a brief delay between deactivation and reactivation reinforces continuity, whereas overlapping embodiments could create confusion.

This paper highlights several gaps: long-term identity retention remains untested, no standardized taxonomy of identity signals exists, and triggering migration through signals seems bound to sequence, timing, and possibly other variables. Future research should focus on multimodal signal integration, longitudinal user studies, and experimental validation of migration mechanisms to ensure seamless and trustworthy robotic mind migration.

This review shows implicitly that user trust in robot continuity is shaped by the effectiveness and clarity of identity signals, emotional attachment to the robot, and perceived continuity. Users who develop strong bonds with a robot may struggle to accept migration if signals are unclear or inconsistent, potentially leading to a loss of trust. Behavioral and conceptual continuity, such as consistent memory recall and interaction style, can reinforce identity and mitigate disruption. In multi-embodiment scenarios, trust depends on predictability—users must reliably recognize a migrated identity to maintain engagement. Poorly executed migrations risk breaking the illusion of continuity, reducing user confidence in the system.

Human perception of robot continuity is influenced by cognitive biases, temporal binding, and event segmentation, yet these aspects remain underexplored. Temporal binding suggests that closely timed events are perceived as linked, reinforcing identity continuity, while longer delays may disrupt this perception. Causality perception influences how users interpret migration—without clear triggers, they may see the new embodiment as a separate entity rather than a continuation. Event segmentation research highlights that abrupt or mismatched transitions may break the user's mental model of a persistent identity.

Robotic identity migration has significant implications for eldercare, assistive technologies, and service industries, yet its real-world impact remains underexplored. In long-term interactions, strong identity continuity could enhance trust and emotional connection, while poorly designed migrations may disrupt user reliance on assistive robots. High-stakes environments like healthcare or customer service may require more robust, immediate migration signals to prevent confusion or errors. Additionally, regulatory and ethical concerns—such as transparency in migration events, user consent, and potential deception—must be addressed to ensure safe and trustworthy deployments.

A. Limitations

This study does not yet address key limitations and alternative explanations that could impact its findings. Assuming identity signals from avatars directly translate to physical robots overlooks embodiment constraints, such as differences in movement, expressiveness, and user perception. User recognition errors in migration studies may stem from individual cognitive differences, prior experience with robots, or environmental distractions, rather than flaws in signal design. Additionally, potential biases in literature selection and technological limitations (e.g., lack of customizable physical markers) should be acknowledged.

B. Future Work

Building on the gaps identified, we propose a structured approach comprising three components. The first component, Migration-Oriented Robot Persona Handling (MORPH), systematically develops and tests multimodal signals that effectively communicate identity and migration. The second component is the Flexible Robot Architecture for Migration and Embodiment (FRAME), a model outlining essential identity elements, such as behaviors and memories, necessary for continuity across embodiments followed by the third component of Assessing and Refining the Continuity (ARC) as an evaluation framework that assesses user experience, trust, cognitive load, and acceptance and where appropriate refines FRAME. The implementation of these components aims to guide future empirical studies toward creating adaptable and trustworthy multi-embodied robots, addressing both technical and psychological challenges of maintaining identity continuity.

In more detail, the first focus to establish a framework and effective applications of robot continuity should be Migration-Oriented Robot Persona Handling (MORPH). Compared to previous models like Agent Chameleons and Blended Reality Characters, a promising area of future work is to shift focus from visual continuity in avatars to a multimodal approach that integrates behavioral and conceptual signals in robots and their different embodiments. While earlier studies suggested static markers (e.g., color, shape) aid recognition, this review highlights dynamic behavioral and narrative signals as potentially stronger continuity signals. Multimodal signal integration would refine and extend identity migration theories, emphasizing the need for flexible, user-driven identity reconstruction rather than fixed visual markers. It would also challenge the assumption that avatars translate seamlessly to physical robots, showing that embodiment changes require new approaches to identity signaling beyond visual representation. Future work should also systematically test timing, causality, and segmentation effects to refine migration signals that align with human cognitive processing. Lastly, future research must validate identity signals across diverse robot morphologies and user populations to ensure broad applicability.

VI. Conclusion

This literature review investigates robot continuity - the seamless transfer of a robot's persona between embodiments - by systematically analyzing current literature and gaps in identity and migration signals. The literature review identifies promising signals, introduces new insights into robot identity and continuity, and highlights remaining research gaps that need to be addressed for effective and efficient robot continuity. It also lays the groundwork for a robot continuity taxonomyand a theoretical framework of robot embodiment migrations.

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