The impact of perceived robotic intelligence on trust and attitude

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***Abstract*—Intelligent robotic agents are increasingly ubiquitous, especially in the service industry. As the deployment of intelligent agents continues to rise in frontline settings, the need to understand how users perceive these agents, form expectations of trust and attitude, become meaningful to effectively predict decision-making and enhance understanding of human-robot interactions (HRI)s. Utilizing a fieldwork approach, this study investigates the relationships between perceived intelligence, trust, and attitude. The findings show the importance of awareness and actuation in predicting both trust in robotic service agents and positive attitude toward HRI. Moreover, connectivity affects trust while dynamism impacts attitude. These findings contribute to existing knowledge regarding HRIs and offer valuable insights for firms that deploy robotic service agents in frontline settings.**

Keywords—Perceived intelligence, trust, attitude, robotic service agent, human-robot interactions

I. Introduction

In recent years, artificial intelligence (AI) has surged to the forefront of technological advancements, revolutionizing industries, and reshaping the human experience [1]. As integration of AI into our daily lives proliferates rapidly, there is a pressing need to understand the dynamics of trust in AI systems, particularly in contexts involving direct human-robot interactions (HRI)s [2].

Trust is a pivotal element that influences user acceptance and reliance on AI technologies [3]. Despite the critical nature of this concept, there remains a discernible gap in understanding how the various attributes of AI agents such as service robots contribute to the establishment of trust. This gap underscores the urgency for research focused on the nuanced factors that can foster or impede the development of trust between humans and their artificial counterparts.

The current research aims to address this gap by examining intelligence factors that shape trust in robotic service agents. Specifically, this study investigates the influence of the four dimensions of perceived intelligence, namely awareness, connectivity, actuation, and dynamism. These antecedents are posited to be fundamental in cultivating trust and positive attitude toward HRI, a precursor to the seamless adoption and integration of AI in various facets of society [4]. By studying the relations between these intelligence factors and trust, the research aims to provide a refined understanding of how trust in AI can be unleashed, paving the way for enhanced HRIs.

II. Literature Review and Conceptual Model

Service robots emerge as a dynamic subset of intelligent agents within the AI spectrum, uniquely tailored for frontline service roles in socially interactive environments such as airports and retail stores, where their autonomous capabilities and human-like presence are critical [1]. Their role within multi-agent systems is not just to complete tasks independently but also to cultivate trust and engender positive HRIs, which are fundamental for achieving user acceptance and operational success in these settings [5,6]. Against this backdrop, the study focuses on four pivotal attributes of service robots, adapted from [7] that are hypothesized to be instrumental in enhancing perceived robotic intelligence and fostering trust in HRIs.

Specifically, in the proposed model, "Awareness" refers to the robot's ability to collect information from its environment or related systems, a capability enhanced by advanced sensors like 360-degree lidar and RGB cameras for comprehensive surroundings perception. "Connectivity" denotes the robot's seamless interfacing with smart service system components, such as customers and service providers, via the Internet of Things (IoT), exemplified by integration with third-party applications. "Actuation" encapsulates the robot's autonomous decision-making and action execution, underpinned by advanced algorithms for path planning and autonomous navigation. Finally, "Dynamism" captures the robot's capacity for learning and adaptation, facilitated by machine learning to refine performance and service delivery through interaction within the service ecosystem. Collectively, these attributes are posited to significantly influence the development of trust in the robotic service agent and cultivate a positive attitude towards HRI, as conceptualized in Fig. 1.

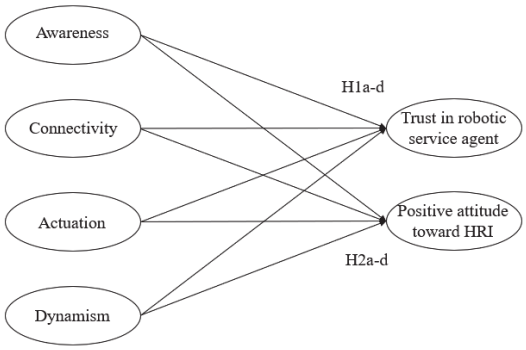

Fig. 1. Conceptual framework.

III. Method

Data was collected via an intercept survey of 255 visitors who have completed a 15-minute tour led by a robotic tour guide in a museum in Singapore. The service robot being deployed is "Temi", an intelligent service robot that can autonomously navigate independently and help users with other daily tasks.

Respondents were invited to complete a 15-minute survey and were reimbursed with a S$20 shopping voucher. To measure perceived robotic intelligence, four items each from the dimensions of awareness, connectivity, actuation, and

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dynamism were adapted [7]. In addition, five items were adapted to measure trust [3], while four items were employed to assess positive attitude toward HRI [2]. All items were scored on a five-point Likert scale, represented by 1 "strongly disagree" and 5 "strongly agree". Demographic data were also elicited.

Most of the respondents were female (64.7%). In terms of age, 46.8 percent of the respondents were between 21 to 24 years old, 27.4 percent were between 25-34 years old, 9.1 percent were between 35 to 44 years old, 11.5 percent were between 45 to 54 years old, while 5.2 percent were above 55 years old. In terms of highest education, 42.5 percent of the respondents held a tertiary qualification, 34.5 percent held an undergraduate qualification, while 23 percent held a postgraduate qualification.

IV. Results

The data was analyzed using PLS-SEM (i.e. SmartPLS 4) [8]. A basic bootstrapping of 10,000 subsamples via the bias-corrected and accelerated confidence interval method (two-tailed test) was applied. The factor loadings, Cronbach's alpha, and composite reliabilities of all the measurement items of the outer model exceeded the cut off value of 0.70, while the average variance extracted (AVE) values are greater than 0.50. Moreover, the square root of AVEs in every latent construct surpassed all their corresponding correlations value [9]. In sum, the measurement items adopted in this study met all the reliability and validity requirements.

As exhibited in Table 1, the inner structural model was assessed through appraising the standardized path coefficient beta values, t-values, effect sizes (f^2), coefficient of determination (R^2), and Stone-Geisser-Criterion (Q^2) [10]. The values (f^2, R^2, Q^2) verified the strong explanatory power of the research framework [11].

TABLE I. Results of the Estimated Relationships

Hypothesis [a]	***Standardized path coefficient (SD)***	***t-values (f^2)***	***Support***
H1a AW→TR	0.171 (0.061)	2.798 (0.040)	Yes
H1b CO→TR	0.264 (0.058)	4.574 (0.085)	Yes
H1c AC→TR	0.316 (0.066)	4.786 (0.100)	Yes
H1d DY→TR	0.117 (0.064)	1.840 (0.015)	No
H2a AW→PA	0.244 (0.066)	3.695 (0.060)	Yes
H2b CO→PA	0.106 (0.068)	1.551 (0.012)	No
H2c AC→PA	0.181 (0.068)	2.664 (0.021)	Yes
H2d DY→PA	0.181 (0.077)	2.348 (0.026)	Yes

[a.] AW= Awareness; CO= Connectivity; AC= Actuation; DY= Dynamism; TR= Trust; PA= Positive attitude toward HRI

V. Discussion and Implications

The findings show the importance of awareness and actuation in predicting both trust in the robotic service agent and positive attitude toward HRI. The awareness of the robotic agent to sense information related to the smart service system and/or its surroundings helps the robot perceive and interact effectively and efficiently with its environment. Moreover, actuation features such as 3D mapping, obstacle avoidance, and user detection significantly elevate users' levels of trust and positive attitude, given the safe and effective operation of the robotic agent in diverse environments, which enhances the robot's autonomy and adaptivity. These attributes, fundamental to the perceived intelligence of service robots, play a crucial role in user acceptance and operational success in service encounters.

The findings provide managers with insights into the critical intelligence dimensions that can enhance user trust in robotic agents as well as evoke positive attitude toward HRIs. Where possible, managers of service robots can invest in the intelligence characteristics of awareness and actuation and communicate these robot intelligence features to their users. Depending on the overall mission of the firm, various robot intelligence strategies can be deployed to cultivate trust or enhance positive attitude.

Despite the insights, the study is not without its limitations. The nonsignificant impact of dynamism on trust and connectivity on attitude invites further investigation into the relations between these dimensions and HRI outcomes. Future research can explore additional individual and contextual factors in varied service settings to fully understand the intricate dynamics at play. Such inquiries can provide deeper insights into how best to leverage robotic capabilities to enhance service delivery and user experience in the evolving landscape of frontline service technologies.

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