Can Robots Take Over Security? A Brief Review and Critique of Security Robot vs. Human Security Agent

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***Abstract*— Security robots are becoming increasingly prevalent for maintaining law and order, offering cost efficiencies and safety benefits in hazardous environments. Despite these advantages, significant questions remain regarding the public acceptance of robots as replacements for human security agents. This paper presents a systematic literature review to explore whether there is a discernible public preference between human security personnel and their robotic counterparts. The review identifies a contextual pattern: individuals tend to prefer human agents in citizen-initiated interactions, and security robots in police-initiated ones. This paper offers valuable insights to guide the future design and deployment of security robots.**

I. INTRODUCTION

Security robots are increasingly prevalent in public and private spaces, including streets and malls, where they serve as security agents to enforce laws [1], [2], [3], [4], [5]. Security robots are defined as "robots deployed to prevent unwanted activities through their presence, surveillance, and ability to notify authorities of unauthorized personnel or actions" [6]. They are now considered a cost-effective solution for law enforcement and security maintenance in dangerous environments [7], fueling their deployment by both public and private organizations.

Despite increasing deployment, recent research highlights concerns regarding public acceptance of security robots [1], [8], [9], particularly questioning whether they are capable of taking on the role of security as human security agents do [9]. Security robots also raise significant challenges related to empathy, trust-building, and ethical implications [10], [11]. Public sentiment mirrors these concerns; for example, when the New York Police Department introduced security robots, many residents expressed skepticism, emphasizing a preference for human police officers [12].

This study, through a systemic literature review, identifies when individuals prefer humans or robots as security guards. Results indicate that individuals may prefer the perceived warmth and nuanced communication skills of human security guards when themselves initiate the interaction, seeking assistance or information. Conversely, when the interaction is initiated by security personnel (e.g., a robot patrolling an area and prompting a user), the perceived efficiency and non-personnel nature of security robots might be preferred.

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This study contributes to the research on human–robot interaction (HRI), providing insights that can inform the design and deployment of future security robotic systems. The findings may also have implications for policy-making in integrating robotics in public and private security sectors, thereby enhancing safety measures while addressing community preferences for interaction with emerging technologies.

II. BACKGROUND

The relationship between the police and the public has been consistently emphasized and widely studied in the policing literature and is considered central to effective security practices [13], [14]. One widely adopted framework for analyzing police–citizen interactions involves categorizing contacts according to who initiates them: citizen-initiated and police-initiated [15]. Police-initiated contacts are typically involuntary interactions initiated by officers for reasons such as issuing tickets, compliance checks, or making arrests [15]. In contrast, citizen-initiated contacts are voluntary interactions initiated by citizens, often to seek information, report crimes, or request help [15]. Research shows distinct mechanisms in these two interaction types, recommending separate analysis in theoretical discussions [16], [17]. Citizens' attitudes and acceptance toward the police are also found to differ substantially across two interaction types [18], [19].

According to national data, the majority of police–citizen interactions in the United States are police-initiated [20]. However, these encounters often lead to tension and public dissatisfaction [21]. When citizens are stopped by the police, they are typically unaccustomed to being treated as offenders and expect to be treated with respect [14], [19]. Yet, officers conducting these stops are often perceived as displaying poor demeanor, including improper attitudes and disrespectful tones, which often prompt complaints [19], [22]. Officers who initiate contact also often face skepticism regarding their fairness and intent [23]. In contrast, integrating security robots is considered a better alternative. While robots are often seen as lacking human traits like empathy and emotional nuance [24], their emotional neutrality and rule-based behavior can reduce feelings of being judged or personally targeted [25]. This can make interactions feel less confrontational, while also lowering social anxiety and negative emotions such as resentment, anger, or fear [25].

Conversely, citizen-initiated contacts are typically considered more positive [17]. The voluntary nature of these interactions inherently grants legitimacy to the intervention, as citizens themselves authorize the involvement of security personnel [17]. This perceived legitimacy fosters more

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favorable attitudes and greater trust toward security agents [23]. It also enhances perceptions of fairness, often resulting in higher satisfaction with outcomes [15]. However, current security robots may struggle to perform effectively in such interactions, as they are often seen as ineffective when people unexpectedly seek help [12]. Human guards remain superior because of their capacity for nuanced communication and complex problem-solving [26]; they can adapt effectively to the unique demands of individual situations.

Against this backdrop, the use of robotic versus human security personnel emerges as a critical factor in shaping public acceptance. As security robots become more common, understanding how different agents influence acceptance of them is essential.

III. Method

A systematic literature review on security agent type was conducted following the guidelines from Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement [27]. The detailed process is depicted in Figure 1.

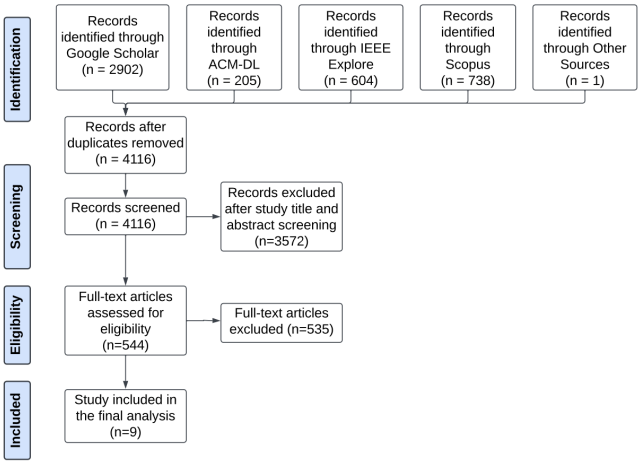

Fig. 1. PRISMA Flow Diagram of Literature Review Process

A. Search Process

We conducted a systematic search using four databases—Google Scholar, ACM Digital Library, IEEE Xplore, and Scopus—to identify related papers. The search terms used were "(Security OR Peacekeeping OR Guard OR Police OR Military OR Safety OR Patrol OR Protection) AND (Robot OR Robots)." These search terms were established through iterative refinement. During the search, we noticed that the terminology for security robots remains inconsistent, as many researchers use alternative terms such as "guard robot" and "police robot." To avoid omissions, we broadened the term "security robot" to include related keywords reflecting its functions and applications, including terms like "guard" and "police." The finalized terms were applied to the full-text search field. Data were collected on August 23, 2023, covering all publications up to that date.

Search results were manually reviewed using search engine result pages (SERPs), and we paged through them until no further relevant papers met our criteria. Each SERP displayed between 10 and 25 results, depending on the database. This process yielded 4,449 results, with one additional paper identified through cross-referencing. Results from IEEE Xplore, Scopus, and the ACM Digital Library were extracted using .BIB or .RIS exporters, while Google Scholar results were retrieved via the Publish or Perish application [28]. All extracted records were then compiled in Rayyan [29] for further processing. After duplicate removal using Rayyan, a total of 4,116 unique papers were identified.

B. Screening Procedure

The screening process consisted of two stages based on clearly defined inclusion criteria: (1) studies published as academic works in English; (2) studies involving human participants in user studies; (3) studies measuring or using security robots; and (4) studies directly comparing outcomes from interactions with security robots to those with human security agents. In the first stage, article titles and abstracts were reviewed, resulting in 544 articles identified as potentially relevant. In the subsequent stage, these articles underwent a full-text screening, which ultimately identified nine studies that fully met all inclusion criteria. Three researchers independently screened the articles using Rayyan to ensure reliability and consistency in the selection process.

IV. Results

A. Outlets

The nine papers were published across a diverse range of venues, with four appearing in journals and five presented at conferences. These venues spanned fields including robotics (2 papers), human–robot/computer interaction (5 papers), human factors (1 paper), and library sciences (1 paper).

B. Sample

Across the reviewed studies, the total sample size was 2,459, with a mean of 273 and a standard deviation (SD) of 301. This indicates a considerable variation in sample sizes across different studies. Most studies utilized relatively large samples, with the largest being 1,009 participants [30], followed by 531 participants [31]. However, one study had a notably smaller sample size, with only 14 participants [26].

The average age of participants across the four studies reported was 32 years (± 10 SD). Only one study [32] reported racial and educational demographics, noting that most participants were White and held a college degree. Out of the nine studies examined, six reported gender distribution. Most had a balanced representation, except [30] (more female participants) and [26] (more male participants). Overall, the combined sample was 46.6% male and 53.4% female.

In terms of sample type, six studies recruited participants from the general population [31], [32], [33], [25], [10], [34], two targeted student populations [30], [35], and one involved police officers [26]. Geographic and cultural contexts varied: two studies were conducted in the U.S. [31], [32], two in Peru [33], [35], two in Japan [10], [25], and one in Nigeria [30], all involving local participants. Two studies [26], [34] did not report this information, though both authors are U.S.-based.

C. Interaction Methods, Security Tasks, and Human Roles

1) Interaction Methods: The nine included papers employed various methods to facilitate interactions between participants and security agents. The most common approach, used in six papers, involved surveys incorporating videos, pictures, and/or text. Of these, three studies [31], [10], [26] used pre-recorded videos, while the other three [32], [30], [34] relied on textual descriptions to depict interactions between security agents and human participants. The remaining three studies employed real security robots to elicit direct in-person interactions: two [33], [35] used RobotMan, while one [25] utilized Robovie-R.

2) Security Tasks: All papers except [32] presented participants with scenarios involving security agents performing specific tasks. Three studies [31], [33], [35] utilized the access control task, where security agents controlled access to certain buildings, requiring participants to present identification before being granted entry. The remaining five studies featured diverse tasks: enforcing COVID-19 protocols and issuing admonishments [25], protecting a victim in need of help [10], conducting surveillance to deter strangers [30], apprehending a pickpocket during a patrol [34], and executing law enforcement clearing operations [26].

Notably, none of the studies informed participants about the level of autonomy of the robots. In the three studies that involved real robots [33], [35], [25], the robots were actually teleoperated by experimenters as needed.

3) Human Roles: Across the nine papers, participants assumed different human roles, forming different interaction relationships with security agents. Based on the human role taxonomy proposed by [36], three roles were identified: bystander, cooperator, and collaborator. In all studies except [26], participants took on the perspective of the general public, acting as bystanders who either evaluated or interacted with security agents from an external standpoint. However, in one study [25], some participants assumed the role of cooperator—working alongside a security agent as shop employees, while either they or the robot handled security tasks. Additionally, in another study [26] participants collaborated with security drones to carry out law enforcement operations.

D. Interaction Types: Citizen-initiated or Police-initiated

The reviewed studies each examined specific types of interactions between humans and security agents. These interactions can be broadly categorized into two main types: citizen-initiated contacts and police-initiated contacts. Citizen-initiated contacts were present in 55.6% of the studies. For example, in [31], [33], [35], participants initiated the interaction by entering a building and approaching the security robot or human guard. Similarly, [26] described interactions in which individuals actively sought to use security drones to carry out specific security-related tasks.

The second major category is police-initiated contacts, which accounted for 33.3% of the studies. For instance, in [25], the security agent detected individuals who were not following safety protocols and approached them to issue admonishments. In [34], the security agent on patrol identified a potential thief and took action to apprehend the person.

Finally, one study [32] did not fit either category: participants were shown the term "security guard" in the survey without any specific interaction described.

E. Outcomes

Papers employed different outcomes to assess human–security agent relationships. This review categorized these outcomes into two main groups: acceptance of agents and perceptions of agents. Acceptance of agents focuses on encouraging humans to interact with the security agent [6] and was examined in 77.8% of the studies. This category includes both behavioral and perceptual measures of acceptance. Behavioral acceptance involves indicators such as participants' tendency to notice and interact with the agents [35], the level of engagement during the interaction [33], and the physical distance maintained [35]. Perceptual acceptance includes factors like trust [26], general acceptance [10], and preference toward the security agents [25], [30], [32].

Perceptions of the agents, examined in 33.3% of the studies, refers to participants' impressions and evaluations of the agents [6]. This includes perceptions of fairness [37], friendliness [37], intimidation [37], intentionality [34], desirability [34], and surprise [34], along with the associated positive or negative emotional responses [35].

F. Findings

The findings are categorized into two main groups by interaction type: citizen-initiated and police-initiated.

1) Citizen-initiated Contacts: Across the nine studies, five papers examined agent type in citizen-initiated interaction. A general preference for human security agents over security robots was identified in those studies, as shown in Table I.

Acceptance. Four studies examined acceptance of the agent, with two focusing on behavioral acceptance and two on perceptual acceptance. Both studies on behavioral acceptance found that agent type significantly influenced acceptance. Authors of [33] discovered that participants engaged significantly more with human guards than with security robots. Similarly, [35] found that people were significantly more likely to notice and interact with a security agent when that agent was a human guard rather than a robot. However, those who interacted with a security robot tended to maintain a closer distance, possibly because of the need to approach the robot's screen or out of curiosity about the robot itself.

The other two studies explored security agent type in relation to perceptual acceptance, and both found a preference for human security agents over security robots. Authors of [26] examined trust and found a clear preference for human security personnel. Law enforcement officers in the study trusted human companions more than security drones. Participants expressed distrust toward security drones because of a perceived lack of control and a belief that humans had greater control and a better understanding of situations. Authors in [10] investigated acceptance and found that participants considered it more acceptable for a human guard, rather

TABLE I

THE IMPACT OF AGENT TYPE IN CITIZEN-INITIATED INTERACTION

High-Level Outcomes	Low-Level Outcomes	Study	Effect	General Results
Acceptance of agents	Inclined to notice and interact with	[35]	Sig	Sig
	Engagement	[33]	Sig	
	Distance	[35]	Sig	
	Acceptance	[10]	Sig	
	Trust	[26]	-	
Perceptions of agents	Positive affection	[35]	N.S.	N.S.
	Negative Affection		N.S.	
	Fairness	[31]	N.S.	
	Friendliness		N.S.	
	Intimidation		N.S.	

[a] The '-' means no statistical test was conducted; the paper showed a trend favoring humans over robots.
[b] All significant effects are the outcome score of human security agents being higher than that of security robots.

TABLE II

THE IMPACT OF AGENT TYPE IN POLICE-INITIATED INTERACTION

High-Level Outcomes	Low-Level Outcomes	Study	Effect	General Results
Acceptance of agents	Better for the job	[25]	-	-
	Suitable for the job	[30]	-	
Perceptions of agents	Desirable (study1)	[34]	Sig	Mixed
	Desirable (study2)		N.S.	
	Intentional (study1)		Sig	
	Intentional (study2)		N.S.	
	Surprising (study1)		N.S.	
	Surprising (study2)		N.S.	

[a] The '-' means no statistical test was conducted; those papers all showed a trend favoring robots over human agents.
[b] All significant effects are the outcome score of security robots being higher than that of human security agents.

than a humanoid security robot, to defend a victim from an attack using non-lethal force. However, when compared to an autonomous security vehicle, the humanoid robot was seen as more acceptable.

Perceptions of Agents. Two studies examined perceptions of agents and consistently reported non-significant results, suggesting that the type of security agent does not influence people's perceptions during interactions. Study [35] found no significant differences in participants' positive or negative affection after interacting with security robots compared to human guards. Similarly, [31] found no significant differences in perceived intimidation, friendliness, or fairness between security robots and human guards.

2) Police-initiated Contacts: Across the nine reviewed studies, three papers examined security agent type in police-initiated interaction. Detailed results are shown in Table II.

Acceptance. Two papers examined the acceptance of security agents in police-initiated interaction and consistently found a higher acceptance of robots over human security personnel. Edirisinghe et al. [25] conducted a field study examining how shop workers and customers responded to a security robot enforcing safety protocols admonishing people. The results found both customers and shop workers favored the robot over a human. Although the robot was noted for lacking emotional capability, most customers believed it was better suited for the job, as being admonished by a robot felt less personal, reduced resentment, and avoided the discomfort of human surveillance. All shop workers interviewed also preferred the security robot to take on the job of delivering admonishments, believing that robots are more suitable as they can be less offensive, easier to implement, and sufficiently effective. Adetayo et al. [30] surveyed 1,009 students and found that most preferred robots for the library security roles, as they could effectively patrol routes, identify outsiders, and issue warnings to human guards.

Perceptions of Agents. Authors of [34] were alone in examining the effect of agent types on perceptions of the agents. They conducted two studies: the first compared female human guards with security robots, and the second compared male human guards with security robots. The results showed that participants perceived the security robots as more desirable and intentional than the female guards, with no significant difference in surprisingness. However, no significant differences were found between security robots and male human guards across any of the measured perceptions—desirability, intentionality, or surprisingness.

3) General Interaction: Study [32] is the only study that did not involve either citizen-initiated or police-initiated contact. Most participants preferred hiring human guards over security robots, regardless of the guard's gender.

V. DISCUSSION

Our goal in this research was to identify when individuals prefer humans or robots as security guards through a systematic literature review. Results highlight how the initiator of an interaction—whether the citizen or the security agent—helps understand preferences. The results suggest that distinct acceptance mechanisms could be at play in these scenarios, with police-initiated interactions revealing a preference for robots given their impersonal nature, reliability, and reduced potential for offending. In contrast, citizen-initiated interactions revealed a preference for humans, highlighting potential issues such as trust with robots. Contributions to the literature, theoretical and design implications, and study limitations are detailed in the next section.

A. Implications for Research

First, the findings of this review highlight the potential critical role of interaction initiation in understanding user preferences. Prior HRI research may have overlooked this crucial factor, often focusing on general acceptance without differentiating between user-initiated and agent-initiated encounters [6], [38], [39]. Our findings suggest that different HRI acceptance mechanisms may be at work in police-initiated versus citizen-initiated interactions. In police-initiated interactions, robots' impersonal nature, consistency, and reduced potential for offense seem to outweigh concerns about trust and control, which were prominent in citizen-initiated scenarios. This understanding can inform researchers about the inherent biases and social norms that affect the acceptance of robotic

systems. This study demonstrates that the same robot might be viewed favorably in one context and unfavorably in another, depending on who initiates the interaction.

Second, the insights regarding the feelings of emotional neutrality of robots compared to human personnel identified in [25] contribute to the discourse on neutrality in HRI. This understanding encourages exploration of the psychological and social factors influencing human perceptions of authority figures, highlighting the potential importance of designing robots that convey fairness and impartiality. This finding prompts further research into how power imbalances affect user preferences for humans versus robots across various security contexts [10], [40]. Ultimately, the perception that robots could enforce rules more effectively and with less personal backlash introduces a deeper understanding of their role in sensitive environments. Exploring how robots can operate without eliciting negative emotional responses could lead to establishing guidelines for utilizing robots in authoritative positions requiring minimal confrontation.

Third, by showcasing the public's preference for robots in specific roles, the literature can inform policymakers on the strategic placement of robots in public security measures [41]. Observing that perceived intimidation, friendliness, and fairness do not significantly differ between robots and humans suggests that robotic presence does not inherently alter emotional interpretations [31]. This stability in perceptions offers a positive outlook for integrating security robots, suggesting that negative perceptions may not be a barrier if robots can achieve high functionality and reliability. These considerations will affect conversations around resource allocation and operational protocols, steering efforts toward models that blend human intuition with robotic efficiency.

Finally, these insights contribute to developing hybrid security systems that leverage human and robotic strengths. The literature can provide a basis for studying optimal workflows and interactions in environments where human and robotic agents coexist. This may include analyzing how best to balance responsibilities and ensuring that each agent type performs in roles that align with societal expectations and operational effectiveness [42], [43]. These findings can promote the development of holistic interaction frameworks encompassing how humans engage with various security agents. This can further enhance our understanding of human–robot collaboration, offering research pathways that study the dynamics of mixed-initiative interactions where human guards and robots work together in security roles.

B. Implications for Design

This study's insights offer valuable design implications for security robots. Findings on trust [26] suggest that future designs should address this critical aspect. This could involve incorporating features that enhance transparency [44], provide clear communication about the robot's capabilities and limitations [45], and allow users greater control over the interaction [11], as emphasized in [26]. The variations in acceptance based on robot morphology [10] also point to the importance of careful design considerations. If robots are to be used in situations where they initiate interactions (e.g., enforcing rules), careful consideration should be given to minimizing the potential for negative emotional responses. This might involve focusing on clear, concise communication and designing robots to appear less intimidating [46].

C. Limitations and Future Work

One limitation is that most literature focuses on routine police–citizen interactions, envisioning robots performing basic roles like surveillance and access control. However, real-world security duties can involve high-stakes, ethically complex scenarios [47], [48], raising concerns such as whether robots should have the authority to use lethal force or harm humans to protect others [49]. Robotic security also introduces privacy risks from extensive surveillance and potential biases in algorithmic decision-making [50], [11]. Future research should explore public perceptions of robotic security agents in these extreme contexts and address moral and legal considerations [11] to ensure the technology's safe and responsible development.

In addition, this work is based on a relatively small number of empirical studies, limiting our ability to conduct a meta-analysis. While existing research suggests a contextual preference, much of the evidence—especially in police-initiated interactions—is qualitative. Quantitative research in police-initiated interactions is needed to support future meta-analyses. Additional empirical studies are also needed to validate the identified preference pattern.

VI. CONCLUSIONS

Security robots are increasingly prevalent in society, assuming security roles traditionally held by humans. We conducted a systematic review of security agent types, revealing an interesting preference pattern: people tend to favor human security agents when interactions are initiated by citizens, and prefer security robots when interactions are initiated by security agents. These findings provide crucial insights for future security robot research and deployment considerations.

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