Fashion for Devices: Altering human perception of security cameras using expressive clothing

Abstract—As smart devices become a ubiquitous part of our environment, the way that devices express and present themselves becomes a critical component of our perception of them, contributing to whether we follow their directions or use them properly. Particular devices have a way of imitating the human perceptual process itself, allowing us to speculate on how they view us, and how that viewing-of-us changes when they present themselves in different ways. One such device is the security camera, a robotic device used for monitoring of public safety in use-cases like healthcare, education, and individual homes. Human perception of security monitoring systems is usually laced with anxiety and concern for privacy due to the way they gaze at us threateningly for monitoring or crime detection concerns. To design security cameras with more user-friendly and approachable appeal despite their gaze, we investigated different scenarios of their use that lead to different expected human reactions and interactions. We designed clothing that signaled the device's intent in specific scenarios based on the perspectives of machine function, machine expressive need, and human acceptance and appreciation. In semi-structured interviews, we found that humans will interact with security cameras differently based on their clothing, but recognize that machine fashion is based on functionality. They also appear to perceive the way that cameras look at us to be different based on what they are wearing. These insights hint at a perspective of critical design for the expressive appearance of devices as opposed to functionality alone for affecting humans' interaction with them.

Keywords—security camera, robotic gaze, machine fashion design, speculative design, machine self-presentation, posthuman design.

1. (Left) Naked security cameras; (Middle) Security cameras covered by functional and emotional clothing; (Right) Interacting with clothed security cameras using a movement-control web interface.

I. INTRODUCTION

As devices use algorithms to better understand us and provide smart default behaviors and anticipation of our needs, it becomes more important to design for their appearance, for the appearance of robotic devices lead to differing expectations and assessment of their abilities and use [14]. A device designed for serving at a restaurant would be out of place in pajamas or greasy coverings, but a chef uniform or neatly trimmed handles would serve to signal its purpose at the setting. In particular, matching the purpose and appearance of devices can improve human-machine cooperation [10]. Some devices have the additional ability to indicate that they perceive us in specific ways. Machines like cell phones, computers, and cameras can give humans the impression that they are being watched [16], creating interactions that affect human perception by the way they see us. Interestingly these gaze-based interactions can then be used to create playful interactions that turn the surveillance-based viewing perception into inventive forms of hide-and-seek [17]. Can we use the appearance of machines to signal how we are being viewed by machines, and in turn affect our perception of the functionality and abilities of these entities?

Digital cameras, smartphone cameras, and closed-circuit televisions (CCTVs) form one set of such perceiving devices whose gaze can be interpreted by humans. Such smart devices with in-built cameras form a ubiquitous network to capture motions and appearances in the environment [23]. The way that devices express and present themselves becomes a critical component of our perception of them, contributing to whether we follow their directions or use them properly. Since CCTVs have the side implication of potentially barging into human's social lives and private spaces [15], people feel uncomfortable and anxious in public and private spaces when facing them [16]. Moreover, most cameras are unclothed, making users feel themselves directly exposed to the cameras' gaze. Clothing for robots has become an emergent topic in HRI. Although robots don't need clothes as a necessity, researchers have proposed that clothing provides an opportunity to mediate technical challenges for robot interaction design [8]. Thus we believe that expressive clothing can also help smart cameras better signal their functions and create better human-machine interactions.

This study looks at how expressive clothing helps machines better conduct their functions and interact with people by offering a speculative analysis [4] of the security cameras' clothing. By analyzing the existing machine and robot clothing and related examples contributed by designers and HRI researchers, we offer a speculative analysis of security cameras clothing. We also prototype expressive clothes for smart cameras in different scenarios that allow for the embodied participation of users. We talked to users in a

semi-structured interview regarding perception of particular security camera devices with different clothing. We analyzed and summarized the current limitations and future directions of the emerging machine fashion research. This research provides framing and examples of machine appearance and clothing design to help develop an interdisciplinary bridge between speculative design and human-machine-interaction systems.

II. Background

A. Surveillance cameras of public spaces

Public and private lives and scenarios have been greatly transformed by the public's concerns about safety [13]. To address the anxieties caused by crime and other serious threats for public security, surveillance cameras have been widely used in various countries [11,26]. However, the rapid development and increased sophistication of video surveillance systems leads to the discussion of individual privacy and information protection [22,25]. A tremendous amount of Individual information is collected without the public's consent and permission and generates a great risk to the spill of personal information, including interception attacks, abuse of cameras, and extorted and stalked behaviours caused by the storage of videos [7]. In the steadily expanded CCTV surveillance society, the public tends to react thoughtlessly and regard public area surveillance as the association of benefits and concerns [12]. Therefore, future research should explore the possibilities of making functional machine clothes to release the anxieties and discomfort caused by surveillance and improve the emotional connections between security cameras and users.

B. Security cameras applied in healthcare

For safety consideration, security cameras create the monitoring system and are widely applied in monitoring house environments remotely. Since the rapid ageing of population caused by low birth rate and the long life expectancy, elderly healthcare has become an urgent issue and requires new technologies to assist and monitor elderly's status [20,27]. Moreover, monitoring home-bound individuals' daily behaviours has positive impacts on the report of patients' worsening conditions [2]. Therefore, monitoring has a dual side in healthcare, arguing that monitoring can be seen as enabling behaviour for elderly living independently or having health issues [5]. For instance, motion-capture enables physicians to better observe and monitor the patients' health status and disease development, which is one important part of tele-monitoring in healthcare [2]. Therefore, users may ignore the negative feelings about the monitoring of security cameras applied in healthcare, such as hospitals or private homes. Since the need for healthcare, the majority of elderly claim that they do not experience any violation of their information privacy under this kind of monitoring [5].

C. Security cameras applied in schools

Surveillance camera system was applied widely in school sites, including the check of attendance and registration, the report of school activities, the monitoring during examination and assessment, and the observation of students' behaviors and spatial limitations [1]. Previous research shows that audiences may take helping behaviour driven by self-concern and others' approval in front of security cameras [24]. However, it is challenging for schools to confirm that security cameras can benefit the reduction of punishment and crime while still strengthening students' sense of school belonging and autonomy [6]. Although the security cameras outside schools can be seen as safekeeping, the majority of students still feel uncomfortable about the surveillance of inside cameras [19]. For instance, security cameras have potentially harmful influences on students' mental and physical health, especially for black students [19]. Concerns remain about the negative impacts of security cameras in such engaged environments, which indicate the need and potentials of making functional clothes for helping security cameras be more user-friendly and expressive.

III. Design goals of machine clothing

According to the related research about robot clothing, clothes enable robots to adapt to several scenarios, remain safe, and express their identity and intentions [8]. Therefore, this research argues that clothing can also help security cameras better achieve their functions through matching of task and appearance, as well as presenting themselves in the appropriate manner for influencing user decisions in a task [21]. These patterns can then be used to activate desired human-camera interactions. In this area of security cameras appearance and clothing interventions, we suggest three design goals: 1) functional, 2) emotional, and 3) expressive.

2. Design goals of security cameras' clothing in scenarios of public (Left) safety surveillance, (Middle) health monitoring, and (Right) educational engagement.

- **functional**: adapts to a variety of public spaces and achieves the purpose of protection, safety, etc.
- **emotional**: acts as emotional expressions of security cameras to achieve more positive reaction from users by invoking care, including in hospitals, elderly healthcare environments, etc.
- **signalling**: acts as an attractive decorative fashion for the signalling intention of engagement [9].

A. Functional clothing for the need of adapting to scenarios and protection

Since robot clothes protect robots from hazardous environments and enable them to be steadily exposed to harsh environments [9], clothing for security cameras could have the same protection function and enhance their durability. Moreover, clothing adapted to the physical environments which help security cameras hide in it could enable users to ignore negative impacts of the surveillance function of security cameras. For users, losing or decreasing their attention to security cameras allows them to behave more freely and actively in public spaces. In addition, designing functional clothing for security cameras should also consider movements and track traces of security cameras to avoid the limitation caused by dressing up.

B. Emotional clothing for healthcare

Since one purpose of security cameras is to protect the wellbeing of their subjects, monitoring systems for healthcare may provide oversight of patient and elderly activities to ensure well being and alert caretakers. In this scenario, the design should reflect the emotional responses the subjects have while being serviced by devices, reflecting previous work that showed robot touch can positively influence subject perception in the care environment [3]. Designing for the emotional reactions of subjects in this scenario to the appearance of the device can determine the level of success for which monitoring systems are designed. For instance, a nurse 's uniform could enhance the sense of being taken care of, which creates a mental connection between the monitoring devices and patients, easing their anxiety about being watched in this scenario.

C. Signalling clothing for schools

The school is a place for engagement and play with accepting, expressive entities. Here, the design is for the educational purpose, much as previous work showed that self-awareness of children can be affected by camera systems that also show the way the system as a whole works [19]. While clothes can represent group identity, designing clothes for security cameras could also signal their individual identity [4]. Hence users can identify and react to different security cameras based on their clothes. To encourage engagement, play, and wellbeing, cameras in schools need attractive decoration and covering for positive influence of students' physical and mental health. For instance, an attractive decoration in the "cute" fashion style enables students to pay more attention to the placement of security cameras and decreases their habitually defensive instinct.

IV. EVALUATION AND DISCUSSION

To evaluate the impact of machine fashion on the perception of users, an in-the-wild study was conducted during an interactive exhibition where visitors varied in age (18-35 years old) and background (students and local visitors). We created two prototypes of the designed clothes for security cameras, including a camouflage clothing based on the functional goal in the public space scenario, and a doll "cute" headdress based on the signalling goal in the education scenario. We separately gave participants the naked camera and the clothed camera for each of the two scenarios in sequence (counterbalanced) while asking them semi-structured interview questions that addressed the participants' feelings and reactions to the decorative security cameras. The researchers first presented the security cameras to the participants in both naked and clothed forms (Fig. 1), then observed and noted user behaviors. Participants were also allowed to freely express their ideas about the scenario, the perception of the gaze, and other matters of relevance. The semi-structured interviews then took place with visitors who gave consent to use their data for academic purposes and to have their interviews recorded (n=8, 4 male, 4 female). A qualitative coding process was undertaken on the interview transcripts to summarize the findings in the following sections.
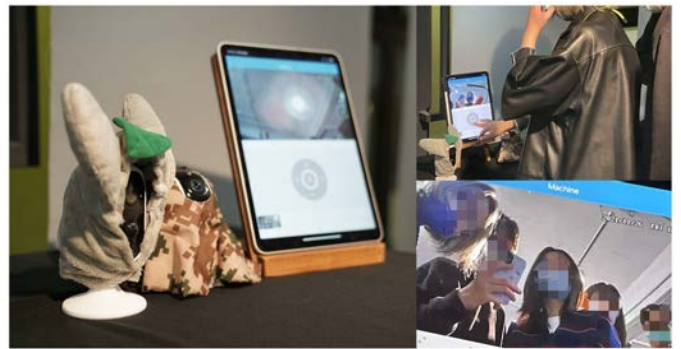
3. **(Left)** The prototypes of security cameras clothing, **(Right)** visitors' interaction with the exhibited prototypes. The app allows user control of the viewing angle of the cameras during interactions.

Interview questions used:
- What is the difference between naked and decorative security cameras? Have you changed your feelings and perspectives about decorative devices?

- Do these clothes help you release the anxieties and uncomfortable uncomfort about the surveillance society? Do these clothes enhance in-situ attention to devices? Do you want to interact with the decorative cameras?
- Do you think the machine sees us differently if it is wearing particular clothes?
- What do you think the clothed machine is trying to say?
- Do the devices wearing clothes give you any association? Why?
- If you are the designer, what kind of machine clothing do you want to create?

A. Machine self-representation by wearing clothes

When asking about the differences between naked security cameras and security cameras covered by the prototypes, participants stated that clothing personifies security cameras and enables them to achieve self-presentation like human beings. Participants also appear to have less negative attitudes and concerns about the surveillance when the cameras were clothed.

> *"...After covering the designed cloth makes me feel like it is more energetic, I will regard it as a person, a living object, and then a small animal."* - P1
> *"The dressed up security camera becomes more lovable, which is different from the unfeeling sense of the naked one."* - P3
> *"...the clothes made security cameras become more lovable,... and I feel less nervous and less sensitive in front of them."* - P4
> *"...Because of the soft material, this rabbit-like cloth makes me feel more lovely ... but I feel uncomfortable with another camouflage cloth."* - P8

Moreover, they mentioned that different designs may generate different impacts and reactions, which are in conjunction with their functions and the scenarios in which they are placed. Participants appear to find that the way that security cameras look at them appears to change based on the different styles of clothing. In particular, the security camera with camouflage clothing (functional goal) in public spaces appears to enable them to associate a human need to hide with the machine, which creates an emotional understanding that may lead to greater acceptance of their role. This is ironic since the machine is trying to hide in this case, but participants rather perceive it as a more raw expression of their desire, leading them to assign human need for anonymity to them, despite their role as an agent of monitoring. Some participants, however, saw the camouflage clothing as a negative

expression of their surveillance strategy. In either case, they appear to perceive the way cameras look at us would be different in different scenarios and with different appearances:

> *"Compared to naked security cameras, security cameras that wear clothing seem to have animal-like characteristics such that they appear to see us in an animal-like way. Hence, I perceive that what they see should be different from what those raw cameras see."* - P5
> *"If the camera actually saw things differently when they are clothed vs. when they are naked, then I would think that they are even more human."* - P1
> *"Humans wear camouflage to hide from the enemy and cover themselves, so I would associate camouflage with the army, hiding, and unfriendly monitoring of their enemies. When decorating the security camera with camouflage, I will feel that this is what it wants to do."* - P8

B. Human-machine interaction based on expressive appearance of devices

Responses from participants who engaged with decorative security cameras showed that their interactions are based on the expressive appearance of devices, including the material, fashion style, colour, and other touchable, signalling, appearance-based elements. This implies that the particular expressive appearance design should consider the nearby environments and devices' functions.

> *"I would prefer to touch the security camera with the cute green ribbon because the material is softer. But if there is no clothing on both cameras, I prefer to touch and engage with the other one because it has a smooth head."* - P1
> *"I think camouflage clothing can be used in some outdoor scenes, such as shooting wildlife documentaries. Another cute cloth can be used at home or a workstation."* - P3
> *"...since different materials have different tactile experience, when I see this furry and soft decoration, I will subconsciously want to touch and caress it…"* - P4

In P1's case, she saw both cameras in clothed and unclothed forms. When both cameras are clothed, she indicated that she would rather touch and interact with the green-ribboned camera in the school scenario (Fig. 1, left), due to its soft furry material. However when presented with both cameras in naked form, she chose the round-headed camera in the public space scenario (Fig. 1, right) because it had a more touchable

shape when in naked form. Thus the clothing of the camera actually changed the willingness for P1 to interact with the device, changing preference for one for the other.

While participants may be attracted by the covering on devices, some of them still proposed that designers can add more interactive design into devices' clothing to personify machines better and achieve more emotional engagement.

> "... *I hope these decorative clothes can generate more interaction with me, such as giving me some feedback or actions when I approach it...*" - P5
> "*...I would feel more strongly about the cameras if the clothing design could be more interactive...*" - P8

One interesting note is that while machine clothing appears to affect the way humans perceive the device, humans may also assign different purposes to clothing for machines vs. clothing for humans. For example, we encountered a participant who was wearing a similar pattern to the public space scenario camera, a camouflage-like pattern of clothing. When we asked him about this coincidence, he held firm to his own special case compared to robots, noting that his clothing is expressive and not functional, unlike the camera's.

> "*My clothing is my human fashion; the machine's clothing is only for its purpose. These are not the same clothes, and I'm actually expressing myself, unlike them.*" - P5

V. Conclusion

This work investigated the way the appearance of devices affects the perception of humans. In particular it took the case of a perceiving entity of the security camera, whose gaze function may be perceived by humans differently in different scenarios and by wearing different clothing. This research provides a speculative view of the way clothing and appearance of machines may be designed in the future based on expressivity and function to optimize machine functionality and human-machine collaboration by changing the way humans perceive the machines in each use-case. We suggested three design goals (functional, emotional, and signaling) for situating the design space for monitoring-perceiving systems, and created two prototypes based on two scenarios (school, public space) for in-the-wild evaluation.

Evaluation suggests an intricate relationship between the way we view machines as being expressive or functional based on their use and our own relationship to them. In particular, we found that participants are more or less willing to engage or touch a camera robot depending on its clothing. We also found that participants perceived the gaze of the cameras differently depending on the style that they are clothed. However since the prototypes both seem to depict unusual entities, they may also be signaling the "cuteness" of the device in addition to their function via clothing. Unlike human's own clothing, humans still perceive machine clothing to be of a different purpose than expressivity in certain situations, centering the view back on the human perspective of fashion.

This work suggests that we pay attention to the appearance of our devices in designing for human-machine interaction, for the human perception of the abilities or perceptions of the devices can change effective engagement and acceptance.

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