Towards Civil Inattention through Gaze for Social Robot Navigation Scenarios

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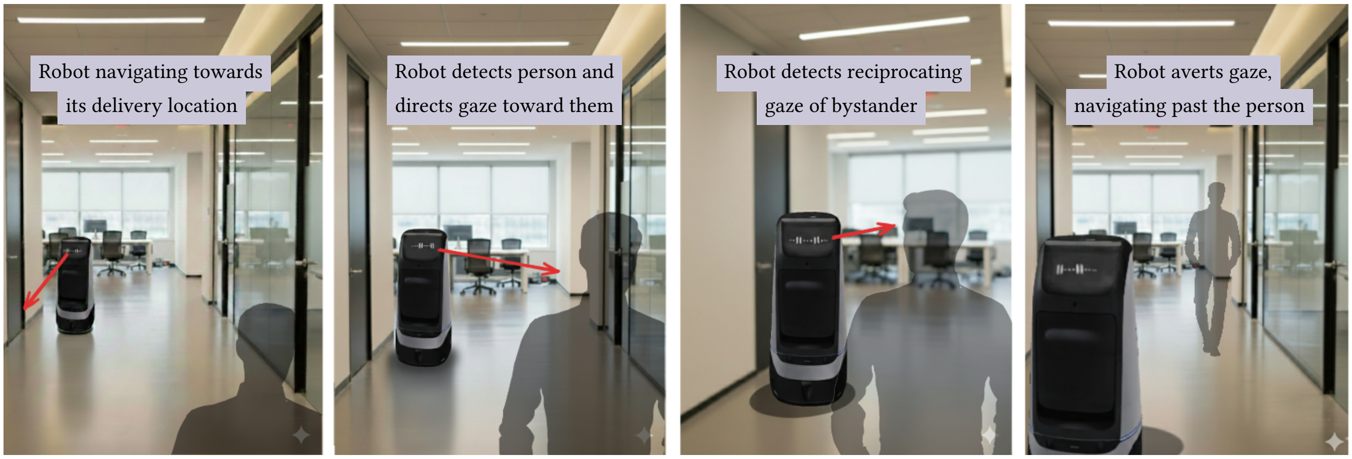

Figure 1: A service robot, performing a delivery, exhibits Civil Inattention by directing its gaze to a bystander (to signal its perception of the person), detecting the reciprocating gaze, and then averting its gaze (to signal its intention to politely withdraw from this brief interaction and complete its task). Image partially generated with Google Gemini.

ABSTRACT

For service robots, navigation extends beyond simply reaching their destination to sharing the space with humans who are differently engaged with the robot's task, ranging from the intended recipients of the service to uninvolved bystanders. Robots must therefore exhibit socially appropriate behaviors that facilitate harmonious human–robot coexistence by making their intentions and goals legible to nearby people. Informed by sociological studies of human–human interaction in shared public spaces, we propose to equip service robots with the social mechanism of Civil Inattention, through which individuals acknowledge one another's presence while signaling non-intrusiveness via brief glances or other minimal cues. We propose a gaze-based mechanism in which the robot briefly directs its gaze toward a nearby human and adapts its navigation policy based on the human's gaze response. If mutual gaze is detected through a binary head pose trigger, the robot averts its gaze and continues with a standard navigation policy; otherwise, the robot adopts a more conservative motion strategy upon a certain distance to human, assuming it was not detected by the bystander. In this paper, we present the core ideas behind the proposed mechanism, rooting them in the relevant literature, and providing a plan for implementation and evaluation, including foreseeable pitfalls and limitations.

KEYWORDS

social robot navigation, civil inattention, gaze behavior, interpretable robot behavior

1 INTRODUCTION

The growing deployment of robots in human-inhabited environments requires navigation to incorporate social considerations beyond purely functional motion planning. These new considerations in human-shared scenarios arise from the fact that movement is influenced not only by physical constraints, but also by social norms, expectations, and implicit coordination [22], domains in which

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humans exhibit remarkable proficiency, making such navigation appear natural and intuitive. As a result, robots operating in these spaces must be perceived not merely as moving objects, but as social agents whose actions are part of an ongoing interactional process [18, 33], conveying cues that respect for personal boundaries [40], facilitate negotiation of shared space [43, 44, 51], and awareness of others [6].

Human–human interactions in brief, incidental encounters where engagement is not the primary goal, such as public and potentially crowded spaces, non-verbal cues play a central role in facilitating smooth coordination [30]. Gaze, body orientation, and motion timing allow individuals to communicate awareness, and intentions without initiating direct interaction. One well-studied behavioral pattern exemplifying this subtlety is Civil Inattention (CI), in which individuals briefly acknowledge one another presence but deliberately avoid direct interaction, thereby signaling mutual awareness while simultaneously indicating an absence of intent to engage in social interaction [21].

Among the non-verbal cues that structure human interaction, gaze plays a central role [2, 15]. Gaze enables individuals to regulate interactions by signaling awareness or disengagement without the need for verbal communication, and plays a crucial role in the display of CI. For instance, when people pass each other in a corridor, they typically exchange a brief glance to acknowledge mutual presence and then avert their gaze, conveying a polite non-intrusiveness.

As such visual cues helps humans signal awareness of others and supports in turn smooth navigation, we propose to operationalize the concept of CI and embed it in the gaze behavior of a service robot. The ability to exhibit CI is particularly relevant for robots whose primary task involves reaching a goal (*e.g.,* performing a delivery) while navigating in a human-shared space. Although their main objective does not inherently require direct interaction with people, their movement takes place in human-inhabited environments, where an appropriate balance of social presence is necessary. The robot must therefore be socially competent enough to be recognized as a social agent, yet not so intrusive that it encourages unnecessary engagement.

Figure 1 illustrates this concept by showing a service robot encountering a person in a corridor: the robot directs its gaze toward the human, who reciprocates the gaze, acknowledging the robot's social presence, after which the robot averts its gaze, exhibiting CI. We hypothesize that embedding robots with such behavior allows them to be not only polite but to be better social agents while navigating. After presenting the relevant literature in Section 2, we present the proposed CI behavior through gaze in Section 3, along with an implementation and evaluation plan, and an analysis of the foreseen limitations.

2 RELATED WORK

2.1 Social Robot Navigation

Social robot navigation has been extensively studied in the Human-Robot Interaction (HRI) field from multiple perspectives [20, 39]. While early work treated humans as obstacles to be avoided by local planners [19], the field quickly moved to incorporate hand-coded social norms (chiefly the proxemics principle) to capture more nuanced information about surrounding humans [31, 49]. Some approaches used circular zones around detected humans [28], while other methods employ learning-based algorithms that leverage motion information, such as position and velocity, to generate more accurate and dynamic representations of personal space [11]. Another line of work looked instead at predicting human trajectories to inform navigation policies, either by learning human trajectory predictors [3, 8, 27, 32, 48, 50] or by mimicking human behavior with crowd models [26, 34].

2.2 Non-verbal Communication Modalities

Social cues, typically conveyed through non-verbal communication, play a crucial role in perceiving the intentions of others. In the context of HRI, these cues allow robots to both interpret (when detected) and convey (when exhibited) human behavior, aiding in turn people's decision-making and the inevitable accommodation work needed to address robots' limitations [43]. The types of cues a robot can employ depend on its embodiment and may include lights [5, 16], sounds [42], or deictic gestures such as neck movements, pointing, and waving [45].

Variations in a robot's motion trajectory, speed, and timing to convey its goals and intentions are commonly referred to as legible motion.Such variations are commonly implemented as adjustments (either hand-coded or learned from data) to communicate *e.g.,* the robot's intended destination [3, 7, 17] or its willingness to interact [46]. Studying such adjustments, Lian *et al.* [35] concluded that incorporating non-verbal cues results in more effective robot behavior compared to navigation policies that treat humans merely as dynamic obstacles.

2.3 Civil Inattention

Civil Inattention (CI) is a concept introduced by the sociologist Erving Goffman, referring to a subtle social behavior in which individuals acknowledge the presence of others through brief visual notice followed by a deliberate withdrawal of attention [21]. This behavior typically occurs in public environments and serves to signal awareness of others while simultaneously respecting their privacy, maintaining personal boundaries, and facilitating smooth interactions. Violations of CI in public spaces can increase tension or stress among individuals sharing the environment and may give rise to misunderstandings, creating a less fluid and more awkward social atmosphere.

While the specific expression of CI is context-dependent and may vary according to cultural norms, the nature of the interaction, and the surrounding environment, brief gazes or nods are often used, and their duration is intentionally limited to prevent discomfort or undesired engagement [1]. Common scenarios where this behavior is easily observed include elevators, public transportation, street interactions, queues, and waiting areas, where individuals typically offer a brief nod, slight smile, or glance to acknowledge the presence of others, before withdrawing attention from bystanders.

Extending the concept of CI to interactions involving robots introduces additional complexity, as robots do not possess genuine social presence or agency. Human responses to robots can vary widely, ranging from complete disregard [43] to exaggerated attention [14] or even aggression [29, 41], depending on whether the robot is perceived as socially relevant. Abe and Colombino [1]

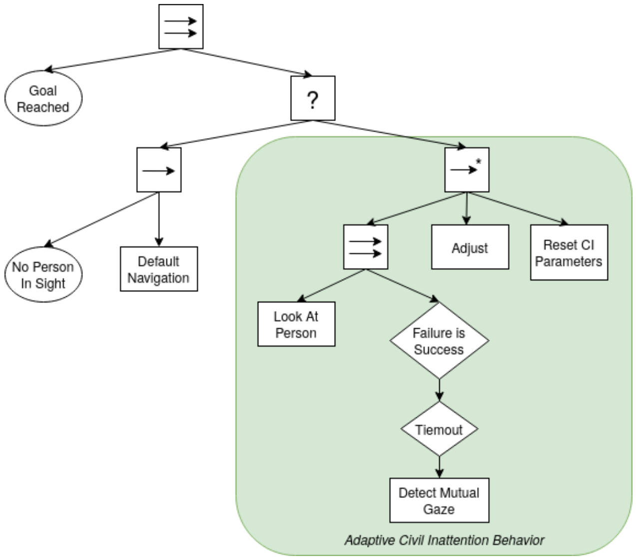

Figure 2: Gaze and Motion behavior switching based on the concept of CI, as a Behavior Tree (notation from [12]).

suggest that increasing a robot's social presence may help elicit more appropriate human responses. In this context, employing gaze as a natural cue for CI could enable robots to politely signal their awareness of humans while demonstrating their unwillingness to engage in an interaction. The alignment of robot's intentions and actual capabilities could, in turn, foster greater human trust and cooperation during navigation.

In this work, we propose to complement social robot navigation by leveraging the concept of CI through gaze to signal the robot's awareness of bystanders without inviting them to direct engagement, allowing it to be perceived as a social agent rather than a disruptive object [25].

2.4 Gaze for Social Navigation

Gaze plays a fundamental role in human social interaction, serving as a key signal of intention, and awareness. In navigation contexts, Hart *et al.* [24] exploit this property by directing the robot's gaze towards its future path, using gaze as a predictive cue for motion.

Inspired by human–human interactions in shared corridors, Senft *et al.* [47] investigate subtle body orientation changes during passing behaviors. In their study, they use an anthropomorphic robot (with a head with fixed eyes) that slightly rotates its torso as it approaches a human to increase acceptance of robots. The authors report spontaneous positive social responses such as smiling or nodding. This finding is particularly relevant to our work, as it suggests that minimal social cues such as torso orientation or gaze can improve the perceived social robot competence while navigating in shared environments.

A more explicit comparison between gaze and communicative gestures is presented by Angelopoulos *et al.* [4] in corridor scenarios involving opposing trajectories within the same lane. To avoid collision, the robot signals its intention to change lanes either through a deictic gesture (pointing towards the desired direction) or through gaze (first looking at the human to capture attention and then gazing toward the target lane). Their results show that while both modalities can convey navigational intent, deictic gestures appeared to be more effective but their requirement of anthropomorphic features makes them usable only for a small subset of robot embodiments. In contrast, gaze is perceived as more natural, less intrusive and more applicable to a larger population of robots, but remains slightly ambiguous.

Finally, He *et al.* [25] systematically evaluate three gaze strategies during robot navigation: (a) aligning gaze with motion direction, (b) directing gaze toward the next waypoint, and (c) briefly looking at humans entering the robot's field of view. Their findings indicate that gaze supports human interpretation of the robot's awareness of its surroundings; however, perceived social presence varies across interaction contexts.

These results suggest that static or isolated gaze strategies may be insufficient to consistently regulate social awareness, underscoring the importance of adaptive robot behavior.

3 CIVIL INATTENTION FOR SOCIAL ROBOT NAVIGATION

The approach proposed here goes beyond staring towards bystanders or fixed-time gazing pattern by detecting the reciprocating gaze and acting on this detection to implement the concept of CI. Figure 2 illustrates the decision-making of the robot's gaze and movement patterns based on human reciprocation as a Behavior Tree (BT) [12]. When a human enters the robot's perceptual field, the robot initially directs its gaze toward the human to signal acknowledgment. If the human visually responds, for example, by orienting their head or gaze toward the robot, the robot subsequently shifts its gaze back to its navigation goal, mimicking CI and signaling both awareness of the human and non-engagement.

However, gaze may not always be reciprocated, for instance when the human is engaged in another activity and does not attend to bystanders. As an example, imagine crossing path with a person walking while staring at their phone. As you cannot be sure that they actually saw you coming (no brief gaze or nod was commenced on their side), you will likely adjust your motion based on how close they are, likely slowing down and steering away from their most predictable trajectory. Similarly, when gaze reciprocity is not detected, we argue that the robots must therefore pay extra attention while navigating and adjust their motion to the lack of acknowledgment from the human side, *e.g.,* by adopting a more conservative proxemic behavior with increased interpersonal distance and reduced maximum velocity. On top of reducing the risk of collisions, the adaptation of the navigation behavior may serve as an alternative form of acknowledgment, signaling awareness through increased spatial caution rather than explicit mutual gaze. Once the CI sequence is complete, the proxemic parameters and velocity are reset to standard navigation for a next possible encounter.

3.1 Technical Implementation Plan

The proposed method relies on the dynamic modulation of the robot's gaze behavior and navigation parameters in response to real-time social cues observed in the environment. This requires a navigation stack that supports online changes like *e.g.,* the NavFn planner of Nav2 Stack [38], where proxemic cost functions and motion characteristics (*e.g.,* maximum speed or interpersonal distance constraints) can be adjusted based on the recognition of reciprocal human gaze. In parallel, the system must provide a mean to show the robot's own gaze state in a way that is perceivable to nearby humans. This entails integrating a gaze-rendering mechanism within the robot's hardware, enabling consistent and interpretable visual feedback aligned with the robot's attentional focus. Finally, the approach assumes the availability of a reliable human gaze-estimation module capable of operating in real time, as accurate detection of human gaze is a prerequisite for closing the perception–action loop. As possible candidate algorithms to detect the gaze, we reference to [9, 36, 52].

3.2 Evaluation Plan

The designed scenarios involve one person and a robot passing next to each other in a narrow corridor, and intersections excluding blind corners where the lack of mutual human–robot gaze visibility severely hinders the CI mechanism. A qualitative evaluation will compare the proposed method with baselines including goal oriented gaze, fixed duration gaze upon human detection, and sustained staring. As we hypothesize the proposed method to produce smoother interactions, metrics quantifying human disruption such as deviations from the ideal (*i.e.* undisturbed by the robot) path, trajectory jerk, and number and duration of human sudden stops will be measured. Such experimental metrics could be measured from video recordings, recorded from the robot on-board cameras and external cameras. Similarly, robot navigation will be evaluated using velocity and acceleration profiles, jerk as an indicator of motion smoothness, path efficiency, and minimum human–robot distance. Gaze-related measures will include time to gaze reciprocation, duration of mutual gaze from the human, distance at which gaze acknowledgment occurs, and the frequency of non-reciprocated gaze events, alongside comparisons between human–human and human–robot interactions in terms of trajectories, passing distances, and gaze timing.

A qualitative evaluation will rely on ethnomethodological interaction analysis from recorded videos and structured interviews, focusing on the sequential organization of gaze, acknowledgment, disengagement, and passing behaviors. Subjective experience will be assessed through questionnaire-based measures, including RoSAS [10] dimensions of warmth, competence, and discomfort, as well as social presence items inspired by the Networked Minds framework [23]. In addition, non-reciprocated gaze and failure cases will be qualitatively analyzed to examine instances of confusion, negotiation, or repair behaviors during interaction breakdowns.

3.3 Foreseen Limitations

First, the proposed approach depends on robust human gaze detection or on related techniques to estimate people's attention towards the robot. Failures in gaze estimation can occur in two primary forms: (a) missed detections, in which a human reciprocates the robot's gaze but the system fails to recognize it, and (b) false positives, in which the system erroneously detects a reciprocal gaze that did not occur.

In the first scenario, mutual acknowledgment occurs, but the robot continues to direct its gaze toward the human, potentially appearing socially inappropriate or signaling a desire to engage. Although this may temporarily disrupt interaction and navigation, the overall impact on human motion is expected to be limited, and the likelihood of undesired engagement is low. This expectation is supported by the ephemeral nature of CI: the robot will gaze towards the person typically only for a few seconds, and any perception that the robot intends to engage will be quickly corrected as the robot re-orients its gaze towards its goal.

As for false positives, the robot may incorrectly assume that its gaze has been reciprocated and act as if the human perceived it as a cooperative social agent. The robot would therefore revert to its default navigation behavior, when, as we argue above, a more cautious behavior may be preferable. Notably, humans are often more forgiving of robot errors than equivalent errors by other humans [37], which may attenuate the social impact of this failure. Analogous lapses in mutual attention can also occur in human–human interactions, for example when individuals are distracted or inattentive, suggesting that these limitations are not unique to HRI. Nevertheless, the default behavior will be chosen to guarantee important safety considerations such as collision avoidance.

A further limitation of the proposed CI mechanism concerns its scalability in environments involving multiple bystanders or groups. Although the method was designed for one-to-one interactions, it could potentially be extended to settings with more than one person. For instance, in a scenario with multiple bystanders, the robot could direct its gaze toward the person whose path is most likely to intersect with its own. However, as suggested by [13], CI also depends on the context and becomes more relevant and necessary in environments with few people and in enclosed spaces. Therefore, further investigation is needed to implement CI in robots across different types of environments.

4 CONCLUSIONS

In this work, we introduced a gaze-based Civil Inattention mechanism as a conceptual approach for supporting socially appropriate robot navigation in human-populated environments. The motivation for this work lies in scenarios where robots are not primarily designed for social interaction but are nonetheless required to move among people respecting social norms and minimizing disruption.

We outlined how brief gaze acknowledgment followed by gaze aversion could serve as a lightweight social signal, inspired by human practices of CI, and discussed how such cues might be integrated into navigation behavior depending on the presence and apparent awareness of nearby humans. Rather than presenting a system-level contribution, this work aims to articulate a design perspective on how gaze could be leveraged to express CI.

The proposed framework builds on prior literature suggesting that acknowledgment cues play a role in social perception and coordination, and it raises questions about how minimal social signals may influence human interpretations of robot behavior. We hope that this work will shed light on the potential role of gaze in social robot navigation and motivate future empirical studies to investigate its effectiveness, limitations, and integration in real-world settings.

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