Augmenting Teamwork through AI Agents as Spatial Collaborators

Mariana Fernandez-Espinosa
mferna23@nd.edu
University of Notre Dame
Notre Dame, Indiana, USA

Diego Gomez-Zara
dgomezara@nd.edu
University of Notre Dame
Notre Dame, Indiana, USA

Abstract

As Augmented Reality (AR) and Artificial Intelligence (AI) continue to converge, new opportunities emerge for AI agents to actively support human collaboration in immersive environments. While prior research has primarily focused on dyadic human-AI interactions, less attention has been given to Human-AI Teams (HATs) in AR, where AI acts as an adaptive teammate rather than a static tool. This position paper takes the perspective of team dynamics and work organization to propose that AI agents in AR should not only interact with individuals but also recognize and respond to team-level needs in real time.

We argue that spatially aware AI agents should dynamically generate the resources necessary for effective collaboration, such as virtual blackboards for brainstorming, mental map models for shared understanding, and memory recall of spatial configurations to enhance knowledge retention and task coordination. This approach moves beyond predefined AI assistance toward context-driven AI interventions that optimize team performance and decision-making.

CCS Concepts: • **Human-centered computing** → **Mixed / augmented reality**; **Empirical studies in HCI**; **Collaborative and social computing theory, concepts and paradigms**; *Collaborative interaction*;

Keywords: Context-Awareness,Augmented Reality, Mixed Reality, Virtual Reality,Large Language Models,Human-AI Interaction

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1 Introduction

Recent advancements in Augmented Reality (AR) devices, such as the Microsoft HoloLens [13], which utilizes gaze-based selection and speech-driven AI assistance, and Meta's Orion [12], which enables ubiquitous and context-aware interactions, have significantly expanded possibilities for collaborative human interactions [10, 25]. These technologies are transforming how teams communicate and collaborate by blending digital and physical environments, enabling more immersive and dynamic team interactions.

Research in Human-Computer Interaction (HCI) has extensively examined how online communication systems impact team dynamics and has proposed diverse solutions to enhance productivity and efficiency in virtual meetings [5, 14, 20]. One such approach is the integration of AI agents, designed to improve coordination, facilitate communication, and support participation. For instance, "MeetingCoach," an automated meeting summarization system [1, 17], detects various behavioral cues in meetings and consolidates them into a post-meeting dashboard to improve understanding of meeting dynamics [18], and "Dittos," a personalized AI agent that replaces team members when they are unavailable [9], demonstrate AI's potential to enhance teamwork in digital settings.

However, AI agents still face significant challenges, particularly in adapting to real-world, multi-user collaboration settings [15, 16]. Most AI systems operate in text-based or static environments [2, 3], limiting their ability to understand spatial relationships, object affordances, and team interactions in dynamic, real-time contexts [24]. This restricts AI's effectiveness in facilitating fluid and adaptive collaboration in immersive environments for team meetings.

1.1 AI Agents in Immersive Environments

To address these challenges, XR researchers advocate for the design of AI agents that are deeply integrated into real-world settings, capable of observing, interacting with, and continuously learning from their surroundings and human collaborators in a dynamic and adaptive manner [6]. A promising application of this approach is the development of LLM-based Non-Player Character (NPC) agents, which have been deployed in video games [7, 8], training simulations [11],

and virtual collaboration spaces [22]. These agents have promised to enhance user engagement by responding to real-time inputs, adapting to human behavior, and facilitating interactive experiences.

Despite these advancements, AI agents in immersive environments still have significant limitations. Current AI-driven systems engage primarily with individuals rather than supporting team-level collaboration, missing the opportunity to leverage capabilities in blending digital and physical environments. Additionally, most AI agents in immersive environments are designed as static assistants, unable to adjust their role dynamically based on team needs. Given that team meetings often involve both remote and in-person participants, AI agents also lack an understanding of proxemics (personal space, team positioning, movement patterns), which directly impacts how they engage in immersive settings.

As team meetings remain a fundamental aspect of organizational work, it is crucial to design AI agents that go beyond one-on-one interactions and instead focus on team behaviors, coordination patterns, and collective decision-making processes. Advancing AI-driven collaboration in immersive environments requires systems that can manage attention across multiple users, facilitate teamwork without disrupting workflows, and dynamically respond to team needs in real-time.

1.2 The Need for AR-Specific AI Agents

While the emerging field of Social VR has provided valuable insights into team behavior in immersive environments [19], limited research has explored these dynamics in Augmented Reality [23]. Existing studies in VR suggest that immersive environments can influence team cohesion, engagement, and trust, but AR presents distinct challenges and affordances that remain largely unexplored [21].

Our prior work [4] examined the differences between teams collaborating using Virtual Reality and those collaborating face-to-face. Specifically, we examined how VR affordances influence team members' closeness to each other when forming the team. Our findings underscored that newcomers meeting in VR felt more included in the team than newcomers meeting face-to-face. Our work suggests that team members' perceptions and collaboration attitudes are shaped by the medium they interact in, rather than solely by interpersonal factors. Thus, we need to expand research beyond VR and into AR, which presents different interaction dynamics, spatial constraints, and opportunities for AI-driven facilitation.

2 Future Work and Workshop Contribution

In our future work, we aim to analyze and leverage AR's spatial computing capabilities in combination with team dynamics analysis to design AI agents that enhance team meetings. These AI agents will function as active collaborators, dynamically generating and adapting supplemental materials to improve communication, coordination, and shared understanding. For instance, AI agents could create virtual blackboards for brainstorming, real-time subtitles for accessibility, or on-demand 3D models to help teams visualize complex concepts. By adapting to team needs in real-time, these AI agents can bridge gaps in understanding, facilitate problem-solving, and enhance collaborative decision-making in immersive AR environments.

2.1 Workshop Contribution

During the workshop, we seek to bring a team-centered perspective, advocating for the real-time design of AI agents for team meetings. We are particularly interested in discussing how AI agents can integrate into AR-based team workflows and contribute to more effective and dynamic collaboration. Additionally, we plan to present early findings from our research on AI agents in mixed reality, contributing to ongoing discussions within the AR and AI research communities.

Building on prior research that has recognized the challenges of virtual and in-person meetings, we propose expanding the discussion to AR environments and addressing the following key research questions:

- RQ1: What are the appropriate designs for AI agents in AR that enhance usability, interaction, and effective team collaboration?
- RQ2: What spatial and proxemic factors should be considered in AR to improve team coordination and engagement?
- RQ3: How should AI agents be embodied in AR to focus on team-level interactions rather than interpersonal, one-on-one engagements?
- RQ4: When and how should AI agents intervene in team workflows within AR? How can they detect when users need assistance without disrupting collaboration?

By shifting the role of AI agents from predefined tools to responsive, context-aware teammates, we can unlock new possibilities for collaborative intelligence in AR environments. Addressing these research questions will be critical for designing AI agents that seamlessly integrate into team workflows, optimize interaction in immersive spaces, and ultimately enhance team performance and decision-making.

Through this discussion, we aim to advance the understanding of AI in AR not just as an interface, but as an active enabler of human-AI team collaboration.

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