EAGER: Cyberlearning with Co-Robotic Teachable Agents

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Fig. 1: Children teaching a robotic agent

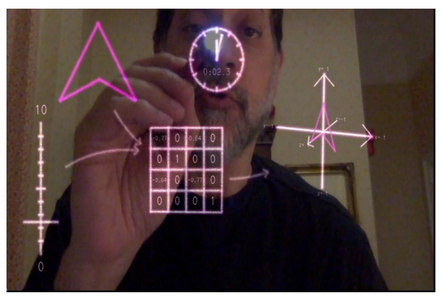

Fig.2: Co-PI Perlin demonstrating Chalktalk

Fig. 3: NSF MRI Holodeck Award # 1626098

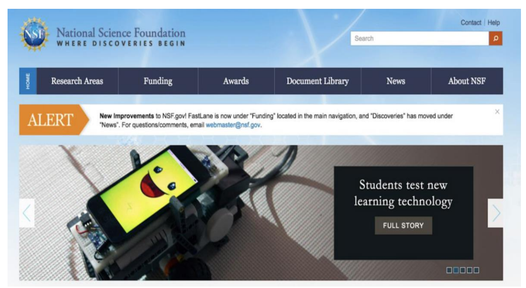

Fig. 4: Robot Quinn – sharing excitement with learners – featured on NSF webpage

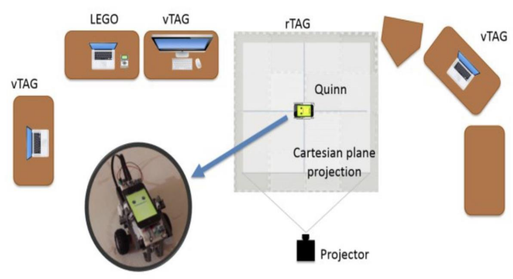

Fig 5. System Architecture

Challenges:

- Teachable agents have emerged from research on how students benefit from tutoring other students
- While there is evidence that these activities are successful at improving programming and robotics skills, the evidence on whether mathematics and science outcomes are improved is less convincing
- Most other efforts using the teachable agent paradigm to date have focused on agents in virtual environments, with few tangible examples
- This research will improve understanding of the unique affordances of a teachable robot with gesture-based interaction, going beyond typical tutoring support

Scientific Impact:

- We will investigate how human-robot teams engage with gesture-based interaction in MR environments, and how these interactions can be enhanced through personalized support that motivate STEM problem-solving.
- We will develop rich models of learners' cognitive and social interactions and improve understanding of how to design diverse perceptual, cognitive and social features for multi-modal physical and virtual teachable robotic agents.
- Our findings on participatory design of ubiquitous co-robotics and MR storytelling and simulation-based interactions will generalize across domains.

Solution:

- We will integrate ChalkTalk, a Mixed Reality (MR) gesture-based storytelling and simulation tool-kit with an advanced Robotic-Teachable Agents for middle school Geometry (R-TAG) cyberlearning research platform
- We will explore how robots and virtual agents can use their multi-modal embodied presence (physical, visual, tactile, spatial, dialogue) and ChalkTalk representations to facilitate learning and team engagement
- We will use methods, measures, and tools to sense and adapt to learners' affective states in ways that promote learning and creativity
- Evaluation will culminate in a summative 2x2 factor experiment investigating: cognitive and social support; cognitive support alone; social support alone, and no support conditions

Broader Impact – Impact on Society

- Our findings on participatory design of ubiquitous co-robotics will generalize across domains.
- This project will create open-source co-robotics cyberlearning tool kits promoted via Educause, CIRCL – The Center for Innovative Research in Cyberlearning, and LEGO Foundation's Global Learning through Play network

Broader Impact – Education and Outreach

- Development of teacher professional growth opportunities that support increased attention to robotics in school settings
- Development and evaluation of education strategies to broaden participation of students from groups underrepresented in education pathways to careers in robotics

Broader Impact- Quantified Potential Impact

- With Rio School District we will engage hundreds of minority and underserved middle school students in collaborative STEM cyberlearning activities
- We will integrate components using NSF Holodeck and its Corelink low-latency open source messaging protocol to foster collaboration and reproducibility across the Nation

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