

# Carnegie Mellon University

## ProSEED/Crosswalk Seed Grant – 2018

Project Title: Holographic Archive of Research Projects @ Carnegie Mellon University (HARP @ CMU)

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Investigator 2: Zhen Bai (Post-Doc Fellow, Human-Computer Interaction Institute)

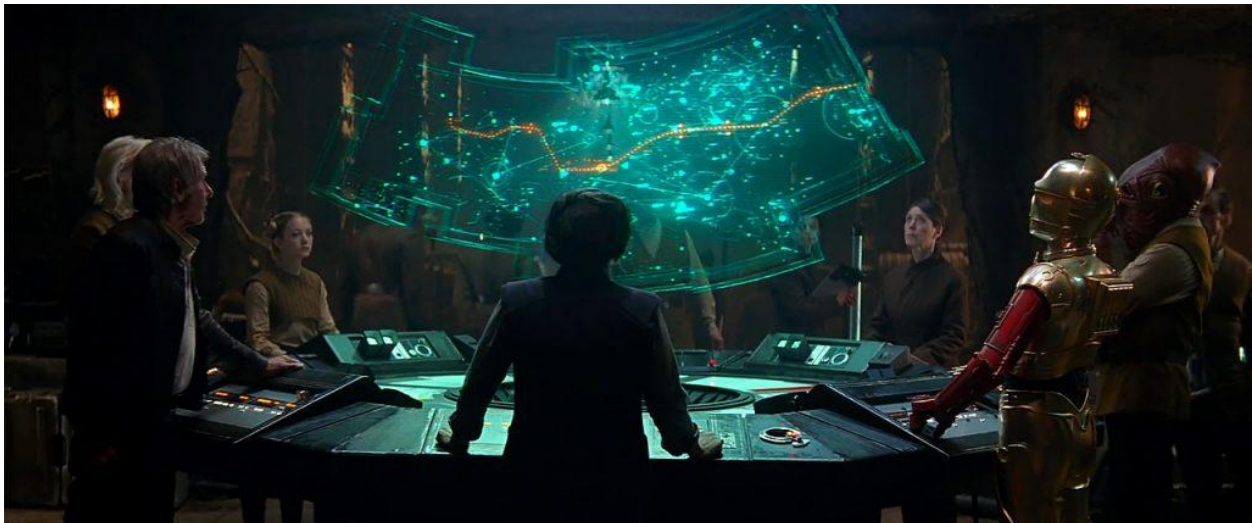
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### ***Abstract:***

Holographic Archive of Research Projects @ Carnegie Mellon University (HARP@CMU) is a digital library of several hundred past research projects from all schools and disciplines, guided by a socially-aware humanoid virtual agent, displayed on a large custom 360 holographic display, where students, faculty, and guests can explore the rich history of interdisciplinary academic research conducted at the university. Leveraging state-of-the-art social AI technologies that the ArticuLab, Language Technologies Institute and Human-Computer Interaction Institute has explored, and holographic augmented reality techniques that a group of students of Computer Science and Arts (Computer Science and Arts) and Entertainment Technology Center (ETC) prototyped, we will newly develop the agent mediated library platform permanently installed in an accessible, popular and highly visible location on campus.



*This scene from Star Wars Episode VII: The Force Awakens illustrates the potential setup of the exhibit.*

***Total funding request: \$2500***

## PROJECT NARRATIVE

### **How the proposed initiative involves and impacts multiple disciplines and communities inside and outside of CMU:**

Post-Doctoral Fellows from the Articulab and Language Technologies Institute and Human-Computer Interaction Institute will create a socially-aware humanoid virtual agent to guide viewers across the spectrum of cool projects at CMU. One of their past prominent projects is SARA, Socially-Aware Robot Assistant (<http://articulab.hcii.cs.cmu.edu/projects/sara/>), led by Yoichi Matsuyama (Primary Investigator), which can build a relationship with a user and then employ that relationship to better achieve the user's goals. SARA is an embodied intelligent personal assistant that analyzes the user's visual (head and face movement), vocal (acoustic features), and verbal (conversational strategies) behaviors to estimate the level of interpersonal closeness that the user feels for the system, all in real time. The system then generates its own appropriate vocal, nonverbal, and verbal behaviors to maintain or increase interpersonal closeness in a way that encourages the user to disclose information that will allow the system to better serve the user's goals. In this HARP project, SARA's dialogue modules will be applied for the library guidance task domain. Another important work of them is SCIPR, Sensing Curiosity in Play and Responding (<http://articulab.hcii.cs.cmu.edu/projects/scipr/>), led by Zhen Bai (Investigator 2). Curiosity inspires people to study your favorite subjects, and stay up late nights reading about topics they're passionate about. She and her team is developing an intelligent virtual child that will evoke curiosity, exploration, and self-efficacy through collaboration in a playful learning environment. For this project, multiparty interaction management and curiosity models will be integrated.

John Choi, a Research Assistant from Computer Science and Arts (Investigator 3), will lead the development of the holographic display platform. He has developed an early holographic display prototype using a microgrant from the Frank-Ratchye STUDIO for Creative Inquiry.

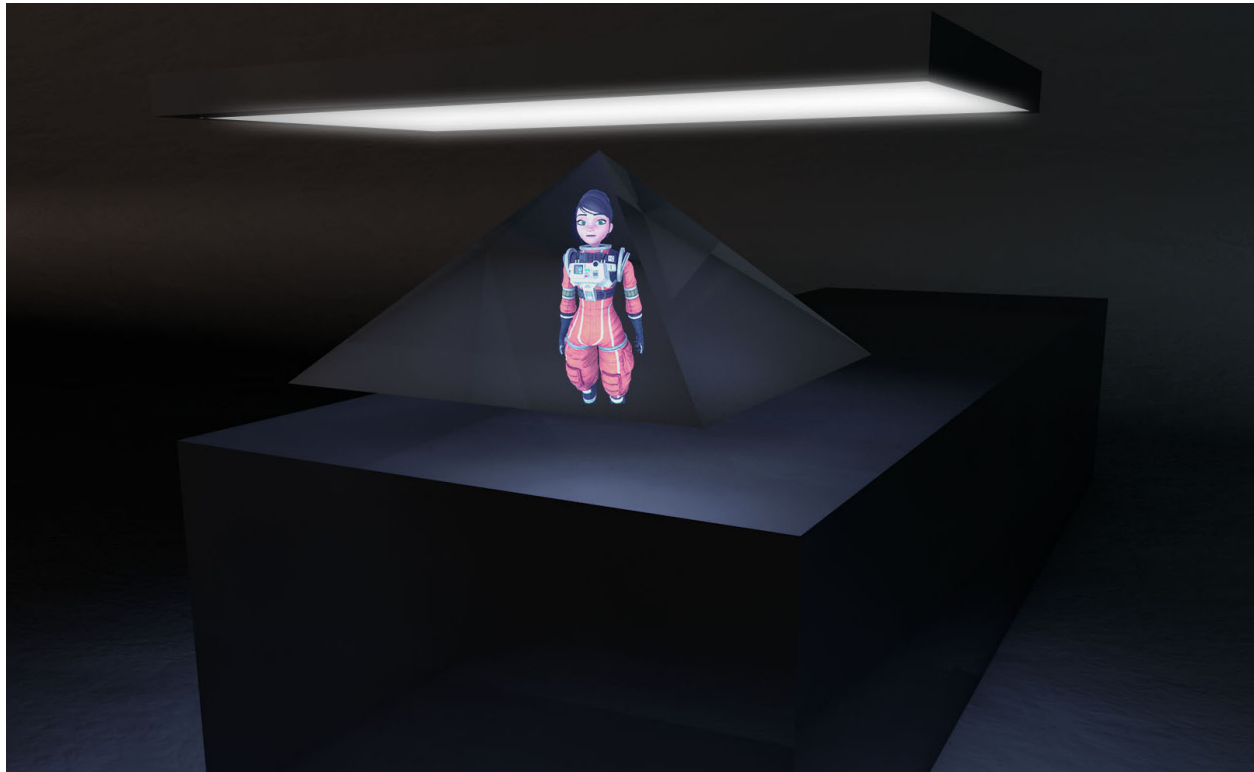
Masters students from the Entertainment Technology Center will work on various aspects of the game design, interface design, character design and computer graphics for the virtual agent and the holographic display. Undergraduates from the Human Computer Interaction Institute will also help the team with creating a highly interactive and immersive user interface that makes use of 360-degree hologram technology in a novel and intuitive way.

In terms of content of the holographic archive, after the platform development, we will interview and collect hundreds of summaries, names of research members, public images and 3D models of various projects from all across the university, with departments ranging from the School of Art, the Robotics Institute, the School of Drama, the School of Business, the Carnegie Institute of Technology, Mellon College of Science, the School of Computer Science and more. In this way, the project is expected to initiate multi-disciplinary collaboration and inspiration across the CMU campus.

### **How the proposed initiative is NEW and innovative:**

There are many cool public robotics and tech exhibits across campus like the Scrabble Robot in Gates, the body tracking information display in the University Center, and the Roboceptionist in Newell Simon Hall. We want to take this a step further by introducing novel open-source holographic display technologies to showcase a wide range of projects from various departments at CMU in a popular and accessible exhibit. Currently, the only collection of the coolest research projects at CMU is housed in the official CMU website, with other projects archived within the independent repositories of their respective departments. In the SARA project, we have built an original knowledge base of the CMU research resources, including faculty information, academic course information and research lab information, that can be retrieved through natural dialogues. We will extend this dialogue-based information retrieval framework to the digital library application.

In addition, there are no cool holograms on campus. CMU could make use of one to further showcase how awesome it is in the pushing the boundaries of technology while intersecting it with other disciplines in meaning ways.



*A rendered image of the virtual character on the HARP platform*

**Desired OUTCOMES from the project:**

The immediate outcome would be that CMU gets an interactive holographic display to showcase its multi-disciplinary research in a publicly accessible format that all guests, students and faculty can enjoy. New students, faculty, and visiting guests get to learn about CMU's rich culture, maps, projects, traditions, departments and history via an interactive holographic display. And finally, dozens of obscure but amazing research projects get local, in-campus exposure and showcasing their work among their peers via an attractive, high-tech augmented reality holographic display platform, further connecting the campus community.

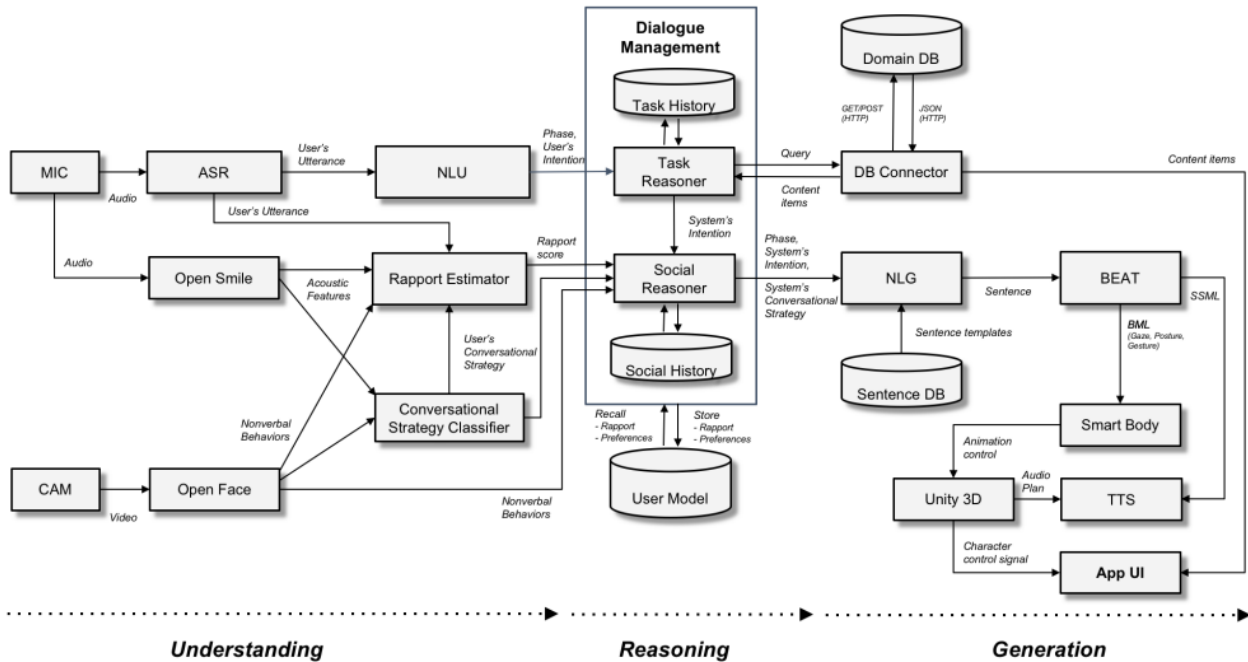
**METRICS we will use to determine whether we have met our desired outcomes:**

The holographic display device will collect and track anonymous usage data containing types of queries, usage statistics and more to gauge the quality and quantity of user interaction (we plan to submit an application to the IRB before the exhibition). This anonymized usage data will then be analyzed and measured to determine the number and depth of impressions made between members of CMU. More specifically, we will evaluate the performance of the system with some objective metrics such as frequency of the usage, guests' returning rate, recommendation item acceptance rate. We will also acquire guests' overall satisfaction via surveys. Within the first year of launching of the holographic display, we estimate the device will have been used several tens of thousands of times.

**How will the initiative be sustained beyond the initial term of the Crosswalk grant?**

Once the initial technology is built and the holographic display exhibit deployed, the system's library software will be designed in such a way that long-term maintenance and updates to the project repository

is simple and easy. As the research being conducted at Carnegie Mellon University is an ever-growing tree of knowledge, we intend to commit a few members of our team to continuously update the hologram's repository of awesome research projects over time.



*Socially Aware Agent Architecture that will be extended for the HARP*

**How we will seek additional funding to help expand the impact of your initiative?**

In the past, we have been awarded grants from various corporations such as the World Economic Forum to develop SARA, Yahoo!/Verizon to develop a mobile version of SARA. Recently, Microsoft has awarded a grant to us to develop a new, modernized Roboceptionist utilizing the very of best of Microsoft's technologies such as Azure Cognitive Services, the Surface Hub, the Kinect and more. They have also been awarded Google Cloud credits (more than \$50K) for intensive machine learning research. This year, we plan to submit a major research grant proposal to National Science Foundation (NSF) about intelligent cognitive agents, as well as Amazon Cloud credits for Research for computing resource, which should expand the capability of the HARP in general.

***Project Timeline: Do not exceed 1 page (letter size, minimum 11pt font, single spaced, 1" margins)***

### **SUMMER 2018**

**Build hologram hardware (May - June, 2018) :** Based on the early prototype funded by the Frank-Ratchye STUDIO for Creative Inquiry (please see the “Other Resources and Current Support” section), we will develop the holographic display hardware with the devices we are requesting in the ‘Budget‘ section.

**Find location to display hologram (July, 2018):** We will find several locations by consulting the Campus Design and Facility Development (we have discussed potential locations with the staffs).

**Get IRB approval for collection of usage data (July, 2018):** In order to obey the data security and privacy policy of CMU, we will seriously consider the data storage and post-processing by consulting the University Registrar division who manages student privacy, data stewardship and governance, academic policy, academic calendars, and university learning spaces. Also, we will contact other legal advisors before submitting an IRB application.

### **FALL 2018**

**Integrate current SARA Project with Hologram display (July - September, 2018):** We will extend the current SARA platform by creating new modules of natural language understanding, dialogue management, and natural language generation. We will also add some essential modules for this environmental situation, such as a multimodal turn-taking and attention modules to handle multiple guests surrounding the HARP display.

**Interview research labs, professors, and graduate students about their projects (October, 2018):** After finishing the platform development, we will approach research labs, professors, and graduate students who may potentially be interested in showcasing own project. We will determine the content format used for the HARP display.

### **SPRING 2019**

**Collect anonymous usage data (November - March, 2018):** With some initial content, we will start exhibiting the HARP demo in the determined location from Fall.

**Create analysis of data and report metrics to ProSEED (March, 2019):** After 3 months exhibition, we will conduct analysis of the usage of HARP, and summarize the statistics as a report for ProSEED.

**Budget: Do not exceed 2 pages (letter size, minimum 11pt font, single spaced, 1” margins)**

All of the grant funds from the ProSEED-Crosswalk grant will be allocated to the purchase of parts and equipment needed to fabricate the parts of the holographic display platform and table. The holographic display is based on a tried-and-true technique called the “Pepper’s Ghost pyramid,” and requires some common display items to work properly.

The major part expenses and justifications are listed below:

**PETG Clear Sheet 3/16x48x96 (172.17)** <https://www.acmeplastics.com/pet-g/pet-g-clear-sheet>  
This item creates the reflective holographic display panel pyramid frame.

**1/2x48in Strip Heater (295)** <https://www.abbeon.com/Item--i-1900>  
This item is needed to bend clear plastic PETG sheets in clean 90-degree angles.

**Weld-On 4 Acrylic Adhesive with Applicator (13.05)**  
<https://www.amazon.com/Weld-Acrylic-Adhesive-Applicator-Bottle/dp/B0096TWKCW>  
This item is needed to glue the plastic frame parts together

**LG TV 55in 4K (499)** <https://www.amazon.com/LG-Electronics-55UJ6300-55-Inch-Ultra/dp/B01N39OF7M> This item is needed to generate the holographic image for projection.

**Dell 21.5in Touch Monitor (262.09)** <https://www.amazon.com/Dell-S2240T-21-5-Inch-LED-lit-Monitor/dp/B00CTODKIO> This item is needed as a touchscreen display user input device.

**Dell Single Monitor Arm Stand (93.30)** <https://www.amazon.com/Dell-MSA14-Single-Monitor-MH1HV/dp/B00C6CMZVC> This item is needed to mount the touchscreen display input device.

**8020 Aluminum Extrusion Parts (Est 300.00)** <https://www.8020.net/>  
Various Framing parts to create the vertical hanging mount for the downwards TV projector.

**4x Saucer Chairs (35 x 4 = 140.00)** <https://www.walmart.com/ip/Mainstays-Faux-Fur-Saucer-Chair-Available-in-Multiple-Colors/24016997> Needed for user interaction comfort.

**Theydon Coffee Table (177.99)**  
<https://www.allmodern.com/furniture/pdp/theydon-coffee-table-wlao1301.html?piid=25903003>  
Needed to place the hologram pyramid on top.

**ASUS VivoMini PC 8GB / 3.1 GHZ / 1TB HDD (548.89)**  
<https://www.amazon.com/VM65N-G063Z-VivoMini-i5-7200U-GeForce-Graphics/dp/B06WV7N9FX>  
This item runs the real-time holographic display software, user input and artificial intelligence.

***Other Resources and Current Support: Do not exceed 1 page (letter size, minimum 11pt font, single spaced, 1” margins)***

The investigators have rich research background in human-computer interaction, 3D graphics, intelligent agent, robotics and human behavior research. They have established connections with several capstone and independent study programs with HCII, CS and ETC, and have supervised 30+ undergraduate and graduate level students to work together in building innovative interactive interface for inquiry-based group exploration. The system development can take place in the lab space.

We have received a generous microgrant from the Frank-Ratchye STUDIO for Creative Inquiry to develop a small prototype of the holographic display technology, which we are pleased to announce that it works like a charm.



*Image of functional prototype developed with microgrant from the STUDIO for Creative Inquiry.*

SARA benefits from generous funding from a Microsoft faculty research award and a Microsoft equipment donation, a gift from LivePerson, support from the IT R&D program of MSIP/IITP [2017-0-00255, Autonomous digital companion development], and a Google Faculty Award and significant donation of Google Cloud Platform tools. SARA was presented at the World Economic Forum (WEF) Annual Meeting in Davos (January 17-20, 2017), and World Economic Forum Annual Meeting of New Champions, in Tianjin, China (June 26-28, 2016).

SCIPR project is generously funded by Heinz Family Foundation.

**References: Do not exceed 1 page (letter size, minimum 11pt font, single spaced, 1" margins)**

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### **SARA: Socially Aware Robot Assistant**

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### **SCIPR: Sensing Curiosity in Play and Responding**

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