Conceptualizing the Design and Use of Augmented Reality Within a Common Operating Picture for Incident Command Systems

Project Definition and Scope

For **Indiana University Crisis Technologies Innovation Lab** and **Director of User Experience, Sonny Kirkley**

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Summary of Project

The Indiana University Crisis Technologies Innovation Lab (IUCTIL) is in the process of developing an augmented reality (AR) design system that assists both incident commanders and first responders in resolving emergency situations in an efficient manner. The future innovations and use of AR within heads-up displays (HUDs) have already proven to be a viable asset in many hands-on industries. Utilizing research and data from interviews, cognitive analysis, and other user experience design techniques, we are looking to uncover what most incident command operators are wanting in a futuristic environment that incorporates the use of AR. Features, workflows, client requirements, and proper contextual user-centered design will be at the forefront of recommendations to a design and development team that will create prototypes. The anticipated research and work from this project will impact the following:

- Demonstrate the value of precise location-tracking, asset management, and other necessary data within incident commander workflows
- Demonstrate the value of using AR in emergency scenarios to assist with situational awareness and decision making while saving more lives compared to conventional measures
- Generate user interface and experience design criteria and requirements for an augmented reality interface
- Recommend a standardized interface and design restraints from requirements set by incident commanders and first responders

Incident command personnel will be the focus of this project; specifically, commanders that work directly with first responders. Understanding their workflows, problems, and goals will be paramount to our research on using augmented reality when performing duties.

The Project Goals

To accurately conceptualize and recognize the user experience in augmented reality for incident commanders, five (5) main goals have been defined:

1. **Understand the current workflow of incident commanders in emergencies**
    a. The current toolsets being used, the steps taken to accomplish tasks, finding the data and information necessary to achieve goals, and other potential cognitive processes involved
    b. Understanding AR is secondary—this is not our focus when receiving user feedback
    c. Attempt to fix problems that incident commanders have when responding to emergencies and propose solutions

2. **Learn what smart-tracking or indoor location-tracking interfaces and ideas would benefit incident commanders**
    a. Investigate the data that is useful to the incident commander and determine how detailed it needs to be
    b. Discover the usefulness of their current toolset and how future effort can iterate and improve upon the incident commander's productivity and flow
    c. Explore what information is currently available for an incident commander during an emergency and uncover any unknown data points that would be beneficial

3. **Investigate the use of location-tracking and other techniques to assist in workflow enhancement**
    a. Demonstrate the value of highly accurate location-tracking in workflows
    b. Validate the use of AR in these settings to assist with situational awareness and decision making
    c. Research if AR can assist current incident commander workflow regarding role assignment, asset management, and resource allocation with a heavy emphasis on location-tracking

4. **Research the benefits of augmented reality interfaces and controls when creating common operational pictures (COP)**
    a. Identify current processes, designs, and tasks that COP applications utilize
    b. Explore tools that handle COP workflows and understand why or how they deliver experiences for their users
    c. Investigate the addition of AR within these interfaces and tools to verify advantages and disadvantages
    d. Discover if modern AR concepts have enhanced experiences for their userbases, particularly for indoor location-tracking, command and control, and other similar situations, such as emergency response

5. **Gather enough ideas and concepts to easily hand-off user interface requirements to an external development team**
    a. Prepare UX design criteria with AR techniques at the forefront
    b. Create workflows for designers and developers to build and materialize
    c. Deeply understand user workflows and how AR would best fit within them
    d. Design AR specific features and functionality at a prototyping level
    e. Find the high-value tasks in incident command workflows and capture them accurately for AR experience purposes

These outlined goals will keep our focus and priorities on client requirements while delivering detailed recommendations about our target user base.

Expected Activities and Deliverables

For each of our project goal's success, multiple activities and deliverables have been identified. The efforts will range from collecting various sets of data and research, conducting interviews with multiple subject matter experts, and developing documents that will help the next team understand what users will require in their workflows and tasks.

1. **Interviews with subject matter experts**
    a. Conduct seven (7) or more interviews
    b. Initial interview will assist in further defining the scope of the project
    c. Second interview will target our users' workflows and understanding their wants, needs, and problems
    d. Third interview will help define persona attributes, needs, wants, and problems
    e. Fourth interview will be explicitly about task-analysis and investigating what works well, what doesn't work well, and what can be improved
    f. The fifth interview will be about reviewing all effort completed with an expert and assist with creating suitable scenarios and storyboards
    g. Two (2) interviews will be conducted with a subject matter expert who is involved in the augmented reality space and has an understanding of how AR can help ICS; may also get more industry connections from these interviews as well
    h. All interviews will attempt to help understand workflows of emergency personnel, information that is necessary or beneficial for the actual user, and conceptualize modern interfaces that can use AR to enhance experiences
    i. Visit in-person the various facilities that today's incident commanders will use when responding to emergency situations or large events

2. **Task analysis document**
    a. A task analysis document will be created to understand how our users are affected by their environment and assess where their actions could be simplified.
    b. Identify areas of opportunity for AR to assist and innovate in their process
    c. Gain insightful information about tasks and outcomes currently in a user's workflow

3. **Persona development**
    a. Three (3) unique personas will be developed
    b. Each persona will be idealized as personnel on different command levels in an incident command system hierarchy
    c. These personas will help future developers understand the types of users that are envisioned to use this technology and help guide their team in the right direction

4. **Affinity map**
    a. Using an affinity map will help organize findings, ideas, and pursue concepts uncovered throughout the project

b. The affinity map will assist in defining common themes through qualitative data gathered from the informal interviews conducted. This data will be used to help create personas that will enable designers to greater empathize with the future end users

5. **Empathy map**
   a. An empathy map will guide us through visualizing our target users' behaviors and create a deeper understanding of their mindset
   b. An empathy map will facilitate a shared understanding of the users' needs and perspectives among the design team and client

6. **Experience map**
   a. The experience of what the user goes through when accomplishing tasks and goals will need to be properly visualized through the use of an experience map
   b. The experience map will serve to illustrate the user's journey through an emergency scenario using AR technology. The map will be used by future designers to empathize with the users and recognize the key parts in the user's journey that are impacted by the design

7. **Scenarios and storyboards**
   a. Scenarios will help with predictions on user behavior while delivering potential experiences and interactions
   b. To help properly explain a journey (story) the user participates in, storyboards can give a visual representation. The story boards will be used to demonstrate the value of using AR technology to enhance situational awareness

8. **Tree-testing**
   a. A tree test will be prepared to discover any usability or findability issues within smaller pieces of an interface
   b. Evaluation of users performing tasks on mock navigations
   c. Explore different exploration outcomes that would benefit users in completing a task

9. **Secondary literature review**
   a. Reviewing previous research will uncover solutions and problems that other research teams have encountered. Some examples of this research include:
      - A framework for AR Usability Evaluation in the public safety communication research realm (**PSCR 2021: Augmented-Reality (AR) Usability Evaluation Framework for PSCR**)
      - Presents grants and funding opportunities for AR in public safety communications research, as well as descriptions of ongoing projects (**PSIAP Augmented Reality (AR) Funding Opportunity**)
      - Research portfolio for User Interface / User Experience work with the public safety community (**NIST User Interface/User Experience Research Portfolio**)

- Description of the CHARIoT Challenge in which participants built AR interfaces or IoT data emulators for first responder communications (**2020 CHARIoT Challenge: Advancing First Responder Communications**)
- A roadmap for planning public safety communications research (**Public Safety User Interface R&D Roadmap**)

10. Work/activity models

a. Demonstrate how the system would work in real life
b. Help the development team clarify user requirements and define the system architecture

11. User Interface Requirements Document

a. After analyzing tasks, feedback, and other requirements, a document will be created to help guide future development teams
b. Various user interface designs that are proven necessary for the user will be recommended
c. The document will contain research artifacts, such as the personas, empathy map, experience map, and more, to enable future designers to grasp the context for which they will be designing. In addition, the document will include an activity model to demonstrate the product's intended workflow and what features should be designed

The expected activities and deliverables will assist in developing a better understanding and thought process for the design and development team in their effort on creating viable features and prototypes.

The Project Timeline

Four Phases, January 31 – May 2

The expected timeline has been outlined for the next four months and broken out into individual phases. All actions and deliverables are tentative. If any changes or updates happen, the timeline will be refreshed accordingly.

PHASE 1 *January 31 – February 21*	
ACTIONS	**DELIVERABLES**

• Continue reviewing secondary literature and researching applicable material
• Perform interview with subject matter expert utilizing a developed protocol in collaboration with a different team
• Update the project definition and scope from feedback given within interview and from client
• Create the first interim report on success and failures for the project
	• January 31
	  ○ Initial draft of Project Definition and Scope
	• February 11
	  ○ Complete interview with Subject Matter Expert
	• February 21
	  ○ Revised Project Definition and Scope
	• February 23
	  ○ 1st Interim Report

PHASE 2

February 22 – March 15

ACTIONS	DELIVERABLES

• Pursue a second interview with a knowledgeable candidate that can help define our future persona attributes, wants, goals, and problems
• Invited to a tour of the IMPD's incident command center to get a better understanding of our user's environment
• Develop an affinity map based off research and interview feedback
• Connect with and interview with a leading expert in AR tech with an emphasis in incident command systems
• Develop two (2) unique personas that are representations of users within an incident command structure
• Develop an empathy map for each persona that targets four main areas: what things they are saying, thinking, doing, and feeling
• Produce a second interim report and potentially update project definition and scope
	• February 25
	  ○ Complete interview with focus on building personas
	• March 2
	  ○ Tour of Incident Command Center
	• March 5
	  ○ Affinity Map
	• March 8
	  ○ Interview with AR subject matter expert
	• March 10
	  ○ Empathy Map
	• March 13
	  ○ Personas Document
	• March 14
	  ○ 2nd Interim Report

PHASE 3

March 16 – April 6

ACTIONS	DELIVERABLES

• Complete an interview, based on questions about incident command task analysis
• Complete the second interview with the AR subject matter expert on more specifics with what is being fielded today
• Produce a diagram detailing our findings and examples when performing task analysis
• Based off the last interview and research, produce scenarios and storyboards that help conceptualize the incident command workflow in AR
• With scenarios and storyboarding in hand, develop an experience map that will assist in identifying major processes and problems that can occur during this workflow
• Produce a third interim report and potentially update project definition and scope
	• March 18
	  ○ Complete interview with focus on task analysis and scenarios
	• March 22
	  ○ Complete second interview with AR subject matter expert
	• March 22
	  ○ Task Analysis Diagram
	• March 25
	  ○ Scenarios
	  ○ Storyboarding
	• March 27
	  ○ Experience Map
	• April 4
	  ○ 3rd Interim Report

PHASE 4

April 7 – May 2

ACTIONS	DELIVERABLES

• Using subject matter experts from previous interviews, complete a feedback session based on concept art and ideas produced by past groups
• With everything completed thus far, create a work/activity model document that pinpoints all the necessary flows and variables within an incident commander's workflow
• Produce our fourth and final interim report with findings and updates
• In addition to the work/activity model, perform tree testing on prototypes, sketches, or wireframes. Depending on the results, research user feedback and create a document detailing pros and cons. This will be presented to a subject matter expert for testing purposes
• Since this research is being handed off to an external team, develop user interface requirements that will explain all visual and interactive experiences necessary for the incident commander. This effort will build on previous research and create/innovate where there are gaps
• Present all the research, findings, and ideas in one final report and presentation
	• April 8
	  ○ Feedback session on concept art and ideas
	• April 14
	  ○ Work/Activity Model Document
	• April 15
	  ○ Tree-testing concepts and prototypes
	• April 25
	  ○ 4th Interim Report
	• April 29
	  ○ User Interface Requirements Document
	• May 2
	  ○ Final Report and Presentation of Research

Conclusion

Our team is excited to explore the first responder’s cognitive work flow during times of crisis to analyze how many enhancements can be completed regarding their situational awareness. First responders and other emergency personnel place their own lives on the line every day to assist the general public. Our belief is that augmented reality interfaces and controls can assist in streamlining their processes with innovative technology and utilizing modern concepts. We hope the future of our work results in saving the lives of many for generations to come.