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Viability of Augmented Content for Field Policing

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ABSTRACT

This paper describes the design and evaluation of a prototype for mobile information provisioning in augmented reality (AR) for field officers of the Dutch police. Five different fictional cases were constructed in cooperation with officers from the Dutch police. These cases were comprised of dynamic as well as static hotspots that would occur naturally during field work. Three different versions of the early prototype were tested using the method of heuristic evaluation. The application was shown to three experts from two police departments. Evaluation of the heuristics, possible future improvements as well as AR viability considerations for field policing are discussed.

Index Terms: Human-centered computing—Interaction paradigms—Mixed/augmented reality—; Human-centered computing—HCI design and evaluation methods—Usability testing

1 INTRODUCTION

In the domain of field policing fast delivery and processing of high quality information is of great concern. Over the past decade mobile applications have enhanced the information delivery to field officers in a myriad of ways, all while having the user interact with traditional two-dimensional interfaces. New information technology has made it's entry into the pocket of the 21st century field officer. From location based information services to mobile reporting possibilities, the Dutch police has adopted many of the technologies found in everyday consumer applications.

Increased computing power of smartphones and high resolution cameras enable the anchoring of virtual elements in three dimensional space even in mobile applications. Adding the additional information layer of AR, we can make the case for added value in the possibly quicker identification of relevant objects in space. Marking a fleeing suspect or indicating the exact location of crime hotspots could theoretically aid officers by utilizing spatial information. Further, the question of whether or not anchoring information in space, that is not of spatial nature, can have a positive effect remains to be answered. Associating information, usually displayed in simple two-dimensional interfaces, anchored to the point of interest could have a measurable impact on speed of information processing.

2 RELATED WORK

Augmented Reality (AR) has long found its way into consumer applications with applications like *Pokemon GO* and *Ikea Place* having achieved widespread success. Entertainment as well as serious games have been utilizing AR widely as early as 2005 [11]. In the domain of industry applications, wide-spread use has been more conservative [12]. There is a growing body of research recognizing the opportunities and challenges of implementing AR systems for other uses than pure entertainment, e.g. in the fields of education [13], remote maintenance and repair [3], medical training [10] or manufacturing [6].

For the domain of policing, and more specifically field policing, research efforts have been scarce. Crime scene analyses aided by AR technology has been one of the more explored topics in the field. Streefkerk et al. [9] pointed out the possible benefits in orientation and collection of evidence, using AR to tag and share evidence information with augmented labels. Similarly, Poelman et al. [8] used AR to have investigators obtain support remotely by experts, which enabled spatial collaboration. There has been evidence to suggest that AR does serve as a possibly valuable technology in the security domain for information exchange [2] and has further been shown to improve situational awareness of remote experts [5]. With the availability of quick and adequate information being a necessity in the security domain [4], the potential of AR as an additional information layer needs to be investigated. As recognized by Cowper and Buerger [1], AR could be a promising technology not only for crime scene investigations, but further be applied to training, supervision, strike team operations and field policing.

With virtually no research having been conducted on AR in the context of field policing, the question of which information could be enriched with the use of AR elements, and which should rather stay in traditional interfaces, remains to be answered. With the development of a mobile AR application we want to investigate the viability of such interfaces for the work of field officers by evaluating an early prototype utilizing AR information representation. This is done to (1) assess the general viability of AR for the police force, (2) inform further iterations of the application and (3) identify content that potentially benefits from being visualized in an AR interface.

3 SYSTEM AND APPLICATION-FLOW

The system is comprised of a smartwatch (LG-Urbane), a smartphone (Samsung Galaxy S7) running the application and an external camera connected via an OTG adapter to the smartphone. The application is designed to recognize static, as well as dynamic, points of interest (POI) using the external camera and alert the officers. Static points of interest are also called hotspots within the police and describe specific locations with high probability of criminal activity that need to be patrolled systematically. Dynamic points of interest can be cars or people, which are dynamic due to not being fixed in their position.

The fictional cases prepared for this paper present officers with two static hotspots and three dynamic hotspots (one car, two persons). Although the cases are fictional, they were designed in collaboration with officers and resemble real cases that would warrant action when encountered in the field. Making the cases actionable will ensure that later situational awareness measures, which are not sensitive enough for minute changes during the assessment of a situation, can detect changes brought upon by AR. Mimicking natural feature detection, the external camera simulates the detection of faces, license plates and points of interest using fiducial markers (type DICT-4x4-50) placed on the POIs. Upon detection within a ten meter range, the phone will play an audible sound to alert the officer. A notification is further also displayed on the worn smart-watch to allow the officer to easily obtain information about the POI by looking at his wrist.

An example (of a person POI) that visualizes the following description of the application flow can be found in Figure 1. Upon unlocking the phone a dialogue is opened to present the officer with the option to either locate the detected POI or neglect it. If the officer decides to locate the detected POI, by tapping the "Markeer persoon" prompt

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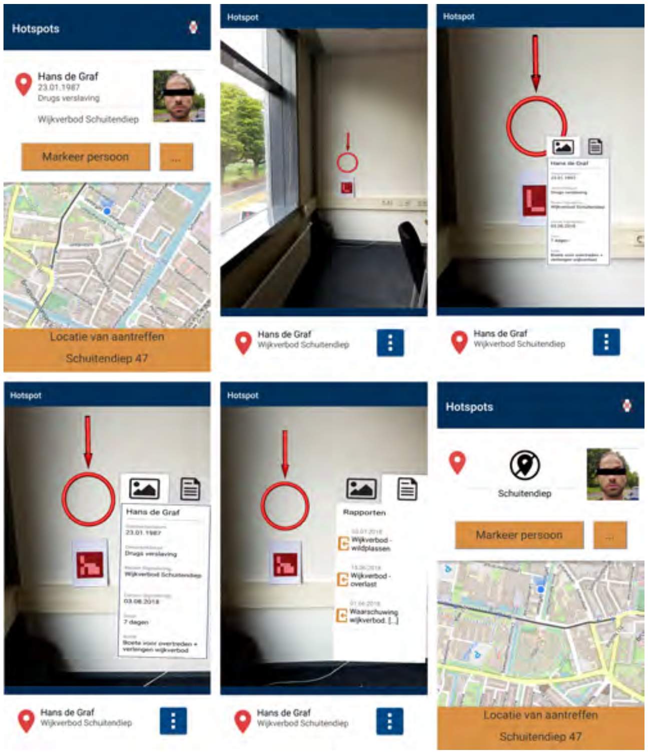

Figure 1: Example screens of person a POI. The screens show examples of (1) the main screen after detection, (2) the navigation indicators (ten to five meters), (3) the additional information panels (five to zero meters), (4) the information panel as part of the 2D UI (AR version 2), (5) the reports panel as part of the 2D UI (AR version 2) and (6) the main screen after detection for AR version 3.

on the screen, he will enter one of two AR modes (depending on the distance to the POI). At a distance of ten to five meters (to the POI) the application augments identification aids, in the form of a circle and arrow, on top and above the POI by utilizing the camera feed of the smartphone itself. Only minimal information is given at the bottom of the screen. In the range of five to zero meters distance, the application will additionally display an information panel augmented in space next to the POI. This panel was designed together with the Dutch police and provides all the information necessary in order to be able to make an operative decision. Additionally, at the top of the panel the user can switch information tabs to view past reports that have been filed for this POI. Using the blue button at the bottom right corner, the officer can open a dialogue to start filing a report about the incident and attach a photo. The general application flow as described here applies to all cases used in this study and only differs in the types of information per POI type.

4 AR Modes

The application was tested using three different versions, altering the way AR elements and information was displayed (see Figure 1). Version one augments all necessary information on a panel anchored to the POI. This means that while the rotation on the z-axis adjusts to face the user (to make it readable from all angles), the panel transforms according to the distance and position of the camera to augment it in a fixed position. In version two the panel is displayed as a two-dimensional interface element, i.e. it is not augmented in three dimensional space. All other components, including the spatial identification aids, remain constant to version one. The third version was designed to minimize textual information as much as possible

Figure 2: Expert deliberations during test in Groningen.

by replacing text with symbols that are in line with currently used symbology in regular police work.

The different AR modes represent different kinds and breadths of information to assess the best modes for quick information processing for future iterations. Version one combines the current standard breadth of relevant information availability in textual form, while introducing augmented identification (circle and arrow) as well as information elements. Version two only augments elements that communicate spatial information, i.e. the two identification markers, while keeping general information on the panel part of the standard user interface. The third version serves to decrease information availability and has officers rely on the system as much as possible, with heavy use of symbols instead of text.

5 Methodology

Expert evaluators, i.e. experienced officers, were used to assess the application. For this study the method of heuristic evaluation [7] was chosen. Given the small sample size, quantitative methods were deemed not suitable. The set of ten heuristics used in this method help to identify problems in usability and user experience that can be utilized to further inform later iterations. Structured interviews further aided to gather qualitative data.

During the evaluation the procedure was as follows. First, all experts present were given an overview of the procedure as described here and the ten heuristics were explained to them thoroughly. Afterwards, each user went through the application two times individually. During the first run-through the expert could get used to the general layout and functionality. The second time around the expert had a better overview of how individual pieces fit together, making the testcase resemble real life application of the system more appropriately. After the second run-through the experts were given a sheet to write down whether or not they think the applications fulfills the heuristics and what could be improved. After the individual assessments were recorded, the researcher demonstrated the application again to all experts together. Open discussion was encouraged and printouts of the application screens were provided to facilitate discussion (see Figure 2). The aforementioned procedure was conducted in its entirety for all three AR versions described previously.

6 Results

A total of three experts evaluated the application; two from Groningen and one from Dordrecht. Each heuristic was evaluated four times (three individual ratings and one collaborative effort) to gain a consensus about the most important pitfalls and benefits of the application. Below are the summaries of the results for each heuristic as taken from the filled out forms and the structured interviews:

- Visibility of system status:
  The system status is communicated clearly throughout, due to the linear structure of the application flow. The text displayed on panels should use a bigger font size to increase readability. Version three was evaluated as less comprehensive, since too many symbols with ambiguous meaning were used.

- Match between system and real world:
  All terminology, and the order of actions, reflect police work adequately. The symbols, again, were deemed unsuitable for police work, since they are too simplistic to convey complex information that is needed for operative decisions.

- User control and freedom:
  The application left experts feeling in control and they especially remarked the ease of switching between info and report panels. A possible source of error was seen in the inability to undo actions.

- Consistency and standards:
  The consistency for the application throughout cases is high, thanks to the functionality being only slightly adapted, with regards to content, between cases. Using symbols in version three loses this consistency and creates too much ambiguity.

- Error prevention:
  The experts could not find room for error during the evaluation.

- Recognition rather than recall:
  The use of symbols forced the experts to recall that information. Using textual description was deemed quicker and less heavy on mental load, since police lingo is already optimized for short textual descriptions that convey a lot of information. The symbols used for describing the danger stemming from a suspect ("hazard class") was stated to be useful.

- Flexibility and efficiency of use:
  Being able to get to the "file report" screen from any of the other screens was reported to be very important in case a situation has already been resolved. On-boarding of the experts within a couple of minutes was stated to be a great benefit as well, making the application easy to use for beginners as well as experienced users.

- Aesthetic and minimalist design:
  Augmenting the information next to the POI was determined to be dangerous by all experts, since it decreases the visibility of the POI. One example mentioned was an assailant with a weapon in hand. Due to the size of the panel needed to make it readable, it would obscure anything on the side of the suspect, including his arms. Using a transparent panel was stated as a possible solution for this.

- Help users recognize, diagnose and recover from errors:
  There were no errors during the evaluation of the application.

- Help and documentation:
  All experts stated that after a quick on-boarding no further instructions are needed. Though it was agreed upon that a general FAQ linked in the application should be implemented.

- Miscellaneous:
  The use of the augmented identification markers was evaluated as important and useful for quick identification of the POI by all experts. Though it was stated that this could be problematic when the POI moves past an officer at a high speed. The time from detection to starting the AR identification could be too long to still have a line of sight with, for example, a driving car or a person on a bike.

7 Discussion

The results from the prototype tests show a lot of promise with regards to the usability and user experience of the application. Almost throughout all heuristics only minor improvements need to be made to address problems. Due to the close cooperation of police and researchers during the design of the application, the lingo, chronology and consistency of information, feedback and interactions are well suited for field policing operations.

One of the more debated aspects of the application was the use of symbols. Version three made heavy use of symbols to test their viability for faster information processing. The researchers originally hypothesized that this would result in less mental workload, but the experts unanimously stated the opposite. The ambiguity of the symbols was seen as a big problem for making operative decisions and all experts preferred textual descriptions. This could be due to the already highly structure nature of police lingo. Using codes and abbreviations, officers are trained to communicate high amounts of information with structured use of language. Replacing this with rather simplistic symbols loses a large amount of information.

Concerning the viability of AR, the panels augmented in space were initially seen as a good addition. In further discussions during the interview, it was clear to all experts that this would provide too much of a danger to their situational awareness in a high-risk encounter. The novelty of having the panels float in space (as it was described by one expert) does not outweigh the danger in having the POI partly obscured. For future iterations transparent information panels or different modes of information delivery need to be considered. The identification markers on the other hand were seen as a very valuable addition to their work. Being able to quickly identify the location of a POI is a new and important addition. The added layer of spatial information from a distance, when action is not imminent, seems to possibly be a valuable asset in the toolkit of an officer in the field.

8 Conclusion

This paper provides important insights for the further development of an AR application for field policing. We validated the general viability of the current application for the work of officers in the field and obtained useful feedback for the next iteration of the system. From this first round of expert evaluations, we can see some of the potential benefits and pitfalls AR technology can bring to the field. While AR content can be beneficial for content that conveys spatial information, general augmentation of information should be done carefully. Due to the high need of situational awareness, and the dangers that results from decreases in it, obscuring part of the vision of officers to augment content should only be done if the benefit clearly outweighs the loss in visibility for a point of interest. With this paper we have laid the foundation for further large-scale field-experiments.

Future research efforts will focus on integrating the feedback from the current study to build a prototype suitable for testing in real-world conditions with a large participant pool. Quantitative as well as qualitative measurements will be used to not only asses the viability of the system, but further to evaluate the impact of the system on situational awareness and task-load.

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