Simulating Next-Generation User Interfaces for Law Enforcement Traffic Stops

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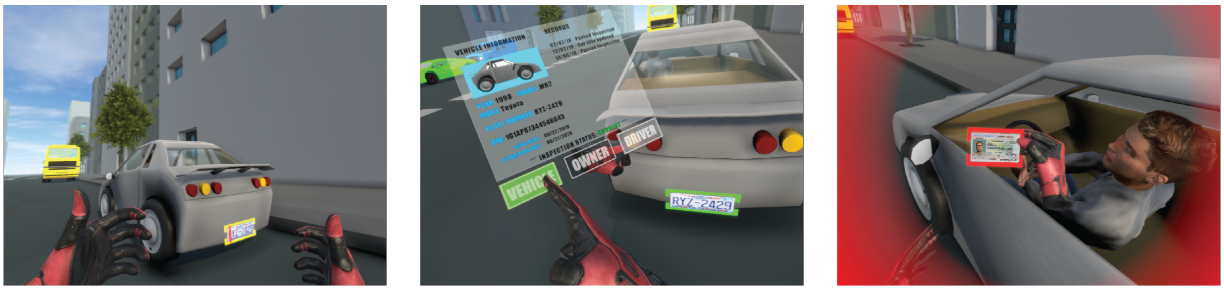

(a) (b) (c)

Figure 1: (a) The interface automatically identifies the vehicle's plate and searches for its information. Color code represents the status of the search. Yellow means that the data is being processed. (b) Once the information is fetched, the interface sends a vibration alert and changes the color code to represent the status of the findings. Green means that the car is clear. The officer can see further information in the arm-mounted display. (c) While checking the driver's license, the interface identifies a criminal record and sends a red alert. The driver's record can be seen in the arm-mounted display.

Abstract

We present the design of a next-generation user interface for law enforcement officers, developed to assist with current traffic procedures. Our design leverages the futuristic capabilities of augmented reality displays, integrating real and virtual elements. Our team has created a traffic stop scenario in immersive virtual reality, where the participant assumes the role of a police officer and interacts with a simulated augmented user interface and a virtual driver.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality

1 Introduction

Traffic stops are a routine operation of law enforcement. They are one of the most common interactions between a police officer and a civilian [2] and only require a reasonable suspicion[1] of law infringement. This can range from the observation of possible vehicular negligence, to behavior such as driving under the influence (DUI). Traffic stops are highly risky due to the uniqueness of each situation. A stop initiated for a simple reason (e.g. a broken taillight) might escalate quickly while information about the vehicle and its occupants is collected. In order to gather information on the vehicle and its occupants, the police officer needs to request legal documents and enter the data into various systems and databases. Alternately, they can use the radio to ask central command to run the data. The radio is used if the officer is driving, as they may not be allowed to type multiple keys, or in case of unresponsive system due to network or other issues that may affect the data requests.

Although the necessity of integrating new technologies into the routine of public safety organizations is an evident concern among first responders [1, 3], the successful adoption of novel user interfaces relies on a clear understanding of first responders' needs, requirements, and contexts of use [4]. We have conducted a series of interviews, discussions, training observations, and ride-alongs with first responders to better understand their processes and practices during traffic stops. This helps us more fully understand their procedures and practices during traffic stops, while revealing gaps and opportunities for which next-generation user interfaces can be designed [5].

As we found in our requirement analysis, a primary concern of first responders in a traffic stop is personal safety. Officers are exposed to risky situations due, in part, to the long gap between requesting and receiving information. To process the driver's documents and vehicle information, it is necessary to use the in-car computer. Only then, might the officer discover that the driver is a criminal with several outstanding warrants. Moreover, during this action, the officer might lose track of the vehicle's occupants.

With the rapid evolution of technology, it is reasonable to envision automated systems capable of scanning a vehicle's plate and the driver's license. Processing the data without the need for user inputs, and sending real-time alerts and augmented information in a heads-up display (HUD) while the information is being processed. This will help keep the officer informed of any problems that may require immediate actions.

Thus, the goal of this demonstration is to show the ability of next-generation user interfaces to assist police officers, while minimizing the risks involved in a traffic stop scenario. Our design enhances the participant's vision with interactive virtually augmented elements. Our main contribution is a virtual on-demand arm-,mounted display that shows information fed by the simulated image recognition system. We simulate these interfaces in virtual reality to allow the evaluation of next-generation tools while the technology is still under

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[1] https://www.law.cornell.edu/wex/reasonable_suspicion

development and not ready for the consumer market. In our scenario, participants are guided through a routine traffic stop. They leverage the capabilities of a 3D user interface to successfully complete the operation. No previous knowledge in law enforcement routines is required. The simulation has different threat levels, showing various benefits of the interface.

2 Design of Next-generation User Interfaces applied to Traffic Stops

The design of the 3D User Interface is based on our extensive requirement analysis with first responders [4]. The most requested features were automated scanning, automated gathering of data, and on-demand information visualization without needs to use the in-car computer. Other requests were simplicity of use, fewer distractions, and access to information summaries based on relevance. Current police software often presents information in a cluttered manner, not optimized to meet law enforcement personnel needs.

We have developed an augmented arm-mounted display that is activated on demand by glance (see Fig. 1b). The display shows a summary of gathered information that is most relevant for the operation. It is possible to interact with the display by pressing virtual buttons on the user interface. The data is grouped by type of information and can be about the vehicle, the vehicle's owner, or the driver. As the data becomes available, it is accessed through the interface.

The system is fed in real-time through image identification captured by a simulated body camera. When key elements are identified, such as the vehicle's plate or the driver's license, augmentations are attached to the identified element in the physical environment, providing feedback (see Fig. 1). A color code is used to display the status of the scan. *Yellow* represents that the element was identified and is being processed, *green* shows that the element was processed and it is clear. The *red* color emphasizes an alert that demands immediate action. On red alerts, the system also shows red vignette surrounding the participants field of view. Vibration alerts are triggered on the arm that holds the virtual display when the information is ready to be accessed. When the arm-mounted display is shown, the element that triggered the vibration is highlighted.

2.1 Scenario Tasks

In the simulated traffic stop, the participant assumes the role of a police officer that has pulled over a vehicle. Through the demo, the participant is guided to execute routine operations in a traffic stop while being assisted by our 3D User Interface. The scenario starts with the participant outside of the police vehicle, and is followed by the subsequent actions:

- Inspecting Vehicle: The participant looks at the vehicle pulled over. When the vehicle's plate is identified, yellow brackets surrounding the plate are shown. The system automatically searches for vehicle and owner information. Once the data is retrieved, a vibration alert is triggered and the brackets change its color to either green or red, depending on the search result. The information about the vehicle and the owner is accessed on the arm-mounted display.

- Approaching Vehicle: The participant walks toward the vehicle. The system actively scans for any suspicious movements and illegal objects inside the vehicle. If illegal items are identified, the object is highlighted in the display and an alert is triggered.

- Interrogating Driver: The participant interacts with the driver avatar verbally. The avatar can understand keyword-based natural language and will answer to greetings and predetermined questions. For example, the driver will hand his driver's license upon request.

- Inspecting Driver: The participant grabs the driver's license. Once the system identifies it, yellow brackets appear around the document. The system automatically searches for the driver information. Vibration and color alerts are fired accordingly. The driver's information is accessed on the arm-mounted display.

2.2 Equipment

We developed the simulated traffic stop scenario and the user interface in the Unity game engine. We use the HTC Vive Pro as a visualization display, and the Valve Index controllers to simulate the hands in the virtual environment. We track the virtual arm-mounted display position with a custom made arm-mounted tracker designed using the Virtual Builds Pebble Kit[2]. The Microsoft Language Understanding Intelligent Service (LUIS) [3] was integrated to process the conversation between the avatar and the participant (the police officer). The simulation runs on recent computer hardware.

3 Discussion and next steps

Our 3D user interface is designed to work in parallel with the existent systems that run on the police in-car computer. It assists in the identification of possible threats that may put the officer's life at risk during the first approach to the vehicle and interrogation of its occupants. Still, the officer needs to use the in-car computer to issue tickets and lookup further information, for example. The scenario is under development, and during the demonstrations it will be possible to collect valuable feedback from the VR community.

For public-safety user interfaces, it is important that the simulated UIs transfer into the real world, so that training in VR can benefit practice. However, abstractions are often necessary due to technical limitations, or to increase the efficiency of the simulation. For the next steps, we plan on design user studies to assess usability, preference, and performance of different levels of interaction fidelity, from a natural interaction using the hands and real locomotion to indirect metaphors, such as ray-casting and virtual locomotion. We intend to perform the evaluations with a group of law enforcement volunteers that are collaborating through the design of the 3D user interface simulation.

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