Covert-Glass: A Wearable that Enables Surreptitious 911 Video Calling

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Abstract
In the future, emergency calls to the number 911 in North America will include the ability to make video calls with 911 call centers yet little is known about how to design such technologies, so they map to people's real emergency needs. We explore this design space by investigating systems that can allow 911 callers to stream a surreptitious video call of an assailant. This paper explores a specific scenario where the person trapped may not be in direct danger from the assailant but is still present in the vicinity. We introduce 'Covert-Glass', technology enhanced glasses that aid callers to conduct a surreptitious 911 video call. The glasses guide a person to control the direction of his/her phone camera based on the 911 operator's input. 911 call takers send remote signals to the user's device and these appear as haptic vibrations on either side of the glasses.

Author Keywords
911 Video Call; Vibrating, Glasses; Tangible, Wearable; Surreptitious Calls.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation: User Interfaces: Haptic I/O;

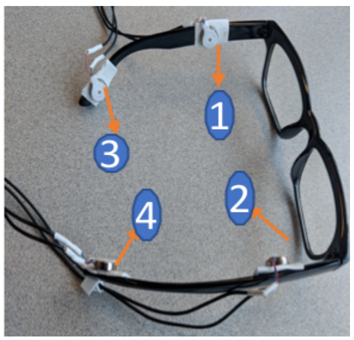

Figure 1: Covert-Glass using Vibration motors for feedback.

Introduction

Emergency calling services in North America are set to adopt next generation technologies in the near future. While commercial video communication technologies have come far, 911 services still use audio calls. The next future step for 911 services is to adopt media/video-supported calls. This could allow for rich information dissemination and better collaboration between callers and call-takers [1].

Yet one of the many challenges [2,3] that can arise during 911 video calls is the control of camera work: the act of moving a phone around to capture the best video footage from a prospective caller to show the necessary information during an emergency [4]. There are also cases where the caller may wish to surreptitiously record/stream a video of an assailant. In such cases, a normal audio-based 911 call may not be the safest option since the assailant may be able to hear the caller. For example, one may be reporting a burglary or a crime scene where the caller is in danger and cannot afford to give away his location through a voice call.

With this criterion in mind, we set out to explore a design space where, in the future, a 911 call operator could receive a video call and guide [3,4] the caller to appropriately point the phone camera at a scene that is intended to be recorded/streamed without having to look at their phone. We created a mechanism of guidance through patterns of haptic feedback [6] that are felt while the caller wears a specialized pair of glasses called ‘Covert-Glass’.

Related Work

There is a range of literature focused on improving communication during video calls by implementing technical improvements or by understanding the nature of human behavior. For example, Konstantinos et al. [8] adopt 3G services at its nascent stage to facilitate voice over internet calls between base-stations and ambulances. Brubaker et al. [9] focus on studying human behavior during a shared-video call. Jones et al. [2] explore the mechanics of camera work involved in mobile video collaboration to show that people have difficulties moving their phones to capture the desired video. Singhal et al. [10] explorered how people react to video streaming in public settings and found larger concerns with wearable cameras over handheld ones.

Our work builds on this prior literature by exploring how haptic feedback can be used as a part of 911 video calls to help guide a users’ phone camera. Vibro-tactile or haptic feedbacks has been used in several research work in the past [7] to convey a feeling/method of communication. We use vibro-tactile feedback in our research to convey discrete signals of information.

Prototype Design

Covert-Glass consists of a custom pair of glasses that support haptic feedback on the frame of the glasses. When a person talks to a 911 call taker using a video call on their mobile phone, the 911 call taker can send signals to the glasses to enable vibrations on each armpiece of the glasses. These vibrations can be used by a call taker to direct the caller as to where they should point their phone camera without having to look at their phone screen or listen to audio in the call. Thus, the camera work can be guided in a surreptitious fashion by the 911 call taker. We anticipate this design

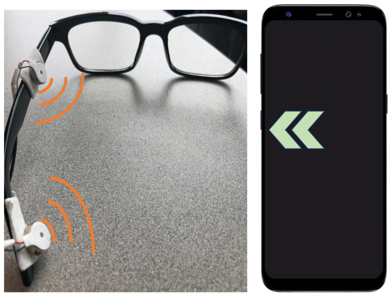

Figure 2: A vibration pattern and required direction of phone movement by user.

Figure 3: User wearing Covert-Glass and carrying out the required phone-camera movement. The yellow arrow illustrates the direction of phone

will be useful in situations where a caller is trying to show a situation to a 911 call taker without having to hold their phone out in front of them (to look at the screen) and making it obvious that they are streaming a video call. This includes situations such as emergency calls about robberies or any suspicious activities.

Usage Scenario:

John, a 22-year old student, goes to his university for his morning class. On a particularly eventful day, he realizes that there are some armed intruders who barge into his classroom and demand everybody to get down below the desk. He understands that the students are being held captives. As he is under a desk, and is present towards the far-end of the classroom, he decides to take out his phone and surreptitiously stream the ongoing pandemonium from beneath the table.

He video calls 911 services and, without any speech, tries to convey the scenario. He subtly holds his phone against his body and the 911 operator sees the scene. The 911 operator realizes that this is a crisis scenario and wishes to understand the scene better by having some form of control over the phone-camera feed. The operator guides the student to move/tilt the phone in certain directions through a series of pre-defined haptic feedback patterns. The student receives these remote haptic signals via the glasses and based on the patterns received, moves his phone accordingly to surreptitiously stream the video.

Implementation and Rationale

Covert-Glass is composed of software that allows two users to communicate with each other using a custom-developed video-calling application. Two actuators are attached to the sides of the glass as shown in (Figure 1). This hardware communicates the haptic feedback to the user through an Arduino, shown in (Figure 3). The overview of the circuit is shown in (Figure 2). The hardware consists of four vibrating motors, with two attached to each side of the glass frame. The two front vibration motors are affixed to the glass at a location to ensure contact with the user's temple region. The two rear vibrating motors are mounted on the glass frame to touch the skeletal bones behind the ears. We chose these locations as these are the harder, bony regions of the human body and are ideal to feel vibrations and discern the different patterns.

We used vibration patterns that are dependent on the spatial location of the actuators and temporal nature of vibrations [8]. We mapped six different hand motions - tilt (left, right), translate-horizontal (left, right) and translate-vertical (up, down) - to the different actuators. When the tilt command is executed through a button press, the actuator 1(left) or 2(right) vibrate (see Figure 1) for 250 ms depending on the call-taker's intended direction for movement. The caller is expected to slide or translate the phone left when both actuators 1 and 3 vibrate together and right when actuators 2 and 4 vibrate together. When the actuators 1 and 2 vibrate together, the caller is required to move/translate the phone up in vertical direction and move the phone downward when a combination of actuators 3 and 4 vibrate together. The duration of translate-vertical vibrations was set at 700ms.

The durations were kept different for each set of patterns as we realized during our pilot testing that participants could easily differentiate between the different directions to move and committed fewer errors when the durations were different. We tested our prototype with three participants during the pilot study. Each participant was asked to identify the locations and the durations (short, intermediate or long) of the vibrations.

Discussion

Covert-Glass is a proof of concept that shows how future 911 calls can take place using an everyday object like wearable glasses. At present, Covert-Glass uses wires for communicating haptic feedback and this obstructs mobility. We plan to implement a wireless version of the prototype in the future. We use certain vibration patterns and though these were easily distinguishable during our testing trials, a detailed usability study will reveal more about the preference of users and better patterns, if any. The objective of this work is to target scenarios where a surreptitious 911 video call may be necessary. With Covert-Glass, our research attempts to show how we can achieve such a call.

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