Design of a Tactile Aid for Non-Observable Mobile Authentication to Address Observation Attacks

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ABSTRACT
Shoulder surfing remains a liability to the security of private data on mobile phones, even as secondary biometric authentication becomes more commonplace. Mobile users in public or shared spaces may therefore shield their screen from external viewers (and themselves) while unlocking. However, this coping strategy can lead to difficult and inaccurate entry. We are conducting a study characterizing this type of interaction and examining the efficacy of a tactile aid to support spatial orientation to the interface, with the aim of augmenting out-of-view PIN and graphical pattern unlocking. Preliminary findings suggest the tactile channel may support eyes-free unlocking, but requires careful integration. We also propose an initial set of qualitative codes addressing user strategies employed for out-of-view interaction.

Author Keywords
Mobile Device; Non-Observable Interaction; Tactile Aids, User Authentication.

ACM Classification Keywords
H.5.2. User Interfaces.

INTRODUCTION AND RELATED WORK
Ubiquitous computing via mobile devices has both helpfully enabled many on-the-go tasks such as shopping, navigation, and banking, but also prompted users to concentrate their sensitive data on one device. For users compelled to authenticate in public or shared spaces, this makes the shoulder surfing threat model a real concern [2, 6]. In an attempt to safeguard those passcodes (i.e. PINs or graphical patterns), users may attempt to authenticate with the device screen entirely out-of-view from both observers and themselves. This may be done by shielding the screen with a hand, or holding it inside a pocket or bag [2]. However, this out-of-view approach imposes obvious interaction challenges, leading to input errors, frustration, and diminished regard for security. Research solutions have been proposed hiding on-screen interaction [12,14], and alert users to observers [4]. Other studies have examined assisting the user with security in dynamic contexts [5]. In comparable interaction scenarios, where visual and auditory channels are blocked or overloaded, tactile feedback (e.g., vibration cues) has effectively supported discreetly redirecting users' attention [1,7,9,10,11,13]. With these issues in mind, we are determining the efficacy of a tactile aid to secure out-of-view mobile authentication. Findings from the study will shed light upon authentication methods susceptible to error or compromise, and tactile cues that may better assist users in these conditions.

METHOD
This study intends to describe non-observable authentication, and tactile cues that may effectively support assistive spatialization as part of two authentication methods (PINs and stroke-based grid patterns). The cues will be integrated to help users find interface landmarks. The study design has been strengthened from a prior study [16, 17], to ensure that meaningful data regarding the impact of tactile cues are collected. A 2x2x2x2 within-subjects study has been designed, including as independent variables screen visibility (in- and out-of-view), tactile assistance (with and without aid), passcode length (four and six digits), and authentication method (PIN and graphical patterns). The patterns and PINs were selected from real world data (the RockYou dataset) with distinct interaction properties that can be used for analysis (e.g. left shift, non-adjacency) [3]. Conditions are randomized to reduce the risk of order effects.

Two mobile web applications have been developed in Javascript for the Google Nexus 5 smartphone, to closely simulate the Android OS PIN and pattern authentication. The applications collect finger position and timing data for each trial, enabling gesture analysis. Tactile cues have been designed using continuous and rhythmic vibration signals, using the built-in phone actuators, using guidance from [7,8,13,15]. To simulate non-observable conditions, a small open-ended cardboard box is placed over the mobile device, shielding the user's view but allowing full range of motion to a single-handed grip. A pre-test demographic and mobile computing experience and opinion questionnaire is administered, along with a fifteen-minute training period. Participants then perform 4 and 6-digit PIN and pattern authentications, both in and out of view (i.e. device obscured under box) and with and without the tactile aid. Upon completion, a post-hoc questionnaire is used to collect subjective feedback.

PRELIMINARY FINDINGS
The study procedure was piloted with five participants, and the application designs, trial procedure, and training strengthened. The study was then conducted with twenty-six participants (predominately 18-34 yrs., 14 males, 12 females), who entered 2,080 simulated passcode entry

attempts. Results from our preliminary analysis confirmed that non-observable authentication is challenging, and clearly more difficult and frustrating to perform than in-view interaction. Some types of transposition errors appeared regularly, such as entering the correct passcode slightly shape out of position. Video of each passcode entry gesture was reviewed by three coders, and over three rounds of coding, five training codes and eleven trial codes were established. A Cohen's Kappa test found strong agreement between the coders ($\kappa = .900$, $p < .0005$). The analysis of this data is ongoing, and the more detailed results have been submitted to a conference [17].

CONCLUSION AND FUTURE WORK

Preliminary findings from our in-process analysis indicate that use of a tactile aid for out-of-view authentication is feasible, but requires detailed consideration of interaction features such as the coding and timing of tactile parameters in the spatialization aid, and the sequence of presentation, rehearsal, and entry in the authentication applications. Based upon descriptions of real-world situational impairments, our follow-on studies will address additional realistic scenarios, such as non-observable authentication in pocket or handbag positions, and ambulatory and sitting postures.

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