Preliminary work on the Opinions on and Acceptance of Obscure Biometrics: Odor, Gait and Ear Shape

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Abstract

Biometric authentication is becoming more common; however, it appears that certain types of biometric authentication are used more than others. This study aims to explore the perceptions of participants towards odor, gait and ear shape authentication, through semi-structured interviews. A pilot study was conducted to evaluate the methodology of the main study. The pilot results indicate that the methodology is appropriate for determining participant perceptions, as well as determining patterns in possibility of adoption.

1. Introduction

Biometric authentication is becoming more prominent each year – according to the findings of the Mercator Research Group, in 2019 around 35% of the US population used some form of biometric authentication [1]. Biometric authentication can be simply explained as using one's unique biological signatures as a mean to authenticate one's self to a service or device [2]. Like other authentication methods, there are both security and privacy concerns revolving around the usage of biometrics [2].

There is a variety of biometric authentication methods (biometric methods) which can be broadly categorized as either physiological trait-based, like fingerprint or retina, and behavioural trait-based, like gait and keystrokes [3]. A large proportion of smartphones utilize biometrics, with companies such as Samsung and Apple using fingerprint reading or facial recognition on many of their devices. In this paper, biometric technologies not commonly found on mobile devices will be subjectively termed "obscure" in the sense that they are less likely to be known to the average user and are noticeably different from these aforementioned biometrics.

The motivation behind this preliminary study is to explore user knowledge and acceptance of obscure biometric methods. We selected three unusual, hence obscure biometrics, based on how abstract they were compared to the conventional biometrics. The three selections were odor, gait and ear shape authentication. Ear shape was selected as it works fundamentally the same way as fingerprint recognition, yet it is not used in mobile devices; odor recognition was selected because it is based on chemical composition rather than feature shape, and gait recognition was selected because it was deemed easier to visualize as a behavioural trait. Limited literature was found presenting odor recognition as a means of authentication. This work therefore proposes a way to address the following research questions:

- RQ1 – How familiar are participants with ear shape, odor and gait recognition technologies?
- RQ2 – What are participants' perceptions of these obscure biometric technologies?
- RQ3 – Are participants willing to adopt these technologies?

The aim of this study is to gain a deeper understanding, not only of how widespread the knowledge of these biometric methods is, but also understand what participants think of them. Additionally, an effort is made to explain the patterns of technology adoption that arise from different participants.

In a pilot study, a smaller set of participants are recruited in order to evaluate the quality of the proposed study and make any necessary changes to the methodology in preparation for the planned study. In this paper, the preliminary work is described, and the study design is justified.

A set of semi-structured interviews were conducted in order test whether or not the proposed methodology can be expanded to a full scale study and yield accurate and meaningful results. The interviews incorporate questions regarding participant knowledge, thoughts before and after being informed about how each method works, and end with the presentation of scenarios involving these methods.

The pilot study results show that none of the explored methods were known to participants. However, most participants were able to make good guesses as to how each worked. After being given information on each method, participants were generally accepting of these authentication methods, although still having concerns. Furthermore, there was a mixed trust in the effectiveness of gait and odor recognition. We hypothesise that participants' perception of obscure biometric methods depends on how well they can relate them to the more conventional biometrics they were personally familiar with and comfortable with used. We plan to explore this link further in the main study.

2. Background

2.1. Odor, gait and ear shape biometric studies

A 2010 study by Gibbs [4] looked at how participants responded to odor authentication, and noted that there was a generally neutral perception (both accepting and not) of odor

USENIX Symposium on Usable Privacy and Security (SOUPS) 2022. August 7 -- 9, 2022, Boston, MA, Canada.

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as a means of authentication, however the author noted a slight inclination toward a negative perception. Also in 2010, Rashed and Santos [5] looked at the perception of odor authentication with a population who was not familiar with the technology, and also observed a neutral view on odor authentication. We are interested in exploring how the perceptions of odor recognition may have changed over the course of a decade. Previous work was not found that explicitly investigated ear shape and gait authentication perceptions, opinions, or acceptance.

Previous literature includes comparative and exploratory studies of one or more of the three obscure biometric methods that we focus on. Fahmi et al. [6] explored the novel usage of ear shape to authenticate the individual answering a call on a smartphone using its camera. The authors propose a software framework through which this can be achieved with a high degree of reliability. Khan and Naaz [7] compared the use of odor recognition alongside finger vein and iris scans. Their study showed that odor has notable strengths over the other two methods, while also having its own drawbacks. In a similarly structured study, Mecke et al. [8] compared the process of opening a door with gait recognition, palm vein, as well as non-biometric key. In this study the authors noted that gait authentication was efficient, however a major drawback was the cost of a failed authentication (user had to walk back and restart the gait measuring process). Some exploratory studies on biometric authentication usage include a study from Henrandez-de-Menendez et al. [9] who explored the usage of biometric authentication applications in the field of education, including the use of ear shape, gait, and odor. This literature review outlined the possible areas where these technologies could be used, and emphasised privacy and security, however the perceptions of the prospective users were not reviewed; highlighting the need to explore the perceptions and opinions of these authentication technologies.

2.2. Biometric technology

A review of the literature regarding the capabilities of each of the obscure biometrics was conducted. The purpose is to gather relevant information that would be presented to the study participants In 2014, Li [10] published an article covering the (at the time) current state of odor recognition, while providing much information on the technologies used, as well as its effectiveness and limitations. The aforementioned study by Khan and Naaz [7] provides adequate information on how odor recognition systems function and combined with Li's paper, ensures accurate information. Boulgouris et al. [11] provides a solid foundation for understanding how one's gait cycle is used in order to authenticate someone. The information is further confirmed by a study by Katiyar et al. from 2013, which provides insight into the types of gait authentication and available analysis models [12]. Lastly, ear shape information from Fahmi et al.'s [6] paper provides adequate information on how ear shape recognition functions.

3. Methodology

We plan to explore this top through an interview study with participants. The interview data will be qualitative in nature and therefore analyzed using thematic analysis.

3.1. Study participants

The two requirements for participation in our study are to be at least 18 years old and to have some prior experience with biometric authentication, such as on a personal device or for work.

We plan to recruit a representative sample of participants, with a variety of background experiences with biometrics, and different educational and technological levels. We plan to recruit at least 25 participants and continue recruitment until saturation is reached.

3.2. Study structure

Each participant will be interviewed individually. The interviews are semi-structured and separated into four parts with a total of nine questions. The structure is as follows: part one – we gather background information on participants' experience with biometric authentication, with three questions; part two – we present the obscure biometrics and ask for initial impressions, with two questions; part three – we explain in detail how each obscure biometric works, answer questions, and ask for updated impressions, with two questions, and part four – we provide two scenarios, and the participants are asked for their thoughts and opinions. Each scenario will be explained to the participants, and each will be followed by a discussion involving their thoughts, opinions, and possibility of adoption. Following part two and before part three, participants will be given a baseline amount of information (as needed, depending on the participant) in order to make sure that participants are providing their thoughts based on the same level of knowledge/understanding. Participants will be encouraged to ask questions for clarification.

Following are the questions used in each of the interview parts (the scenarios are discussed in the following section):

Background:

1. What type of authentication do you use for your devices (such as passwords, pins, pattern-pin, etc.)?

2. Are you familiar with the term biometrics or biometric authentication? Could you explain it to me?

3. What types of biometrics do you think you have used before?

Initial impressions:

1. Have you ever heard of ear shape authentication? What about gait authentication? What about odor authentication?

2. What do you believe each one of these methods authenticates? How do you think they work?

Later impressions:

1. Do you have any new thoughts on these authentication methods?

2. Does any of ear shape, gait or odor seem like authentication methods you would use? Why or why not.

Scenario thoughts:

1. [After scenario 1 presentation] Do you feel that any of these biometric methods are sufficiently secure? Which would you be more comfortable with using? Do you believe that these are any better or worse than fingerprint or retinal scan?

2. [After scenario 2 presentation] Do you feel that any of these biometric methods are sufficiently secure? Which would you be more comfortable with using? Do you believe that these are any better or worse than fingerprint or retinal scan?

3.3 Study materials

Baseline information: This information is taken from the studies discussed in section 2 and include the following kinds of information on each of the three obscure biometrics: a) how it works, b) how it is implemented, and c) strengths and weaknesses. An example of provided information is as follows: "Body odors can be classified in one of primary, secondary and tertiary odors. Tertiary odors include perfumes or similar odor-based products. Secondary odors are created by one's body in response to health changes, and one's primary odor is a fundamental odor that the body produces which is unique, does not change, and cannot be covered or removed. E-nose technology includes sensors that can identify the unique chemical structure of one's primary odor. Their strength lies in high accuracy, but drawbacks include a high time requirement for chemical analysis. Improvements in the technology allow for more real-time detection at the cost of accuracy."

Scenarios: Inspiration for each scenario was gained from the background literature discussed in section 2. The scenarios were intentionally made very unique from each other, specifically contrasting personal device authentication in one scenario, with passive biometric scans in a public space in the other scenario. The two scenario prompts are as follows:

1. Consider how odor can be used to find and identify people. In forensic science, different aspects of science are used to find and identify criminals. Let's say that an airport had odor sensors that scanned everyone's odor as they entered, in an attempt to find a match from their odor database for criminals or suspects being looked for.
2. Consider the next generation of smartphones, one of which you would be getting. Instead of a face scan or fingerprint, your phone is unlocked by identifying your movement via gait recognition. As you walk, your phone can tell it is you who is walking with it and will unlock right away when you take it out for usage. Alternatively, if you are sitting down or not moving sufficiently and want to unlock, you lift your phone to your ear, as if to pick up a call, so that it scans your ear's details and unlocks.

3.4 Analysis

We decided that emergent coding would be a suitable method for code generation in this study, complementing the thematic analysis [13], considering the qualitative nature of the data collected. It is referred to as *emergent* coding, as codes are created as they come up [14]. As new ideas potentially emerge from successive interview analyses, subsequent encodings become richer. Therefore the thematic analysis will be dynamic in nature as more codes are procedurally generated.

3.5 Pilot study process

We ran an informal pilot study with five participants to test our methodology and identify any shortcoming to the design process. The participants included friends and colleagues and were recruited by word of mouth. The pilot study was carried out with both in-person interviews and virtual meetings, and the interview data was coded in order to start drawing preliminary insights. This process also served as practice for each step in the analysis process, from coding to formulating a theory. We acknowledge that five participants are few for piloting a perceptions study, but we believe that sufficient data was gathered in order to ensure the future study methodology.

4. Preliminary Results

We present the results from the pilot study herein as examples of preliminary insights that are worth further exploration in the main study. All participants had used several types of authentications, including biometric authentication. All participants were both familiar with the concept of biometrics as a way of authenticating themselves, and also able to adequately define what biometrics are. All five participants had past experience with conventional biometrics as means of authentication, including fingerprint and facial recognition, entirely on smartphones or computers.

When asked about whether or not they had ever heard of odor, gait or ear shape authentication, all participants stated they had not heard of any of them. Subsequently, each participant was asked how they believed each method worked, and all participants answered correctly for ear shape authentication, and all guessed correctly how odor recognition works, although none were confident in their guess. Gait recognition was not guessed correctly, as a result of participants not being sure of what exactly gait was.

In part three of the interview, after they were provided with information, participants were asked if they had any new thoughts on the three biometric methods. Generally, most participants were unsure of the gait authentication, citing possible flaws, and all participants found odor recognition the hardest to understand fully. Only one participant brought up

the topic of privacy regarding any of these authentication methods, while all participants discussed their thoughts stemming from how they envisioned themselves using each method, explaining why they may not be useful for them.

For both scenarios, participants had mixed thoughts regarding the usability, privacy, usefulness and comfort of the authentication methods presented. In the first scenario, participants explained that they would not have any issues with odor authentication, under the assumption that it worked perfectly.. This sentiment was not shared by all participants, as some questioned its effectiveness. This was despite being explicitly told that, theoretically and for the purposes of the scenario, primary odor recognition is extremely accurate. Similarly in the second scenario, all participants were not concerned about privacy, but mostly questioned the effectiveness of gait authentication, while generally trusting ear shape authentication.

5. Conclusion and future work

In conclusion, this preliminary study allowed us to evaluate the proposed methodology, identify areas of improvement, as well as areas to focus on during interview sessions to answer our research questions.

Recruitment for the main study will be done by advertising the study via posters, social media posts, as well as snowball sampling. We will encourage participants to share the study with individuals who may be interested in participating.

Future work for the main study includes running the methodology on the full participant set and conducting the full analysis on the gathered data. The use of emergent coding, combined with snowball sampling means that later participants may yield a greater set of codes. This means that it may be progressively easier to observe trends and patterns in participant perceptions and adoption outlooks.

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