Designing More Private and Socially Acceptable Hand-to-Face Gestures for Heads-Up Computing

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ABSTRACT

We propose a subtle one-handed finger interaction technology for heads-up computing, which utilizes the proprioceptive advantages of the face as the contact surface combined with the imperceptible characteristics of micro-gestures to improve the social acceptability and privacy of hand-to-face gestures in public environments. Its implementation was based on the use of a finger IMU which can collect data generated by finger movement. We verified the feasibility of this interactive technique in three public environments and the results of user study showed that our Interactive technology performed good social acceptability and privacy.

CCS CONCEPTS

• **Human-centered computing → Gestural input**.

KEYWORDS

Hand To Face Gestures, Face Touch, Social Acceptability, Privacy

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1 INTRODUCTION

In today's era of rapid change, the field of human-computer interaction is undergoing a major shift from being device-centric to human-environment centric. This shift means that the focus of technology design and development is more on how to better adapt and serve the needs of human users and the environment in which they operate.As a novel means of human-computer interaction, HeadsUp Computing constitutes the embodiment of this shift. We focus on the role of HeadsUp Computing in protecting users' privacy and security. To this end, we will explore a new interactive technology for HeadsUp Computing to make users' interaction more private and socially acceptable.

Human face has its natural and unique advantage in terms of human-computer interaction due to its relatively large interaction space, its ability to provide haptic feedback and its inherent proprioception [12, 19]. For interactions based on human face, hand-to-face gestures have gained a lot of attention in recent years [8–10, 16, 18–20]. It can provide users more diverse gestures, but equally, its compelling action limits its application scenarios due to especially privacy reasons [9].

In past studies, hand-to-face gesture interaction was more commonly used in virtual reality scenes based on head-mounted displays, and users mainly explored in private environments, such as home and personal office. Due to the limitations of these scenes, many researchers ignored the easily perceptible characteristics of hand-to-face gesture interaction, which may cause trouble to people around them if they are in a public scene.In addition, as indicated in [4, 6], gestures can not only used for describing people's behaviors, but can sometimes represent people's psychological activities. Therefore, when performing gestures, people may be concerned about their privacy and would not like to explicitly show their hand acti ons[9, 11].

With the improvement of the level of hardware, head-mounted devices are gradually becoming lightweight, and people's use of head-mounted devices is no longer limited to private personal places. Over the years, Designers are increasingly designing interactive devices to look like the common wearables in our lives, such as watches and glasses. As these devices become less visible, the user's own interactions become more noticeable. Therefore, the design of hand to face gesture interactions will now have to take into account the surrounding environment.

In recent years, in order to conduct more implicit gestures, more studies have begun to investigate microgestures [2, 3, 13–15]. Microgesture refers to the subtle movement of the fingers [1, 7, 20] and it has been formally defined since the work of Caillet et al. [1]. With this in mind, we redesigned hand-to-face gestures with high privacy and social acceptability, more precisely, we designed 20 basic gestures according to the two factors: finger touch mode (click, slide and symbolic) [2] and finger contact position (fingertip, finger pulp, nail and knuckle) [14]. Then we gradually induced a series of user's basic gesture choice for different task through interaction tasks in augmented reality. Finally, after analyzing the user agreement rate of each task and evaluating the user's subjective

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feelings, we retained 12 gestures that most fit user's preferences as our final designed hand-to-face microgesture set.

2 DESIGN OF HAND-TO-FACE MICROGESTURES

Before formally conducting our participatory design procedure, we first conducted a rigorous design consideration based on our previous design experiences. More precisely, in previous research works on hand-to-face gesture design, a core idea was to leverage **large available space on the face as an an interaction surface**. Thus, previously, hand-to-face gestures were usually designed to choose different positions of the face. However, as indicated in [9], large finger movement on the face are generally noticeable and may often lead misunderstanding in public environments.

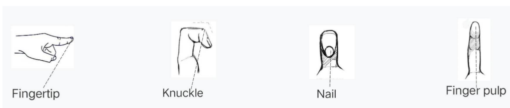

Figure 1: Four parts of the finger that touch the face.

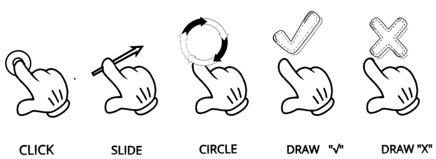

Figure 2: Five types of finger movements with last three are symbolic microgestures.

In order to better integrate into social scenarios, the designed hand-to-face microgestures should not be limited to deliberately select a specific position to achieve corresponding interaction task, but should be based on current scenarios as well as users' natural body position.Based on the above considerations, we shifted our design focus from the face to the fingers. As we all know, movements of different positions of fingers can be already easily captured by wearable sensors [5, 17], thus it is feasible to choose different parts of the fingers to design hand-to-face microgestures. For example, we can divide the finger parts that are in contact with the face into fingertip, knuckle, nail, and finger pulp. In addition, since previous studies generally classified the gestures into three types [2]: tap, swipe and symbolic, in our design, we also leveraged these classifications and did not consider complex combined gestures.

To explore the design space of hand-to-face microgestures, we first conducted preliminary design with various participants and then classified the designed gestures according to several factors.

3 GESTURE DETECTION AND RECOGNITION

As we mentioned before, the original intention of our microgesture design was to facilitate the use while maintaining the implicit feature. At the same time, optic-based detection devices, such as cameras, are usually limited by ambient light and occlusion while acoustic-based detection devices, such as microphones, are often limited by ambient noise. Therefore, to achieve the designed hand-to-face interaction and also meet the precision requirements, we decided to propose a detection device attached to the finger (rather than on the face). Since such a wearable device should on the one hand have high precision finger movement detection ability and on the other hand should not be too expensive, we finally decided to design a hardware system based on the IMU sensor.

4 SOCIAL ACCEPTABILITY EVALUATION

With well designed hand to face gesture as well as excellent technical performance, the final step before application of hand to face gesture was to evaluate its social acceptability. To to this, we conducted real world simulation with three common public scenarios and compared them with previously proposed hand-to-face gestures:(1) Office, (2) Restaurant and (3) Subway.In this live-action simulation experiment, to maximize fairness and objectivity in evaluation, we divided the participants into two groups: "user" and "observer". The "user" was responsible for completing the gestural interaction, and the "observer" simulated the people around them in the real environment. In each experimental trial, one participant served as the "user" and the other nine participants served as the "observer."

In terms of gestural interaction, in addition to our proposed interactive technology hand-to-face microgestures, we also introduced two previously proposed hand-to-face gestures, which were gestures proposed in Facesight [16] and in EarBuddy [18] respectively.In each scenario, we asked participants to perform the three types of gestures/microgestures in turn.We leveraged a 7-point Likert scale to qualitatively evaluate the three different gesture types. Participants were asked to rate the hand-to-face microgestures/gestures from the following aspects:

- Social acceptability: the degree of acceptance by people around the gesture performer.
- Privacy: the perceived level of people around the gesture performer.
- User perception: the degree of discomfort of the gesture performer.
- Fatigue: the fatigue level of the gestures.

Overall, based on the results of Likert analysis, we found that our interactive technology was better than the other techniques in terms of social acceptability and privacy. This was in line with our expectations and was also the design intention since at the beginning, we would like to design more private and socially acceptable hand to face gestures for heads-up computing.

5 CONCLUSION

We propose a novel hand-to-face micro-gesture interaction technique for heads-up computing. By leveraging a participatory design method, we designed a set of implicit hand-to-face microgestures that able to protect user privacy. Our final user study in real scenarios verified the usability of the proposed interactive technology and confirmed its acceptability in public use. As the latest exploration of applying microgesture to on-body interactions, the proposed interactive technology have the potential to inspire more research on interactions based on micro movements.

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