To touch or not to touch? : comparing Touch, mid-air gesture, mid-air haptics for public display in post COVID-19 society

1 Introduction

The new norm of touch free social interaction post Covid 19 raises questions around survival of public touch screen kiosks. People's hygiene concern about interacting with public displays significantly increased based on the fact that bacteria originating from people's intestines, gut, nose, mouth, throat, and feces can be found in many this kind of devices[1], such as on airport check-in screens[2] and on touch screens in restaurants[3], hospitals and grocery stores[4]. A new method to interact with the public touch screen is needed, such as mid-air interaction. In mixed reality areas, it is not rare to use mid-air interaction, and many experiments have been conducted for investigating the usability and practicality of mid-air interaction in different scenarios. Study shows that compared with touch, mid-air gesture makes no substantial difference regarding the player experience[5] when playing games, but it has accuracy and orientation problems due to the lack of hardware-based physical feedback. Users' perceptions of vibrotable stimuli has been proved as an important aspect of user experience and performance for gesture interaction as well[6]. Thus we initial plan is developing a mid-air haptics touch application(MAHT) based on a public kiosk for reducing the spread of COVID-19 and other communicable diseases, and conducting a user study to compare this prototype with two interactive techniques: touch and mid-air gesture touch(MAGT).

2 Our work

2.1 Interface Design

A virtual world of Customer Feedback Kiosk is set up in Unity based on a NZ airport. For the purpose of the prototype, 3D modelling of four coloured buttons (Figure1-left) representing the emoticons (happy, ok, bad, terrible) were designed and an interactive sequence was created for the click of an emoticon. On recognising the tap gesture over a specific button, the corresponding emoticon is chosen as an answer.

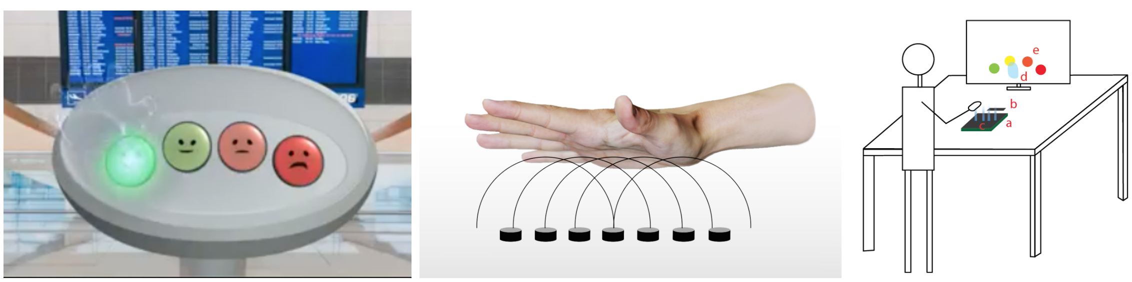

Figure 1: **Left:** Example of a hand avatar pressing a virtual button. **Middle:** Multiple ultrasonic waves converging to a point to create a tactile sensation in mid-air. **Right:** Implementation of Future of Touch. a) UHD5 kit- ultrasonic array; b) Leap Motion hand tracking camera; c) Haptics sensations; d) Virtual hand avatar; e) Interactive buttons.

2.2 Hardware

The application is deployed as a WEB AR interface on a system integrated with Haptic Touch development kit hardware platform. The tactile sensor (Figure1-Right-a) in the kit is made up of an array of 256 transducers. Each element can emit ultrasonic vibration with adjustable magnitude and frequency. These ultrasonic speakers are used to generate focal-points of ultrasound in mid-air strong enough to create haptic sensations(Figure1-Middle). The kit connects to a PC to work in our demo and the Leap Motion Controller (Figure1-Right-b) [7] included in the kit is used to handle the hand tracking aspect of the game.

2.3 Interaction Design and Development

The interaction between the user and the interface is controlled by gesture recognition and haptic feedback. To create a seamless connection between the virtual and real world, the interaction space has been set up in careful consideration of the Leap Motion controller's specific tracking area. We chose four choice answers as the interactable space was limited. The interface design uses a transparent round button where the options are displayed to mark out the hand tracking area for optimising this hand interaction. A transparent digital hand is designed to mimic the user's hand movements on the screen, closing the gap between the two worlds. The transducer array was also split into four parts to align with the interactable space(Figure2-Left). The array will be activated only when the leap motion controller recognises the hand gesture being made, such as press and release of the button. On experimenting with the haptic feedback points, a point vibrating vertically was found to be ideal to simulate a hovering button, and we used a group of points, rotating as they separate, to simulate a click as the user presses down. A feedback loop was created to make the selection happen virtually when the button is pressed and released(Figure2-Right).

Figure 2: Left: A hand avatar hovering above four interactable space for buttons; **Right:** A hand avatar presses a button

3 User Study and Results

We conducted an experiment to compare three hand interaction techniques: 1)Touch (Figure 3-a), 2)MAGT(Figure 3-b), 3)MAHT(Figure 3-c), with 10 subjects aged between 18 and 54 years using the within-subject method. In our experiment we collected qualitative data on usability and satisfaction and quantitative data on accuracy and target selection time.

Figure 3(Left to Right): a) Touch; b) MAGT; c) MAHT; d): Result of user study

The error counts we collected during the experiment indicated that Touch interaction has 100% accuracy, while MAHT has 98% and MAGT 95% accuracy in average. Compared with MAGT (Mean = 1.678) and MAHT (Mean = 1.269),Touch method also shows its advantage in Tager selection time with a 1.215s mean time. Compared with Touch, subjects found that the novel gesture and haptics interaction take more time to learn and slightly complex(Touch: Mean = 1.12; MAGT: Mean = 2.89; MAHT: Mean=2.76). However, they suggested with proper visualization of hands, and design of gap between buttons, the mid-air interaction will be a very practical application with less hygiene concern in a post COVID-19 world and will give them confidence to use a public kiosk with such techniques. Compared with gesture interaction only (Mean = 3.22) and conventional touch (Mean = 3.375), the haptic feedback(Mean = 3.875) gives participants a sense of touch and makes the experience enjoyable. Overall, 60% of the participants suggested that the touch experience is the best, while 40% of them commented that the Mid-air haptic touch experience is the best.

4 Conclusion and future work

The results of questionnaires and interviews pointed out that before practically deploy the Mid-air haptic touch kiosk in the public area, we still need to improve the design of interface, such as the distance between buttons or size of virtual hands to reduce error rate, and design proper training instruction to increase learnability of the interfaces. Nevertheless, the future of this application is promising as participants show positive attitude towards this prototype and look forward to the large-scale deployment of it in the future to keep everyone safe in the post COVID-19 world.

Reference

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