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1. Input

1.1 Low complexity of a gesture set: The quality and volume of a gesture set that is used for control should remain minor-complex. Gestures requiring longer than a second, and sets containing more than five entities may not enable a Reflexive Interaction. This is because the user would start thinking about the gesture assignment, which creates significantly added cognitive load. Therefore, technologies do not need to be capable of distinguishing 25 facial and head gestures, for instance.

1.2 Applicability of facial and head gestures: Specific facial and head gestures can be successfully implemented in critical mobile scenarios, such as when riding a bike. In this example controlling a music player by facial gestures has shown to enable the completion of the primary task without a distraction.

1.3 Using the ear canal to register facial activity: Facial and head gestures can be detected inside the ear canal through the use of electric or optical sensing technologies.

1.4 Electrical Field Sensing technology can be wearable: A differential amplification EFS can be sensitive enough towards minimal changes in electric fields of the human body in order to sense facial-related and other kinds of gestures and activities, furthermore it is applicable in a wearable scenario.

1.5 Gaining context information from inside the ear canal: A sensor resting inside the ear canal can detect the skin’s conductivity, ear canal deformations, muscle contractions, and even brainwaves. These sensing possibilities yield a great quantity of indications on the user’s mental state, (e.g., indicating tiredness, determine sleep state,...) and physical state (e.g., indicating physical exhaustion through facial gestures, detecting walking activity by created artifacts,...).

1.6 Social acceptability of on-body tapping: Tapping on one’s own body doesn’t feel awkward and is potentially social acceptable (also depending on body position). For instance, tapping on the stomach area or side of the body is experienced to be more natural than raising the hand towards the head and tapping on the frames of a person’s own glasses. Speech input can be used for low-complex commands, but may be also less preferred than a quick on-body tapping gesture.

1.7 On-body interaction is a personal activity: Mapping the execution of a phone call or the control of an image browser to a desired body part varies upon each person’s personal preference. Expanding input space for possible gestures relating to interactions on one’s own body parts may be more feasible than expanding it to another person’s body due to societal stigmas, cultural faux pas, religious laws, and personal privacy.
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1.8 Expanding the variety of on-body gestures: We can expand input space with supporting input techniques for eye- and hands-free interaction. On-body interaction can go beyond binary tapping gestures and be enriched by using soft or long touches, hovering gestures on the limbs and body, using arms for tapping on the hip, or with the use of leg gestures. It is to note that precision is generally reduced when gestures do not include the use of the fingers. Also, when shifting towards hands-free input on our body, input space might not increase.

1.9 Mobile availability of on-body interaction: On-body interaction yields a high surface area of availability, unless interaction on the bare skin while wearing clothing is required. Based on proprioception, users are not necessarily required to visually focus on the input gesture, thus a primary task may remain uninterrupted, which is an important basis for a Reflexive Interaction.

1.10 Alternative control through explicit foot gestures: Explicit foot gestures based on plantar pressure exertion do not occupy resources of commonly used primary interaction channels, such as heel tapping and weight shifting, which provides additional input for control. Making use of simple foot gestures may not disturb the user’s main task and thus abet a Reflexive Interaction.

1.11 The foot can reveal current context: Identifying the current context can substantially favour a Reflexive Interaction. With the use of a capacitive insole, the position of the foot is suitable to infer and determine context through detecting the user’s current body posture, specific walking activity, and the floor type the user is walking on. This environmental and user specific information indicates the readiness of a user to become involved in a parallel task, so to perform a Reflexive Interaction.

1.12 Utilizing the individual footprint: The generation of an individual footprint based on foot shape, weight, and style of walking enables the creation of an implicit user authentication. User habits and cognitive resources are very individually pronounced. And therefore, adjusting input and feedback modalities individually can help to create better user experience.

1.13 Subtle foot gestures yield social acceptance: Foot gestures are subtle and not usually recognized by others during a conversation. Quick foot gestures can be more discreet in non-use foot scenarios and thus tend to be socially acceptable.

1.14 A Reflexive Interaction is compatible with Microgestures. Complex input and feedback is not possible to be executed in a manner of a Reflexive Interaction due to the increase in cognitive demand. It is assumed that in future, complex feedback will still require visual focus by our eyes, while complex input will remain with a coordination by the fingers. However, Microgestures proposed by Wolf seem to be successfully executable in a manner of a Reflexive Interaction when fingers are not occupied by the primary task.
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2. Feedback

2.1 High noticeability of visual feedback: When being outside on the go, notifications, such as audio or haptic notifications (e.g., a ringing or vibrating phone) are quickly overlooked. This also applies to other stimuli when high level of noise is present. In contrast, visual feedback, such as displayed in our peripheral vision, yields a major advantage of being highly noticeable, also in mobile situations.

2.2 Exploiting visual peripheral perception: Visual peripheral perception does not limit the user to performing real world tasks, but instead provides an additional feedback channel that should be exploited in HCI more in depth.

2.3 Recognisability and display position: The display position of a PHMD has a major impact on the level of recognisability. The Middle-Center arrangement provides high noticeability, which favours a quick response, but can quickly interfere with the primary task. Using a low-complex stimulus, such as a colour change, makes the Middle-Right, Top-Center, and Top-Right positions also interesting for a Reflexive Interaction.

2.4 Recognisability and visual stimulus: Stimuli make a difference and should be carefully designed when aiming to enable Reflexive Interaction. Motion and colour are perceived more quickly with a lower error rate, than detailed information, such as text, which is normally recognized very late or may even be overlooked.

2.5 Scaling feedback to a subtle level: Scaling feedback down to a subtle but still perceivable level can be challenging because users have varying individual sensitivity thresholds. However, the benefit of subtle feedback is that it does not negatively influence the primary task. Based on the design it can even significantly support the task, such as reducing reaction time.

2.6 Noticeability-distractioon trade-off: We can clearly see that highly noticeable feedback like heavy vibrations, draw a great amount of attention. In contrast, very subtle feedback is less distractive but sometimes overlooked. We face the challenge of providing subtle but noticeable feedback, as well as selecting a suitable modality.

2.7 The perception of subtle feedback is affected by background noise: When a high level of noise is present, such as external vibrations or audio, subtle feedback will be overlooked more often. However, overloading the user with multiple tasks does not negatively affect the perception of subtle feedback.

2.8 Supporting the user with forcing feedback: Forcing the user to react to a notification favours recognisability, minimizes reaction time, and improves task completion times, thus supporting the execution of a gesture in a way that favours a Reflexive Interaction.

2.9 Social and ethical considerations with forcing feedback: Applying a forcing feedback may raise ethical responsibility concerns. A significant amount of users would prefer not to use a system that scales a notification alert up to a forcing level.
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2.10 Preferences for feedback modalities: Feedback is perceived different across individual body parts. Certain combinations of feedback modality and location of the body part are not equally applicable to all users. Although users have an individual preference for modalities, there are also similarities, such as none preferred feedback at the head.

2.11 Using notification patterns: Using stimuli patterns to convey complex information, such as vibrational patterns under the feet, generally requires longer actuation time and yields higher error rates which work contradictory to a Reflexive Interaction.

2.12 Using vibrotactile feedback for minor-complex notifications: Haptic notifications can replace visual feedback, but only in limited ways. For instance, a vibrotactile turn-by-turn pedestrian navigation is possible without obstructing the user. However, when it comes to navigating in unknown territory, visual hints, such as a map, are required to deal with ambiguous situations that people would encounter in cities.

2.13 Distributed feedback for stress reduction: Overloading the visual channel with too much information can result in a cognitive overload and thus create stress. We can reduce stress by presenting information within different types of modalities while distributing information to multiple body parts.

2.14 Walking speeds influence haptic perception: Using alternative feedback modalities in a mobile scenario enables the visual focus to remain on the street. Haptic feedback can serve as an alternative channel here, although increasing walking speed will influence haptic perception negatively.

2.15 Vibrotactile feedback at the foot: Even though the foot is exposed to vibrations from the impact when touching the ground with each step, it is still capable in perceiving vibrotactile signals precisely and not significantly worse than other body parts.

2.16 Feedback in shoes is subtle: Implementing feedback in a shoe or in an insole is silent, thus it does not disturb others when engaged in real world tasks. Notifications, such as incoming phone calls, will be recognizable without the disturbing of others in an inappropriate situation such as during a business meeting.

2.17 Improving immersion with foot interfaces: A foot interface, such as an insole, enables for natural leg movements to be used and tends to increase immersion. Haptic sensation under the foot, for instance, could simulate collisions and ambient information from the ground surface, such as gravel or hot sand in a desert. Moreover, a rising temperature in the shoe can make the user to unconsciously feel uncomfortable.

2.18 Adaptive perception and perception latency: While being on the go, vibrotactile feedback may be missed or only perceived after a short period of time, this can be caused by several reasons, one reason being the unfaivoured type of floor one is walking on. A rising temperature, such as created by a Peltier Element, may also not be quickly perceivable due to the built in adaptation of our bodies’ “central adaption phenomenon”, which makes a person unable to recognize slight changes in temperature. Nerves have this unique ability to acclimate to discomfort until becoming numb.