Bonjour! Greeting Gestures for Collocated Interaction with Wearables

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Abstract
Wearable devices such as smartwatches (SW) and head-worn displays (HWD) are gaining popularity. To improve the collocated capabilities of wearables, we need to facilitate collocated interaction in a socially acceptable manner. In this paper we propose to explore widespread used greeting gestures such as handshakes or head gestures to perform collocated interactions with wearables. These include pairing devices or information exchange. We analyze the properties of greetings and how they can map to different levels of wearable pairing (family, friend, work, stranger). This paper also suggest how these gestures could be detected with SWs and HWDs.

Author Keywords
Smartwatch; Head-worn Display; Wearable interaction; Input techniques; Device Pairing.

ACM Classification Keywords
H.5.2. Information interfaces and presentation: Interaction.

Introduction
Wearable devices such as smartwatches, sports armbands, head-mounted displays and smart glasses are increasingly finding their way into people's everyday life. Together with existing devices, such as phones, tablets and traditional desktop-based computers, they

Figure 1. Two examples of greetings: western handshaking and thai greeting.

form an elaborate device ecology that allows users to appropriate and choose devices based on their affordances, properties and functionality. Users are no longer interacting with single devices, but rather use a multitude of devices as portals into a shared information space. Within the research community the complexities, interactions and usefulness of traditional devices, such as phones and tablets, are relatively well understood [4, 10, 14]. These novel wearable devices, however, pose a set of new fundamental social challenges from the user perspective related to (i) device configuration and pairing, (ii) information exchange, and (iii) collaborative work in collocated situations.

Current advances in wearable computing are increasingly exploring technical solution to these challenges by covering novel gestural interactions with wearables [9, 11, 12] and interactions distributed between wearables and handheld devices [1, 5, 6, 7]. However, it is unclear what the social implications of these techniques are and how they might be appropriated by end-user.

In this work, we propose exploring *social greetings*, which are the first step in creating a natural and appropriate interaction between humans [8]. These social interactions have been previously applied to Human Robot Interaction (HRI) [3]. However, work on HRI mostly focuses on the phases of the greetings rather than on the properties of the greetings gestures, which are crucial in the context of interaction with wearable devices.

In this position paper, we propose to use greetings gestures for collocated interactions with wearable devices that are based on existing accepted social conventions, interactions and protocols used in non-digital human to human communication. We argue that by informing the design of interaction techniques and applications for wearables with existing social protocols and gestures, users will be empowered to appropriate and use them in a more effective and less social awkward way. In this paper, we describe the properties of greetings and the relation to ad hoc collocated interactions with wearables, and we introduce two technology concepts that implement and embrace this design space.

Interaction Scenario

Alice just returned from Korea, where she took many pictures and videos using her head-mounted display. When meeting her colleague Bob, they shake hands to greet, causing the system to make a collegial association between their devices. After receiving a buzz from the watch, they both know that their devices are paired and ready. Alice talks about all the exciting stuff she has done on holiday, and asks whether Bob wants to see some of the pictures she took. Alice then touches the side of her HWD to browse through her holiday pictures until she finds the one she wanted to show to Bob. She then performs a swipe gesture on the HWD in the direction of Bob, who is offered to receive the image. After accepting it by touching his own HWD, he sees it appearing on the screen. After a short chat about the holiday, Alice waves goodbye to Bob as she is leaving. This causes the watch to buzz again to indicate that the device connection is broken off. The image that was shared with Bob's HWD is removed.

Later that day, Alice meets her boyfriend Frederik. When they meet she kisses him, causing the system to create a personal association between the devices. A buzz on their smartwatch confirmed the pairing of their devices. Frederik asks whether she can share one of

the videos she made during her trip. Alice again browses through her archive of pictures and videos. While browsing Frederik can see a preview of all the images and videos that his girlfriend made. When spotting a video still where Alice was having a cocktail, he laughs and asks Alice to send that video. Alice swipes in the direction of Frederik to send the full video to Frederik, who immediately starts watching it. After leaving, the devices disconnect automatically after the system detected that they are no longer in the same place. Frederik, however, keeps the video and sends it to his playlist using a touch gestures on his HWD.

This envisioned solution takes advantage of the fact that wearable devices are embedded directly on users who can thus simply perform everyday life gestures to perform collocated interaction with their wearables. However many parameters need to be taken into account in order to design such interactions. This requires an in-depth exploration of the design space and social implications.

Social Properties of Greetings

Social properties of greetings can be leveraged for collocated wearable interactions, in particular to configure or pair collocated devices. This sections is not an exhaustive list but rather an initial summary of properties of social interactions in human-human interaction.

Proxemics and Space

The field of proxemics studies the non-verbal communication of personal space involved in social interactions [2]. Proxemics describes how space is used in interpersonal communication and how social interactions employ and unfold in space over time. Previous work has described how interpersonal physical distance is related to social zones, identifying four zones between intimate (0-50cm) and public (>4m) [2]. This concept has been successfully explored for cross-device interactions using the concepts of F-formations (the physical arrangement of a group of persons) and micro-mobility (interpersonal orientation of devices) [10]. Kendon [8] identified different types of greeting gestures according to these inter-personal distance, from distance salutation to final approach and close salutation. Distant salutation is usually associated with gestures such as waving, head tossing, head lowering, nodding or head dipping [8]. Other approaches include palm presentation; smiling and head setting (erect head for instance). Closing salutation can involve non-contact salutation, handshake, embraces or other cultural-dependent salutations such as bowing. The entire salutation process is, thus, a defined process with several clearly separate steps.

Group Dynamics and People

Along with the formation, the number of people involved in the greetings defines the social context, i.e. from private to public. Each type of context will engage the participants in a different level of collocated interaction. People generally change their behavior depending on the size of the group. These temporal processes of change determine the intra- and intergroup dynamics within or between several groups. The number and type of people involved in the interaction will, thus, influence both the verbal and non-verbal communication strategies and protocols used to interact with other people. Group dynamics are directly influenced and shaped by proxemics, which describe how space is appropriated by groups during interactions.

Historicity and Formality

Groups and individuals have varying procedures for specific behaviors such as meeting, acknowledging or interacting with another person. These procedures and protocols are governed by the level of formality that is upheld between the actors of the interactions. Such procedures are directly influenced by (i) the level of familiarity between people, (ii) the location of the interaction, as well as (iii) the social status of the actors. The level of familiarity of two persons can be recorded as the number of times both paired their wearables. This information could be used to facilitate interaction with already known people, for instance when greeting a group of people, only the wearables of those already known will be paired. The wearable could also consider the location or proxemics between people to filter between available devices. People that are standing away from each other might not be interested in connecting their devices, even if they know each other or were previously engaged in interactions.

Culture and Background

The social conventions for salutations vary with cultural backgrounds from handshaking to bowing (Figure 1). Moreover, the same gesture may have a different social meaning in different cultural contexts. Pointing is an example of a gesture that in some cultures is considered an appropriate non-verbal means of communications but that in other cultures is considered extremely rude. Different cultures, thus, place different symbolic meaning into both non-verbal and verbal communications. The temporality of these interactions can also play an important role in social interactions. The way temporality is perceived by different cultures but also different types of people within a coherent socio-cultural setting, determines how people gesture and salute each other. These processes are socially negotiated over time, and evolve based on historicity and formality. A device pairing mechanism should, thus, consider the cultural context in addition to the type of greeting gesture. Moreover, it can allow for rapid iteration between different types of connection strategies that fit on the socio-cultural setting of the interaction.

Greeting gestures

Greeting gestures can be subdivided into two types: those with contact or without contact. Touching another person during the greetings relates to both cultural and social aspects and involves a physical gesture usually with the hand or arm.

With contact

Within the same cultural background, different types of physical contacts are usually associated to different social proximities: handshakes, kisses, tap on the shoulder or high-five are examples of socialized greeting gestures that occur in different levels of proxemics. Handshakes are, e.g., a more formal way of greeting each other, while kisses or high-fives are examples of interactions done with more familiar people, such as friends or family. Since wearable devices are usually worn on the body parts that are involved in these gestures, such as the head or hands, they will be physically shaken synchronously, which could facilitate gesture detection. We can further characterize these gestures with the body parts involved, i.e. hand-hand (handshake or high-five) or head-head (kiss) for instance, to support device interactions within different levels of familiarity.

Figure 2 Two people shaking hands using smartwatches.

Without contact

Contactless gestures, such as waving, pointing or pressing the palms together (greeting used in many Asian countries) are examples of gestures that are less well embedded with proxemics and historicity. Since they do not require people to physically touch each other, they are more widely appropriated across different interpersonal physical distances. Strangers, use these gestures to draw the attention of another person. Because of this, contact-less gestures can be interpreted or acknowledged by accident as other unrelated users might obstruct the visual connection between interacting users. These gestures are also not necessarily synchronous (a temporal span may separate two persons' gestures) as they require several acknowledgment and response steps. To characterize the temporal aspect of contactless greetings, we can use Allen's temporal properties [13], which defines how two events relate temporally: for instance, two gestures can be performed in sequence, in concomitance or in parallel.

Gestures features

Greetings gestures have different properties that can be leveraged to detect the ongoing situation but also to learn about differences between humans. These features include:

1. Direction: *the degree to which the gesture is directed towards another person or group*. Direction refers to the orientation, positioning and intentionality of the gesture. The correct interpretation of directedness is particularly important for gestures without contact as they need to be asynchronously interpreted by another party.
2. Duration: *the length of the gesture that is directed towards a person or group*. The length can be dictated by social protocol or be appropriated by a person depending on the social context or situation. E.g., in a case a directed gesture is not recognized, the person may prolong the duration as an attempt to establish an interaction with another person.
3. Intensity: *the intensity of the gesture towards another person*. Intensity refers to the strength, explicitness and power of the gesture. Intensity can be used by people to express social status, such as dominance or hierarchy, but can also be leveraged and appropriated to make their gesture more explicitly, strong or personalized. Intensity and duration often interplay during the establishment of interaction with other actors.

Using wearables for social pairing

Greetings may differ between different cultures, but will be most likely consistent within the same environment. We propose to leverage this form of gestural and implicit non-verbal interaction to start and pursue collocated interaction with wearable devices. Wearable computers embed multiple sensors that enable the detection of greetings and other social interactions.

Smartwatches

Most handshakes or hand gestures used to greet can be easily detected using either IMU sensors, with a combination of accelerometer, gyroscope and magnetometer (Figure 2). A simple accelerometer could be enough for simple handshakes (as seen in Figure 4) while more advanced sensing (6 or 9 DOF) could provide better accuracy.

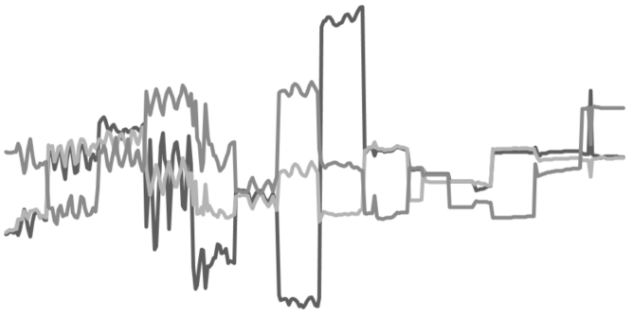

Figure 3 Synchronized accelerometer data can be used to detect shaking gestures.

Head Mounted Displays

Head mounted displays can be used to detect head gestures or movement of the upper part of the body using IMU sensors. As such, a HWD could be used to detect someone bowing or kneeling in front of another person (Figure 3). Computer vision can be used to detect people facing the user and interpret their head, neck and upper body gestures. Both the IMU and camera sensing could be combined into hybrid sensing.

Figure 4. Two users wearing a head-worn display bow and pair devices.

Conclusion

Our proposal explores the use of social aspects of greeting gestures to perform collocated interactions with wearables, such as pairing devices or information exchange. We analyze the design space of greetings and how they can map to different levels of collocated interaction. We also suggest how these gestures could be detected with SWs and HWDs.

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