Mnemonical Body Shortcuts: Body Space Gesture Recognition

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Abstract

We present a body space based approach to improve mobile device interaction and on the move shortcut triggering performance. The human body is presented as a rich repository of meaningful relations which are always available to interact with. An inertial sensing prototype was developed and evaluated, proving to be suitable and efficient for mobile interaction, accomplishing a good recognition rate.

1. Introduction

Mobile computers are currently omnipresent, and became a part of the user's daily life. Their potentialities are diverse: communications, GPS, video and music players, digital cameras, game consoles and many other applications. The characteristics of these multiple-task devices surpass the desktop user interfaces and give more importance to new possibilities in human-computer interaction (HCI). Moreover, the interaction while mobile is different because users' visual attention is not always focused on the device, making eyes-free and low-workload important characteristics to create a suitable mobile interface. Also, there is a core of applications that are used recurrently, and their menu access is often too slow due to the limited input capabilities. This implies the growing importance of shortcuts: users need fast application access and actual mechanisms (key and voice) are not suitable to on the move, public interaction [1]. To overcome mobile shortcuts issues and ease on-the-move mobile device interaction, a gestural input technique is proposed. Gestures are a natural and expressive method of human communication and are often combined with body hints to empathize an idea (i.e. reaching the heart to show an emotion). We give special attention to the body space and related mnemonics to increase shortcut usage and therefore improve user mobile performance.

2. Mnemonical Body Shortcuts

We define Mnemonical Body Shortcuts as gestures made using a mobile device towards different body areas, resulting on the triggering of applications within the device that are culturally or personally associated with that specific body part. Such an interface will ease shortcut remembrance while maintaining the natural aspects of a gestural-based interaction and the advantages of using gestures while on-the-move. To validate our approach we developed a Radio Frequency Identification (RFID) prototype able to associate body parts (through sticker tags) with any given mobile device shortcut (i.e. an application or a call to a certain contact). User evaluation showed that, even against some established key shortcuts, gestural mnemonics had better recall results (even when prompted 1 week later) and may surpass key shortcuts low memorization issues, providing also a wide range of possible associations, when compared with the physical limit of keys present on a mobile device.

3. The Prototype

The use of an RFID prototype, even with a high recognition rate and being extremely appropriate for a demonstration on Mnemonical Body Shortcuts, is not suitable for a full-scale deployment, mainly considering aesthetics and acceptance issues. Accelerometers are cheap, small, available and promising regarding the information on performed gestures. An accelerometer is classified as an inertial sensor and it measures not only the dynamic acceleration but also static acceleration.

3.1. Gesture Recognition

We decided to approach the gestural recognition using a feature-based approach. The signal was firstly captured, received and pre-processed in order to aggregate useful information. As the captured signal is noisy, we isolate the movement using a simple variation threshold and use a Hanning window smooth algorithm. Then, we defined a set of 12 different features of the signal, namely the maximum, minimum and final values from the X, Y, Z and total amplitude signal. After feature extraction, we were able generate training sets, fill the feature space and use classifiers to detect the class of each new gesture. The classifiers used were k-Nearest Neighbors (k=50) when a large test set is available and Naïve Bayes classifier for reduced test sets.

3.2. User Interface

By default, we consider gestures starting in the chest and finishing in a body point making it possible for any individual to use the system with a default training set (12 body points trained with 20 users). Nevertheless, the user can train different gestures as long as they remain consistent. To launch an application the user performs a gesture and marks the start and end of the gesture by pressing an action key. The system gives 3 types of feedback: visual (the name of the application to be launched and a progress bar), audio (the application to be launched) and vibrational (according to the recognition certainty, i.e., when some doubt lingers the vibration is longer). After a gesture and appropriate feedback, the user has the opportunity to cancel or alter his selection. The user can abort a shortcut, within a preset time frame, represented by a progress bar. This mechanism is useful when the user makes a mistake or gives up launching an application. On the other hand, even when the user draws a desirable gesture, the system can trigger the wrong application. This happens when two or more gestures are associated with the same body point or when a gesture is misrecognized (close body points). Thus, the user can navigate through a list of shortcuts, ordered by recognition certainty. Both mechanisms allow users to effectively control shortcut triggering and therefore be confident on its use.

4. User Evaluation

We evaluated the prototype both considering recognition ratios and usability issues.

4.1. Recognition studies

First, we tested the feature-based algorithm with an offline analysis on its recognition. We collected 60 gestures from 20 users, and cross-tested all those gestures in various forms. We achieved interesting results using kNN and Bayes classifiers, such as a 97,9% recognition rate with only three trainings (5 random gestures) and 97,3% recognition rate without considering any training from the user (only data from other participants), also for 5 random gestures.

4.2. Usability Evaluation

Usability tests were focused on finding the recognition results for both personalized and default gestures (including while on-the move), but also to test the user interface and gather user feedback on the prototype. **Effectiveness.** The effectiveness of the prototype is mainly related with recognition accuracy. Considering a self-training set, we had a performance of 80.5% recognition while moving and 89.5% while standing. Considering default gestures, the values reach 90% while moving and 92.5% standing. **Usefulness.** We measured the usefulness of the prototype by the number of errors produced during tests (entering an unwanted application). It happened in 3.3% of the cases as in only in 1.3% users had to stop their movement to interact with the mobile device. Furthermore, users only needed an average of 2.5 clicks and 3.8 seconds to trigger a shortcut. **Learnability.** To analyze the system learnability we observed the recognition improvement across training phases. For example, for a standing position, the recognition evolved from 70% with one train, to 81% with two trains and 89.5% with three trains. **Likability.** We used a final questionnaire to assess users' opinion, rating some characteristics from 1 to 5. Within the most relevant results, we found that users preferred audio feedback (4.9), classified the alteration feature as very important (4.8), classified it as a good mechanism to use while mobile (4), to rapidly access applications (4.2) and generally appreciated it (4.8).

5. Conclusions and Future Work

We presented a gesture approach to improve mobile device interaction. An inertial sensing prototype was evaluated achieving high recognition rates even while moving and gathered consensual satisfaction. In the future, we will evaluate our approach with blind users that can highly benefit from a fast-launching interface.

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