Strathprints Institutional Repository

This version is available at http://strathprints.strath.ac.uk/46525/

Gestural product interaction: development and evaluation of an emotional vocabulary

Abstract

This research explores emotional response to gesture in order to inform future product interaction design. After describing the emergence and likely role of full-body interfaces with devices and systems, the importance of emotional reaction to the necessary movements and gestures is outlined. A gestural vocabulary for the control of a web page is then presented, along with a semantic differential questionnaire for its evaluation. An experiment is described where users undertook a series of web navigation tasks using the gestural vocabulary, then recorded their reaction to the experience. A number of insights were drawn on the context, precision, distinction, repetition and scale of gestures when used to control or activate a product. These insights will be of help in interaction design, and provide a basis for further development of the gestural vocabulary.

1. INTRODUCTION

As technology becomes increasingly sophisticated, consumers expect more powerful and natural user interfaces than has previously been the case (Shan, 2010). The innate human characteristic of movement and gesture make its use attractive in the control of products (Costello & Edmonds, 2007) and is likely to be important in the era of ubiquitous or pervasive computing (Abawajy, 2009). A new generation of motion controllers which currently are mainly used for gaming, such as the Microsoft Kinect for Xbox 360 (Microsoft, 2010) are expected to be used in an increasing range of products , making whole body interaction with technology a reality. This process has already begun, with the use of touch interfaces combined with accelerometers and gyroscopes on tablets and smartphones initiated by the iPhone (http://www.apple.com), and projects to develop gesture control for televisions and home entertainment systems by companies such as Hitachi (http://www.hitachi.com) and Toshiba (http://www.toshiba.com).

The use of gesture, however, introduces a range of complex factors, including culture (Rico & Brewster, 2009; Yammiyavar, 2008), ergonomics (Fikkert, 2010; Saffer, 2008) and emotional

response (Larssen, Robertson, & Edwards, 2006). Of these, emotion is the least understood, with the field of Emotional Design (Norman, 2004) emerging comparatively recently to address unrewarding and in some cases problematic user experiences. A product or machine may well 'do the job' but a positive emotional reaction is fundamental in ensuring that the interaction is pleasurable (Benyon, Hook, & Nigay, 2010). While it has been demonstrated that the use of gesture in gaming can engender positive emotions in players (Isbister & DiMauro, 2011; Lindley, Couteur, & Berthouze, 2008) and have driven much of the technology in gestural control, it is necessary to move beyond simply manipulating avatars and consider how movement can be used as a fundamental part of interaction with machines in our everyday lives.

1. The emergent technologies herald a shift in emphasis from designing *interfaces for use* to the *interactions of use*: the fundamental way in which we execute product operations. Gesture-based interaction possibilities are becoming increasingly important in doing this, as they bring the functionality of machine operation and the means of interaction for the user closer together. By better understanding how we react to the use of gestures in a practical setting, future designers would be then able to select and utilize appropriate gestures for different product operations and functionality. The aim of this research is therefore to explore what emotions and feelings gestures engender in users when interacting with sophisticated devices and systems.

1.1. EMOTIONAL RESPONSE

There is a long history of the consideration of emotional reaction to movement in dance and drama. A number of recognized systems exist, such as Meyerhold's (1969) biomechanical exercises to develop and release the emotional potential through movement, the Feldenkrais Method (Feldenkrais, 1972) for learning movement and enhanced body function, and Laban's (Laban, 1960; Laban & Lawrence, 1974) movement studies on the physical and expressive variations behind human motion. Regarding the interface with devices and systems, emotion has been described as a key consideration for new Human Computer Interaction (HCI) technologies, including gestural control (Benyon et al., 2010; Larssen et al., 2006). As these become more manifest in everyday life, social acceptance of their use becomes important. Research examining the social acceptance of gestures in public places (Montero, Alexander, Marshall, & Subramanian,

2010; Rico & Brewster, 2009) has broadly established that, while there are variations across demographics and cultures, as long as the gestures are not too large and demonstrative, people are willing to both use and observe them in social settings.

1.2. APPLICATION TO INTERACTION DESIGN

Research on the use of gesture for product interaction has primarily been carried out in the area of HCI (Fikkert, 2010; Quek et al., 2002). Karam and Schraefel (2005) present a classification system for gesture which is useful in identifying the different types of movement typically used when interacting with products and in daily life:

- Deictic gestures – Indicator-relative gestures used to indicate an object, direction or location. Deictic gestures consist of a pointing gesture, but importantly are different from the manipulation of pointing a screen cursor, for example.

- Manipulation gestures – Used to control an entity using a close relationship between the actual gesture and virtual entity.

- Semaphore gestures – Used to signal symbolic gestures. The gestures can be static or dynamic. Un-manipulative gestures often fall in this category.

- Gesticulation – Gestures used along with speech. They are considered the most natural gestures.

- Language gestures – Used to convey sign language. These depend on gestural and symbolic vocabularies created specifically for the communication of words and letters.

In terms of interaction design, a blend of different deictics, manipulations and semaphores are typically used. As interfaces become more attuned to the emotional state of users, it may be that gesticulation has a greater role to play in the operation of products. In this research, we wanted to consider how emotion could relate to the practical operation of products. For example, if a traditional light switch is replaced by a motion controller, what would be an appropriate motion to activate the lighting of a room? It could be an energetic action such as a snap of the fingers or clap of the hands to induce a happy or excited mood. Conversely, a wave or patting motion may be selected to invoke a more relaxed feeling.

Rather than focusing on just one 'product' , and in order to consider a range of movements and functions, we decided to examine the interaction with a web browser. While the web browser is a commonly used application, it also allowed a range of discrete tasks to be identified, and a distinct gesture assigned to each. In observing and analyzing how users reacted to the range of browsing tasks and their associated gestures, broader insights for future product interaction design are drawn.

2. METHOD

The experiment was designed to allow users to experience a gestural interface and to explore how different gestures affect their emotional state. It was assumed that users' level of experience of web browsers would vary and so this was considered as part of the user background profiling in the experiment. Based on an examination of common web browsing behavior, a set of eleven of the most commonly used commands was created. This consisted of: select; backward/forward; scroll vertical; scroll horizontal; zoom; refresh; new tab; close tab; exit browser; stop; context menu. Users were required to utilize these commands to navigate a series of web pages.

1.3. DEVELOPING A GESTURAL VOCABULARY

Once the task was developed, gestures relating to each command had to be allocated. To do this, a focus group consisting of eight design engineering students was presented with a range of gestures selected from literature. The gestures were presented both through written descriptions and graphically, an example of which can be seen in Figure 1.

Back/Forwards(2)

Beating-Slashing. Exercise: Beat a carpet with beater, or hit a nail with a hammer.
Throwing-Slashing. Exercise: Throw coal with a shovel, or a package from hand to hand.
Smoothing-Gliding. Exercise: Smooth cloth by hand , or lace with iron
Smearing-Gliding. Exercise: Smear whitewash on a wall with brush, or mortar trowel.
Flipping-Flicking: Exercise: Flip dry towel or wet towel with hand.
Jerking-Flicking: Exercise: Jerk bottle rinsing it, or break string with hand.

Figure 1. Focus group example

The group discussed each of these in turn, and had the option to suggest alternative gestures for the command. After all the gestures and commands had been reviewed, the group then decided on the most suitable gesture for each command. As part of this process, the number of gestures was shortened to ten when it became apparent scroll vertical and scroll horizontal could be combined to one type of gesture incorporating different axes of movement. The set of gestures developed is shown in Table 1. This was supplied to users in the experiment as a reference.

Table 1. Gestural vocabulary used in experiment, with illustrations and descriptions

Command	**Select**	**Forward/ Backward**	**Scroll**
Gesture			
Description	Air Grab - Move hand over item to be selected and grab by moving fingers in to fist position.	Moving Clock Hands - With index finger pointed out in front rotate anti-clockwise to go back a page (or more), clockwise to go forward a page (or more).	Flick - Short hand movement in direction you wish to scroll.
Command	**Zoom**	**Refresh**	**New Tab**
Gesture			
Description	Pinch - Move thumb and finger together to zoom out. Move thumb and finger apart to zoom in.	Whole Arm Swipe - With your arm stretched out move from right to left, as if you were clearing everything of a desk.	Grab top corner and drag to middle - Grab top right corner of the screen and drag to middle to generate new tab.
Command	**Close Tab**	**Stop**	**Close Browser**
Gesture			

Description	Grab middle and drag to bottom corner- Grab middle of the screen and drag to a bottom corner to close a tab.	Flat Hand - Hold hand up and fingers verical with palm facing the screen.	Flat Hand - Hold hand up with palm facing the screen.
Command	**Context Menu**		
Gesture			
Description	1. Air Grab - Select item. 2. Twist fist clockwise - Bring up options menu. 3. Wave hand - Scroll menu. 4. Air Grab - Select menu item / Twist fist anti-clockwise - Close options menu.		

1.4. RECORDING USER RESPONSE

As the experiment was intended to explore the experience different gestures elicited, several methods were considered for determining the emotions experienced by the user. These included physiological measurements (Flaisch, Häcker, Renner, & Schupp, 2011), the Self-Assessment Manikins (SAM) (Bradley & Lang, 1994) and semantic differentials (Al-Hindawe, 1996).

Developed by Osgood (Charles E. Osgood, 1964; Charles Egerton Osgood, Suci, & Tannenbaum, 1957), the semantic differential technique uses bipolar adjectives (good/bad, valuable/worthless) to understand the connotative meaning of objects or concepts. It has been used in a range of settings, but in this instance provided us with the opportunity to identify appropriate measures through the exploration of appropriate semantic differentials for the gestural vocabulary. This was distributed immediately after users had completed the web browsing task and allowed us to define an appropriate granularity of response – the questionnaire had to be reasonably quick to complete while providing an appropriate level of detail.

In developing a semantic differential scale, Al-Hindawe (1996) recommends the utilization of focus or feedback groups. Therefore the focus group used previously for selecting gesture was used to select adjectives for the semantic differential scales. The group suggested adjectives they associated with each of the gestures through informal discussion, and these recorded. In post-session review, five were selected for each gesture and antonyms identified to create opposing

pairs. The limit of five adjective pairs per gesture was intended to ensure the task of completing the semantic differentials did not become laborious. Figure 2 shows the semantic differentials for the refresh gesture.
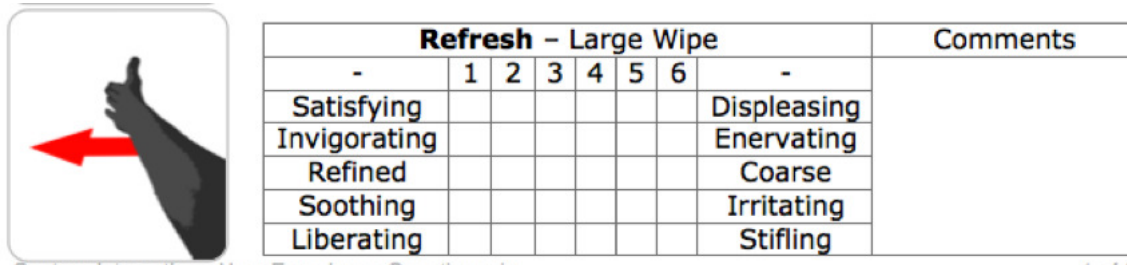

Refresh – Large Wipe								Comments
-	1	2	3	4	5	6	-	
Satisfying							Displeasing	
Invigorating							Enervating	
Refined							Coarse	
Soothing							Irritating	
Liberating							Stifling	

Figure 2. Semantic differential example

1. EXPERIMENTAL SETUP

The experiment was conducted using a 'Wizard of Oz' technique (Salber & Coutaz, 1993). This means that the participant's gestures in the experiment do not directly control the output – in this case the web browser. The user's gestures are instead interpreted by a controller who is observing the user and controlling the computer. The Wizard of Oz setup has been successfully used in a variety of other gesture interaction studies (Fikkert, 2010; Hoysniemi, Hamalainen, Turkki, & Rouvi, 2005; Hummels & Stappers, 1998). While direct user control of the interface would be preferable, the literature suggests that the setup is suitable for gesture interaction experiments. The implementation in this instance was based on the projector-based set-up described by Fikkert (2010), and is shown in Figure 3. The participant stood behind a table supporting the projector, viewing the web browser via a projected screen of 850mm x 740mm. The participants works through the task before completing the semantic differential questionnaire afterwards. The operator also took additional notes based on observation of user behavior.

Figure 3. Wizard of Oz experimental set-up

1. USERS

Thirty users aged 18-70 took part in the experiment. Prior to undertaking the task, users were asked to complete background information including: age, gender, occupation, and cultural background. They were also asked to comment on their expertise in this area by rating (5- very good, 1- poor): technological adeptness (degree of comfort in interacting with electronic products and interfaces in general); web browser familiarity (related to the amount of time spent browsing web pages, downloading files, interacting with social media etc.); and gesture control familiarity (whether they had used games controllers or similar gesture control interfaces previously). It was considered that broader exposure to science fiction film and TV may influence users' familiarity with complex machine interactions. This was not, however, deemed problematic to quantify and beyond the scope of this study. The average ($\bar{x}$) and standard deviation (σ) of the user responses is shown in Figure 4. Most viewed themselves as being technologically adept ($\bar{x}$ = 3.9 σ = 0.99) and all users were either familiar or very familiar with a web browser ($\bar{x}$ = 4.63 σ = 0.55). Users' familiarity with gesture-controlled products, however, was lower and varied more greatly ($\bar{x}$ = 3.03 σ = 1.13) than technology in general or web browsers.
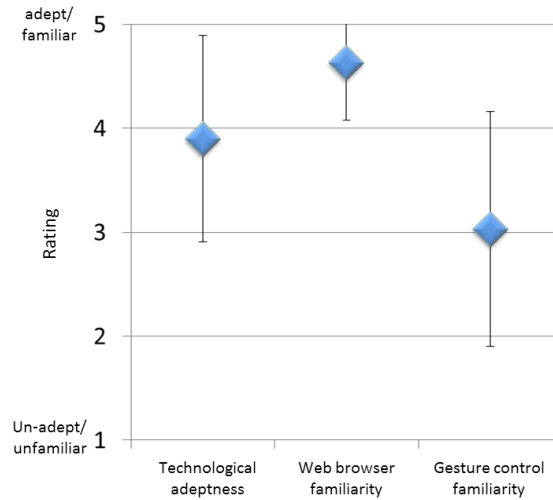
Figure 4. Average and standard deviation of users' technological adeptness, web browsers familiarity and gesture control familiarity

3. RESULTS

The results of the semantic differential questionnaire were reviewed. For each gestural command, Figure 5 shows the mean value across all 30 users for the five related semantic differentials. These results, along with qualitative user responses, are reviewed for each command in turn in the sections below.
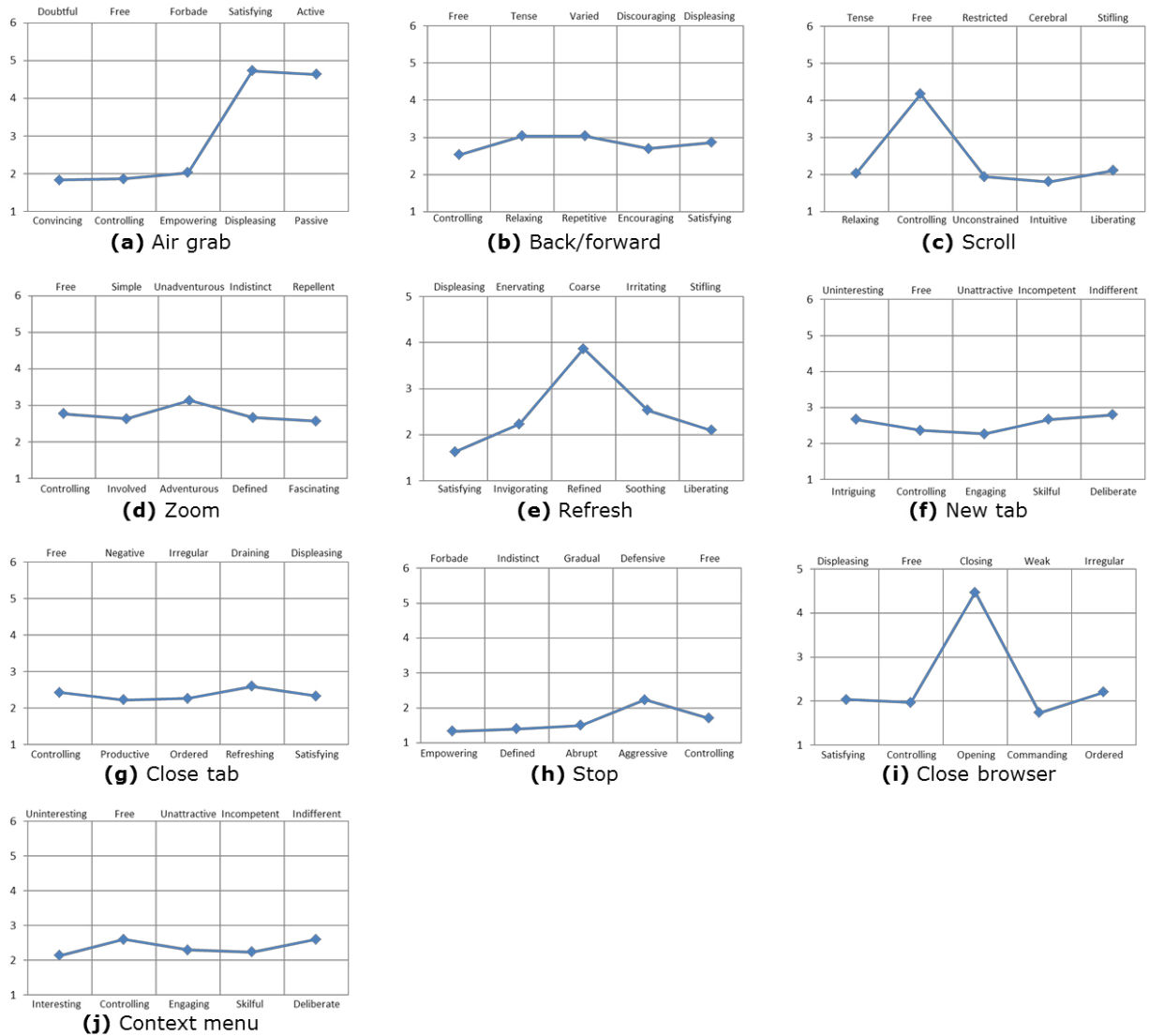
Figure 5. Average user response to semantic differentials for each gestural command

1.5. SELECT (AIR GRAB)

A gesture involving a grabbing motion, with the user closing their hand as if to grip something. All users executed this gesture easily and seemed to find it intuitive. Users had strong feelings relating to the air grab as shown by Figure 5(a)**Error! Reference source not found.**, where the results of the semantic differential tend towards the limits of the scale. Users felt very active while completing this gesture, which may be due to an association with grabbing a physical object. The fact that the gesture felt convincing is important: even though an object does not exist, the

movement engenders a strong emotional reaction that correlates with the movement itself. This is more visceral than for example a mouse click to achieve a similar function.

1.6. BACK/FORWARD (MOVING CLOCK HANDS)

A gesture involving the user rotating their pointing index finger anti-clockwise to go back and clockwise to go forward. Of the gestures tested here, this was one of the most delicate, with 17% of the users commented that they would prefer a bigger gesture involving the whole hand. Satisfaction levels with the gesture were middling, as shown in Figure 5(b). The gesture came across as slightly repetitive, but users also found the gesture encouraging. Users tended to find the gesture both relaxing and controlling though not compellingly so.

1.7. SCROLL (FLICK)

A gesture involving the user flicking the hand, as if brushing the page around with the fingers. Due to limitations of the experimental set-up, this consisted of a short hand movement in direction the user wished to scroll and did not incorporate the more sophisticated "momentum" based on strength of movement associated with many touchscreens. Despite this, from observations users appeared to enjoy using this gesture. From Figure 5(c) it can be seen that the users had strong feelings – both intuitive and relaxing were selected at the limit of the scale. Some users did find the scroll cerebral and those who did tended to rate themselves very low on familiarity with gesture control products or on how technologically adept they were. Though not at the limits of the scale the feeling of liberation, being free and being unconstrained were also selected by the users. These feelings and the loose physicality of the gesture have a lot in common.

1.8. ZOOM (PINCH)

A gesture involving the user pinching their fingers together to zoom out and spreading their thumb and forefingers to zoom in. In Figure 5(d) it is clear that the users did not feel any strong emotions. Though not at the limits of the scale there were clear feelings from the gesture, which were controlling, involved and defined. Of the users who found this gesture to be freeing rather than controlling they all rated their familiarity with gesture technology low. Similarly they also tended to find the gesture simple rather than involved. A couple of feelings did not come across as

strongly for the users: on the fascinating/repellent scale and adventurous/unadventurous the output was only marginally towards fascinating and adventurous.

1.9. REFRESH (WHOLE ARM SWIPE)

A gesture involving a large sweeping action with the user's arm. Through observation it was noted users particularly enjoy this gesture, and this is reflected in Figure 5(e) It can be seen that the users found the gesture highly satisfying as well as invigorating. Users' comments also suggested that this was an enjoyable gesture, highlighting that it was distinctive and fun. The gesture also came across as being coarse, soothing and liberating. As the gesture involves considerable physical motion, it was interesting that this was the case – the effort required does not seem to have been an irritant.

1.10. NEW TAB (GRAB AND DRAG, TOP CORNER TO MIDDLE)

A gesture involving the user air grabbing the top right hand corner of the screen and dragging and dropping into the center. This represented pulling a new window from a tab bar onto the middle of the screen. From **Error! Reference source not found.**(f) it can be seen there were no especially strong emotions associated with it. The gesture did, however, come across as somewhat intriguing. The seven users who did not find it intriguing were unfamiliar with gesture-controlled product prior to taking part in the experiment. The gesture also came across as controlling and engaging, which aligns with its fairly direct mechanics. The two scales that only just swayed in one direction were skillful and deliberate showing these were not strong feelings for the users.

1.11. CLOSE TAB (GRAB AND DRAG, MIDDLE TO BOTTOM CORNER)

A gesture involving the user air grabbing the middle of the screen and dragging and dropping their hand to the bottom corner. This represented the concept of throwing away the current window. Three users commented that this gesture was too easy to confuse with the Select and New Tab gestures. **Error! Reference source not found.** shows that this gesture did not create particularly strong reactions, but feelings of being productive, ordered, satisfied are still evident. Whether the gesture is refreshing or draining is unclear, with neutral feedback.

1.12. STOP (HAND UP FLAT)

A simple gesture involving the user holding his or her hand flat with fingers vertical. Users had very strong feelings associated with this gesture, as shown in Figure 5(h). There was very little variation on the feelings about this gesture across the users, where they found it to be empowering, defined, abrupt, aggressive and controlling. This is reflective of its visceral and universal nature. There were some interesting comments about the gesture from users, including "felt like a break in song", "simple and obvious" and "wasn't sure how to long to hold it for".

1.13. CLOSE BROWSER (TWO-HANDED GRAB AND DRAG, MIDDLE TO BOTTOM)

A gesture involving the user air-grabbing the middle of the "screen" with both hands before pulling down and dropping. It evoked strong feelings within the users as can be seen in **Error! Reference source not found.**(i). Feelings included satisfying, controlling, commanding and ordered. Users also felt the gesture to be closing and this relates to the purpose of the gesture in exiting the web browser. Several users highlighted that the gesture felt definitive, with the two hands emphasizing it as the end of a sequence. Three other users, however, commented that having to use two hands was a negative factor.

1.14. CONTEXT MENU (AIR GRAB, TWIST, WAVE AND AIR GRAB)

A gesture involving multiple parts due to the task it performs. The user at first air grabs before rotating his or her closed fist to bring up the context menu. The user then moves his or her hand up and down to scroll up and down the menu before air grabbing to select the required item. In **Error! Reference source not found.**(j), skillful is seen as the only emotion felt very strongly by users. Four users felt this gesture was difficult to do therefore doing the gesture was a skillful process. It can also be seen that the users felt the gesture was also clearly interesting, controlling, engaging and deliberate.

4. DISCUSSION AND RECOMMENDATIONS

In reviewing feedback, several themes emerged as important in the development and use of gesture. These include context, precision, distinction, repetition and scale, and these have been reviewed below.

1.15.   CONTEXT

Gesture which mimic commonly used actions from real life can be effective in recreating the emotions typically associated with them. The stop command, consisting of a vertical flat palm, is an embolic gesture that would be recognized in any context and was to the users very definite in nature. Its associations with a break, defensiveness or even aggression could, however have a negative impact in relation to the interface. It is therefore important to consider possible connotations of any motion and how they relate to interface functionality. Another example is the select gesture, which consisted of the air grab and again engendered strong reactions in users. It resembles a real-life action, and while no physical object is present for the user to hold or touch, the motion itself was sufficient to engender the feelings of decisiveness. In this sense, the grabbing action is well suited to item selection in the interface design. On the other hand, the back/forward action, which invoked winding clock hands, also mimicked real life but was less intuitive and less effective in engendering emotional response. This suggests that familiar and commonly used motions should be employed where possible, but need to be aligned with appropriate interface functionality.

1.16.   PRECISION

Gestures involving looser, more imprecise movements were found to engender positive, free emotions within the user. The scroll gesture was an example of this. It is directional in nature, with the motion correlating to cursor movement on the screen, but the motion is undefined in that the user chooses the direction of movement. This led to unconstrained and free feelings in users – the opposite of the constrained feelings caused by the more precise and prescribed select feature. Another example was the refresh gesture. While this was a consistently popular gesture, it was also identified as coarse, suggesting that the lack of precision in the gesture may also be a factor in its attractiveness. Creating a relaxed feeling when utilizing interfaces is important for user satisfaction, and ways to incorporate freedom or flexibility in gestures wherever possible may be important in achieving this.

1.17.   DISTINCTION

Gestures that are distinct were found to be more satisfying and create stronger emotions in users. The refresh gesture, with its large sweeping action, was highly appreciated by users. It was also

noted that the gesture was very distinctive, and hard to do by accident. Unlike the refresh gesture which has a distinct movement the new tab gesture, a grab and drag from the top corner to middle, and the close tab gesture, a grab and drag from middle to bottom corner, were commented on by users as being too similar and therefore confusing. This affected how deliberate the new tab gesture felt. It also affected the overall experience of the gesture, which shows that defined gestures created stronger feelings within a participant. Defined does not necessarily mean simple: if the task is not obvious then the gesture does not need to be. The relatively intricate gesture associated with the context menu was positively received. The appropriateness of the physical action for the intellectual task is what matters, and the sequences of grabs and twists, perhaps suggestive of opening a door or turning a key, in this case aligned well with the sentiment of exploration associated with using a context menu. When gesture, emotion and functionality correlate as in this instance, the interface has succeeded.

1.18.   REPETITION

Users tended to find gestures involving repetitive motions laborious and disengaging. The back/forward gesture in particular proved an irritant. The gesture, which consisted of a clockwise or anti-clockwise winding motion, required several revolutions of the finger. For something that is consistently used, this involves more time and effort than is desirable. As a consequence, it can very quickly become tiresome. For gestures such as the refresh, with its broad sweep of the arm, there are additional ergonomic considerations in that if it is used repeatedly it may cause muscle strain. It is therefore very important to include the likely frequency of a command when deciding on an appropriate gesture. While distinction, as previously discussed, can be a powerful emotional differentiator, it cannot be at the expense of fundamental ergonomic issues such as economy of motion, speed of execution and energy expenditure. This is distinct from combinations of movements – most of the motions here consisted of only one or two elements apart from the context menu. The sequence of distinct motions used in this case may have been a factor in its positive reception and should be considered in the construction of more complex gestural interfaces.

1.19.   SCALE

Gestures should be related to the size of the controlled system or output. For example, a full sweep of the arm is a large gesture suitable for controlling images or systems as big or bigger than the human body. In the experimental set-up, users found the small gestures to control the large, projected screen to be disconcerting, which affected their overall satisfaction. An example of this was the back/forward gesture, which users found to be too small, suggesting a bigger gesture involving the whole hand rather than just an index finger would be more appropriate. The zoom gesture, with its pinch to zoom motion, provoked similar comments of dissatisfaction. Further exploration revealed this was related to the delicate nature of the gesture in a relatively large setup. The gesture is commonly used on touch screen devices, and typically far smaller canvas sizes. Within the interface itself, it is therefore appropriate to relate the scale of physical movement to functionality – for example using arms and wrists for grander actions and fingers for more intricate tasks. In addition, the size of execution carries an emotional content: a big arm sweep is an emotionally stronger indication than the same arm motion only with smaller amplitude. This should be considered for the control of machine functions where amplitude (such as volume, speed etc.) are important. The fact that larger, more imprecise movements generally seemed to prove more popular is also worth considering in an overall gestural vocabulary.

1.20.   CONCLUSION

While the results presented are in important step in exploring the emotional aspects of gestural interaction, there are several issues that should be considered for future work. The Wizard of Oz technique proved effective in facilitating the experiment, but the presence of an operator in the room may have influenced results. None of the previous studies cited that used a Wizard of Oz examined the emotions and feelings of users. Some users may have felt uncomfortable with the thought of being observed, and in future experiments a fully-operational interface allowing uninhibited control is desirable. Semantic differentials are an established and appropriate way of recording emotion but did raise several issues. There was a balance between the number of scales used and the time to complete the questionnaire. Only using five for each gesture meant that the results were not as expansive as they could have been. Additionally, the adjectives chosen and implemented did not always allow users to fully express their emotional reaction. Adding the

comments box for each gesture did prove useful as users often expanded on what they were feeling and why.

The main findings from the work include the identification of context, precision, distinction, repetition, and scale as critical factors for consideration in gestural interface design:

- Context – Familiar and commonly used motions should be employed where possible, and aligned with the product functionality.

- Precision – Looser, more imprecise movements tends to create positive feelings within the user and should be used where appropriate.

- Distinction – Distinct, with decisive motions, tend to be more satisfying and create stronger emotions in the user.

- Repetition – Unnecessary repetition should be avoided as users quickly find this laborious and disengaging. Appropriate combinations and sequences of movements can, however, add interest.

- Scale – Gesture size should relate to the controlled system or output, with small movements utilized for intricate tasks. Location and social setting should also be considered in this context.

REFERENCES

Abawajy, J. H. (2009). Human-computer interaction in ubiquitous computing environments. *International Journal of Pervasive Computing and Communications, 5*(1), 61-77.

Al-Hindawe, J. (1996). Considerations When Constructing A Semantic Differential Scale. *La Trobe Papers in Linguistics, 9*(7).

Benyon, D., Hook, K., & Nigay, L. (2010). *Spaces of interaction.* Paper presented at the Proceedings of the 2010 ACM-BCS Visions of Computer Science Conference, Edinburgh, UK.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavioral Therapy and Experimental Psychiatry, 25*, 49–59.

Costello, B., & Edmonds, E. (2007). *A study in play, pleasure and interaction design*. Paper presented at the Proceedings of the 2007 conference on Designing pleasurable products and interfaces, Helsinki, Finland.

Feldenkrais, M. (1972). *Awareness Through Movement*. New York, NY: HarperCollins.

Fikkert, F. W. (2010). *Gesture Interaction at a Distance.* Doctor of Philosophy, University of Twente, Enschede.

Flaisch, T., Häcker, F., Renner, B., & Schupp, H. T. (2011). Emotion and the processing of symbolic gestures: an event-related brain potential study. *Social Cognitive and Affective Neuroscience, 6*(1), 109-118. doi: 10.1093/scan/nsq022

Hoysniemi, J., Hamalainen, P., Turkki, L., & Rouvi, T. (2005). Children's intuitive gestures in vision-based action games. *Commun. ACM, 48*(1), 44-50. doi: 10.1145/1039539.1039568

Hummels, C., & Stappers, P. J. (1998, 14-16 Apr 1998). *Meaningful gestures for human computer interaction: beyond hand postures.* Paper presented at the Third IEEE International Conference on Automatic Face and Gesture Recognition.

Isbister, K., & DiMauro, C. (2011). Waggling the Form Baton: Analyzing Body-Movement-Based Design Patterns in Nintendo Wii Games, Toward Innovation of New Possibilities for Social and Emotional Experience. In D. England (Ed.), *Whole Body Interaction* (pp. 63-73). London, UK: Springer.

Karam, M., & Schraefel, M. C. (2005). A taxonomy of gesture in human computer interactions *Technical Report ECSTR-IAM05-009*. Southampton, UK: University of Southampton.

Laban, R. (1960). *The Mastery of Movement* (2nd ed.). London, UK: MacDonald and Evans.

Laban, R., & Lawrence, F. C. (1974). *Effort* (2nd ed.). London, UK: MacDonald and Evans.

Larssen, A. T., Robertson, T., & Edwards, J. (2006). *How it feels, not just how it looks: when bodies interact with technology.* Paper presented at the Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments, Sydney, Australia.

Lindley, S. E., Couteur, J. L., & Berthouze, N. L. (2008). *Stirring up experience through movement in game play: effects on engagement and social behaviour*. Paper presented at the Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, Florence, Italy.

Meyerhold, V., & Braun, E. (1969). *On Theatre*. London, UK: Methuen Drama.

Microsoft. (2010). Kinect for Xbox 360 Retrieved January 4th, 2011, from http://www.xbox.com/en-gb/kinect

Montero, C. S., Alexander, J., Marshall, M. T., & Subramanian, S. (2010). *Would you do that?: understanding social acceptance of gestural interfaces*. Paper presented at the Proceedings of the 12th international conference on Human computer interaction with mobile devices and services, Lisbon, Portugal.

Norman, D. (2004). *Emotional Design: why we love (or hate) everyday things*. New York: Basic Books.

Osgood, C. E. (1964). Semantic Differential Technique in the Comparative Study of Cultures. *American Anthropologist, 66*(3), 171-200. doi: 10.1525/aa.1964.66.3.02a00880

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*.

Quek, F., McNeill, D., Bryll, R., Duncan, S., Ma, X.-F., Kirbas, C., . . . Ansari, R. (2002). Multimodal human discourse: gesture and speech. *ACM Trans. Comput.-Hum. Interact., 9*(3), 171-193. doi: 10.1145/568513.568514

Rico, J., & Brewster, S. (2009). *Gestures all around us: user differences in social acceptability perceptions of gesture based interfaces.* Paper presented at the Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services, Bonn, Germany.

Saffer, D. (2008). *Designing Gestural Interfaces*. Sebastopol, CA: O'Reilly Media, Inc.

Salber, D., & Coutaz, J. (1993). Applying the Wizard of Oz technique to the study of multimodal systems In L. Bass, J. Gornostaev & C. Unger (Eds.), *Human-Computer Interaction* (Vol. 753, pp. 219-230). Berlin, Germany: Springer.

Shan, C. (2010). Gesture Control for Consumer Electronics. In L. Shao, C. Shan, J. Luo & M. Etoh (Eds.), *Multimedia Interaction and Intelligent User Interfaces* (pp. 107-128): Springer London.

Yammiyavar, P., Clemmensen, T.,Kumar, J. (2008). Influence of Cultural Background on Non-verbal Communication in a Usability Testing Situation. *International Journal of Design, 2*(2), 31-40.

1.21.   BIOGRAPHIES

1.22.   ANDREW WODEHOUSE, UNIVERSITY OF STRATHCLYDE

PhD in Design, University of Strathclyde, 2010. Andrew Wodehouse is a Lecturer in Design at the Department of Design Manufacture and Engineering Management at University of Strathclyde. He worked as a product design engineer for a number of design consultancies prior to this, and his PhD focused on digital information support for concept design.

1.23.

1.24.   JONATHON MARKS, UNIVERSITY OF STRATHCLYDE

MEng in Product Design Engineering, University of Strathclyde, 2011. Jonathan recently graduated with a Masters in Product Design Engineering with Distinction from the University of Strathclyde in Glasgow. He has a strong interest in the design and development of consumer electronics with a particular focus on interface design.