Designing User Interaction for Face Tracking Applications

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Abstract. Face tracking could potentially become a powerful new technology in the Interaction Designer's arsenal, providing new modes of access to computing and communications. However, such interfaces could be misused in ways that confuse and worse misrepresent users, leading to poor interactions. Careful considerations of the human face, facial expression and the characteristics of tracking systems are required to ensure responsible design. This paper begins to explore this necessary field of study highlighting the need for future experiments. We conclude that due to the imperfect nature of tracking systems, feedback is immensely important and we consider methods of providing this.

1 Introduction

Apparatus for tracking the facial expressions of humans have existed for some years [1][2]. Traditionally these have been captured using markers placed on the face, however using computer vision techniques markerless systems are becoming viable [3][4]. The inconvenience and expense of marker based systems limit their use to specialist applications with large budgets, the markers are quite obtrusive and inhibit performance. Markerless systems enable many to have access to this technology using only an inexpensive camera, in a variety of locations and situations. There are a wide variety of applications including: mobile videophones, animation, broadcast television, accessibility aids and affective computing. Using such technology there is the scope for creating extremely natural computer interfaces and communication systems. However, we present some properties of such applications and argue that these systems require special attention.

Our current work is in the development of a markerless face tracking system for the Prometheus project [5] a three-year collaborative LINK project under the Broadcast Technology Programme funded by the UK DTI and EPSRC. The project includes markerless face and body tracking, actor and clothing model animation, scene construction and three-dimensional display technologies. It is seeking to build a virtual production chain for 3D television to encapsulate these technologies.

The Prometheus face tracker uses a single camera to capture the actor's performance in real-time, using a tracking algorithm derived from [6] and described by [7] from which it derives the head's orientation and the facial expression.

This can be encoded as an MPEG-4 stream [8] and be used to animate a photo-realistic head.

The thoughts presented in this paper are the result of our own experience using markerless face trackers over the past three years and the application of research from other areas to this new field. As yet we have not verified our hypotheses by experiment. Our hope is to open up this area for further study.

2 Characteristics of Face Tracking Systems

It is important to understand the nature of face tracking systems in order to design responsible user interfaces.

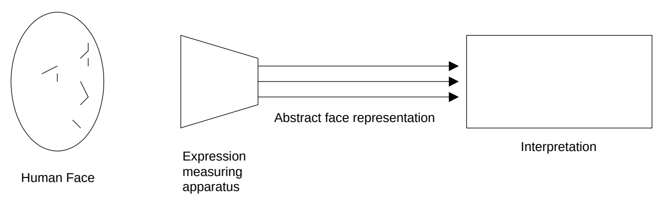

Fig. 1. A minimal face tracking system

Figure 1 shows the minimal set of components required for a face tracking system: the human face, expression measuring apparatus generating an abstract representation of that face and an interpretation stage, where that representation is manipulated. Arising from these components any face tracking system will exhibit the combination of their characteristics, regardless of its form. We also consider there to be two broad system classes; Facial Human-Computer Interaction (FHCI) and Human-Human Computer Mediated Facial Communication (CMFC). This section considers the general characteristics and those of the two classes.

2.1 Characteristics of a Minimal Face Tracking System

The human face is an extremely mobile and flexible device. There are enough muscles in the face to distort the face into over 7,000 unique facial actions [9]. The face can move fast too: the smallest perceptible expression exists for as little as one twenty fifth of a second [10]. However the features and their placement on the human face are universal and in addition Darwin [11] claimed that there are universal expressions that are recognised cross-culturally.

The expression measuring apparatus transforms the motion of the face into some abstract representation of the expression. There will inevitably be some optimal operating conditions e.g. the actor is within the field view of the camera, the lighting is correct, and some constraints on the range of facial motion detectable.

We will only consider here computer-based systems where the representation of expression will exist as a digital sequence. The sampling process required to convert continuous facial motion to a discrete digital sequence will necessarily introduce quantisation noise and have a limited frequency response.

The effects of digital representation are also dependent on the specific representation we use for expression. There are many existing schemes including: FACS (Facial Action Coding System) [12], MPEG-4 FAP (Facial Animation Parameter) [8], AMA (Abstract Muscle Action) [13] and FAML (Facial Animation Markup Language) [14]. Any conceivable scheme is an abstraction of reality and as such will be more or less suitable for some applications. For instance, systems implementing the original FACS scheme can not represent asymmetric expressions, but FACS can provide a high-level description suitable for machine classification of emotion [12]. The MPEG-4 FAP coding gives a lower level representation defining the displacement of known control points on the face along significant axes. Associated displacements along other axes must be interpreted and cannot be represented explicitly in the coding. Since MPEG-4 does not prescribe how the interpretation should proceed, expression reconstruction will vary between implementations.

Inevitably there is delay between the expression being posed and its complete interpretation. There will be a trade-off between accuracy and system performance, which will be made according to the application; be it real-time or off-line.

Given the mobility of the face, the issues of representation, and the current state of the art, it seems likely that any tracking system will remain 'blind' to some classes of expression in the foreseeable future. The tracking equipment and representation of expression should be chosen to match the requirements of the ultimate application.

2.2 Characteristics of Facial Human-Computer Interaction (FHCI)

We consider computer interfaces driven by human face tracking as belonging to a class of interaction that Nielsen calls "Non-command User Interfaces" [15]. These interfaces are those which do not rely on formal commands and syntax, such as command lines and WIMP (windows, icons, menus and pointer) paradigms. Examples of such are gesture recognition systems [16], eye tracking [17] and ubiquitous computing scenarios [26].

Eye tracking systems are cited as an example of a non-command style interface and many of the issues surrounding eye tracking are also common to face tracking. For example, care must be taken with the interpretation of eye tracking data, since the movement of the eye is far more complex than the viewer is consciously aware. The eye makes frequent saccades and even when fixated there is significant jitter. Also the distinction between exploratory and intentional eye fixations must be made to avoid the 'Midas touch' effect where everything the user looks at is selected, for instance every folder is automatically opened even when the user is merely reading its name [17].

Similarly with facial expression we are generally not directly aware of our current expression and many of the movements we make are not necessarily intentional. It is impossible to disengage the face, it is 'always on' even when distracted by something else. Jacob [17] suggests the use of a 'clutch', pressing a key or making some other form of input to release the face.

While the eyes have a clear mapping as a pointing mechanism, the face is much more flexible and the high level concepts expressed are less easily mapped to computing tasks. More "natural" input modes does not necessarily lead to more intuitive interfaces.

2.3 Characteristics of Human-Human Computer Mediated Facial Communication (CMFC)

Human-Human Computer Mediated Communication is concerned with enabling real-time communication between two or more people via computers and networks.

We seek face to face communication as it facilitates non-verbal communication, which helps us gauge the attitude of the other party with more confidence. The generation of facial expressions is in part at a subconscious level, it is difficult to have conscious control of the expression on the face all the time. For instance, few people can artificially pose a convincing smile, as they are unaware of the spontaneous timings that occur. Our true emotions are hard to suppress and professional actors are considered skilful, so we tend to trust the facial cues we see.

However, where facial expression is represented digitally, it can be duplicated, stored and modified; as with any other binary sequence. We can imagine a face tracking system where dishonest faces are caught by the system and replaced with amiable expressions. It becomes possible to manipulate consciously something that was largely out of control and digital facial expression no longer naturally reflects our true emotions. There is clearly much scope for deceit. We should therefore question whether there is any basis for trust in this scenario. Will this devalue this means of communication in virtual environments?

Donath [18] discusses many implications of using representations of a human face in the design of computer-mediated human interactions; including the perception of identity, social identity and expression.

In certain circumstances it might become desirable to hide our facial identity or only selectively reveal different attributes to different people [19] due to the large number of social assumptions inferred from the appearance of a face.

3 Feedback in Face Tracking Applications

From our previous analysis, face tracking applications necessarily have limited capabilities. The user should be informed of these by a responsible application, allowing them to adjust their behaviour with predictable and so learnable results. We introduce here three feedback mechanisms through which the user can become aware of an application's capabilities: Reviewable, Reflective and Indirect.

3.1 Reviewable (Non-real-time feedback)

An application is Reviewable if it allows the user to review how the machine has interpreted the face, before it is committed. This essentially allows the "undo" function with which we are familiar in the desktop paradigm. Making the actions of the user reversible inspires confidence and promotes the exploration of the systems. Examples of this include animation applications where face tracking data can be iteratively reviewed and tweaked by the artist until the desired character manipulation is achieved.

However, there are some classes of face tracking applications where this review is impossible. For instance in real-time telecommunication, where the machine must interpret the face and reconstruct a rendering of it at the far end instantaneously.

3.2 Reflective (Real-time feedback)

An application is Reflective if it presents to the user a real-time view of the machine's interpretation of their face. This should allow the user to learn the cause and effect relationships and the degree of expression that stimulates large or small responses. Most face tracking systems today incorporate some augmented self-view indicating the computer's interpretation [3][4].

However, there are some applications where feedback in this way is difficult. Consider a machine where a display (optical, aural or haptic) can not be physically incorporated into the device due to the small size, or other operating constraints.

3.3 Indirect

In everyday social situations we can not see our own facial expression, only gauge them indirectly via the response of others. Applications may be designed using a similar feedback approach.

For example consider Figure 2 which illustrates a communication system. Participant 1 only sees a reconstruction of Participant 2's face and vice-versa; hence each is aware of the other's reactions. However as we have previously discussed, any system will have capabilities and limitations, being blind to some faces and misinterpreting others. There are two stages of interpretation in this loop, each potentially having a different set of characteristics, both of which can manipulate the reconstructed face in unintended ways. This may result in misunderstanding and confusions, especially where each participant is unaware of the limitations of the underlying system. With necessarily imperfect interpretation stages this style of feedback may prove to be hazardous.

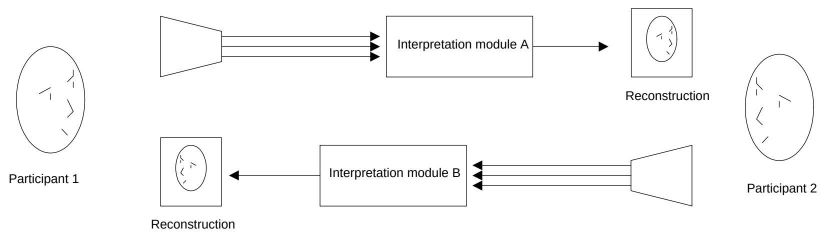

Fig. 2. Indirect Feedback Example

4 Face Tracking Applications

We present here a set of scenario applications and discuss their properties and design challenges with reference to the application classes and possible feedback mechanisms that could be employed.

4.1 Mobile Videophone (CMFC)

The problem of reliable translation of facial expression is of particular importance in telecommunications applications; for instance a mobile videophone arrangement where the participants' faces are tracked and drive virtual masks visible to the other. The most obvious advantage of tracking and virtual masks over coding the video is the reduced bandwidth requirement for high level descriptions of facial motion. In this scenario the expression must be interpreted in real-time and sent immediately to the receiver, so this can not be made a reviewable system. We would discourage designing an indirect system for the reasons discussed. However it may also be difficult to implement a reflective system using video due to small screen sizes for handheld devices, and alternative output modes should be investigated.

Here the system has an obligation not to misrepresent. Given this situation there must be overwhelming evidence before a "dangerous face" is pulled. A dangerous face is one that expresses an extreme emotion, for example an angry snarl or a suggestive wink; these may differ between cultures. Human translators of conversation face a similar problem, although in most circumstances they are able to verify the speaker's intention. For these reasons it would seem likely that such systems would tend to be used for relatively passive exchanges.

4.2 Animation (CMFC)

In this scenario the goal is to create a stream of data that can be applied to the head of an animated character to recreate a believable sequence of facial expressions, emotions and lip synchronisation. The quality of the data is of the greatest importance; in terms of frame-rate, range and smoothness of expressions. Thus the priority of the tracking application is to capture the raw data with as much precision as possible, so that post processing to determine facial motion has the greatest chance of success. That is to say capturing uncompressed frames of video from high quality cameras at a high frame rate, that can be analysed by the computer at its leisure after capture has completed. Gleicher discusses the challenges of using vision techniques to drive animation in [20].

We feel a degree of real-time feedback is important to demonstrate to the user that the video input is acceptable. The system should also be reviewable to enable the user to determine and correct (by re-recording or manual editing) any misinterpretations made in the processing.

4.3 Broadcast Television (CMFC)

Using face tracking to code video or drive 3D facial models as part of a virtual production chain such as Prometheus [5] provides advantages for broadcast (e.g. news or chat shows) in that the output can be scaled more intelligently for different transport networks and end devices.

As with animation, quality is the main priority, and a delay while processing occurs is acceptable. However if the broadcast is "live" then there is no opportunity to review the computer's interpretation before broadcast. The real-time reflective interface must show sufficient detail to allow the producer to make quick decisions whether to trust the output of the computer. Particularly with news broadcasts it is again important not to pull dangerous faces with extreme emotion that might put a different slant on the content. Hence a fairly emotionless, cautious approach is required in the tracking.

4.4 Accessibility Aids (FHCI)

Non-intrusive facial tracking provides obvious advantages for users who find traditional input devices - keyboard and mouse - difficult or inconvenient to use. Jacob [17] suggests that for quadriplegics or for users whose hands are occupied (e.g. pilots) eye or face tracking interfaces provide significant benefit, even if they perform only minimally well because the users have no other available method of input.

If face tracking is to be used for controlling user interfaces, the tracking algorithm must run in real-time but not absorb a major share of computational resources, since other tasks must be able to run concurrently [21].

This scenario provides some inherent feedback since the user can see how the interface has responded to their actions through menu option choosing, or navigation through virtual worlds. However, because of the potentially dangerous consequences of some of these actions, the interface should also be at least partly reviewable with the options to confirm actions or undo mistakes.

Existing techniques have focused on gross head movements or eye tracking, but as techniques and computing power improves the ability to detect and process more subtle gestures and expressions will become possible. This will lead to richer interaction and an increased bandwidth flow into the computer [22]. However the gestures must be natural to avoid fatigue through repeated actions.

4.5 Affective Computing (FHCI)

Affective computing is concerned with responding appropriately and sensitively to user's emotions. For example MIT [23] have developed a CD player that plays music based on the listener's current mood and listening preferences. There are applications of affective face tracking in ubiquitous computing environments, where the aim is to make many computers available throughout the physical environment, while being effectively invisible to the user.

Emotions and mood changes are generally gradual and the computer will only become 'aware' of a user's mood over time. Hence continuous real-time feedback is inappropriate, as is occupation of a large portion of the available display space. A small visual token (e.g. icon, light, flag) or ambient change may be more useful. Existing research has already addressed classification of emotion in faces [10][24] and real-time systems that combine this with face tracking are feasible in the near term.

5 Discussion

Having presented our views on the classes of face tracking applications, some mechanisms for providing feedback and some sample applications we now discuss some of the specific issues that arise for interaction design.

5.1 Manifested Interfaces

We observe that the interaction may be constrained and not fully natural. Consequently face tracking applications must expose the system's capabilities and make them apparent to the user so as to allow their actions and the reaction to be predictable and learnable. The interface mustn't suggest too much or too little functionality.

It has been suggested that "Face-to-Face Implies no Interface" [25]. Ideally this would be the case, but practically given the imperfect nature of the tracking and representation, we consider a manifested interface to be essential. We must prevent failures in the system being responsible for escalating failures in the communication. In their description of Ubiquitous Computing, Mynatt and Nguyen [26] note that, "...systems rely on implicit sensing that is naturally ambiguous or error-prone, it is up to the designer to help users comprehend the, sometimes variable, limitations of the system."

In dealing with error, there are two ways in which the tracking can fail: the system can lose track of the subject (system failure), or it can misinterpret a facial expression (false reading). In the first, the computer is aware of its failure and alerting the user can be straightforward. In the second, the computer makes a mistake on a single frame, but doesn't realise it. In addition the user may also not spot that the fed back interpretation is incorrect. That is, we suspect that if in general the tracking is perceived to be correct, quick aberrations will go unnoticed. However in CMFC systems, the recipient may notice the mistake, particularly if the expression posed was "dangerous". Therefore if the system is to allow dangerous faces and not cautiously filter them out, then feedback must specifically alert the user to their creation.

In situations where a reflective interface is appropriate a 'Magic Mirroring' metaphor provides a useful tool. The user can see themselves on the screen as they face it; it appears like a mirror which augments the view with computer generated markers. For this metaphor to be apparent the screen and camera must be collocated and the image must be flipped horizontally in order to maintain the illusion. This is the interface currently employed in the Prometheus tracker.

The choice of markers is important. Some existing systems [3] overlay the face with spots that reflect the image features being tracked. The augmented face appears as if physical markers had been stuck to the skin. This interface seems appropriate if the captured data is used to reconstruct the same feature motions on a remote model of the face, however no clue is given as to the computer's understanding of the expression. For example in lip tracking enough information could be inferred from the points around the lips to correctly reconstruct the face, but the unseen classification as happy or sad could be incorrect. Here, more iconic markers may provide an advantage by giving the user a pictorial representation of the computer's understanding - for example a symbol depicting creased lines overlaid on the brow to represent the detection of a frown. It is possible to use multiple reflective interfaces to give the user feedback pre and post interpretation. For example displaying of both the feature detection and the 3D puppet.

If a true reflective interface is not appropriate - because the display is occupied by something else, or there is no display - subtle feedback is still possible through the use of colour, sound or other modes.

5.2 Interface Paradigms

As we have demonstrated there are a number of application scenarios in which we feel it is desirable to have face tracking based interfaces. In these circumstances the expression capture equipment (for instance camera) may be the primary or sole input. The traditional interface paradigms of pull down menus and windows have been designed for mouse and keyboard operations and a new set of primitives may be needed for face tracking based interfaces. The use of face tracking, or any other "natural" communications mode, does not necessarily result in intuitive interaction and requires careful design, as we discussed in relation to the problems of eye tracking.

5.3 Initialisation

Attention must be given to the design of the initialisation stage in which the face is first acquired. The delay and impositions of this stage must be endured by the user each time the interface is used. Here the face cannot be augmented or labeled as the system is not yet aware of it. Practically since the computer is still searching for the face a greater amount of processing is taking place that will inevitably lead to lower frame rates and an increased latency in the feedback. In a more ubiquitous scenario where the user is not directly aware of the interface, the initialisation becomes hidden and this acquisition stage becomes even more complex, as there can be no dialogue between human and machine.

5.4 Expression Representation

The internal representation for the interpreted facial expression should be chosen to match the target application. For instances where reconstruction or playback of the face is required low-level prescriptive representations are good since this reduces the requirements on the player to understand or interpolate the data. If understanding is required then progressively higher level representations and the tools to convert between these interpretations are crucial. High level representations are also key to reducing bandwidth requirements.

5.5 Trust in CMFC Systems

Trust is a fundamental notion a communications system, that the message sent matches the message received. In a CMFC system we have considered the dangers of the system pulling “dangerous” faces unintended by the user and the consequences for the discourse.

Additionally we highlighted the responsibility of the system to have overwhelming evidence before such a face is sent. Additionally, where the sampling rate of the face acquisition is below that of the speed at which an expression can pass over the face we observe that brief expressions can become unobserved. Ekman finds “micro-expressions” of approximately 25th of a second to often disclose dishonest behaviour, where normal “macro-expressions” often last between half and a few seconds [10]. In such a system the recipient could not perceive these micro-expressions and would not be given the opportunity to judge the other as dishonest. However, Ekman showed visual lie detecting to be a difficult task at which many of us are poor.

All these factors mean that a CMFC user should be prepared for the representation of the other to deviate from reality. A responsible application should endeavour to match the users’ perception of the systems trustworthiness, with reality. It is our hypothesis that too much trust will be attributed to the system, leading to communication difficulties. Assuming that to be true, we would need to introduce an element of mistrust in the user’s mind.

There are many ways in which we build trust relationships and there has been work to extend these notions to computer interfaces [27][28]. We are considering promoting a little mistrust in the interface, which requires that many of these principles are actively broken. In a face interface there are a number of ways in which we might change the user’s perception of trust, mainly through the appearance of the head, it’s animation and the voice. One approach may be to deliberately make the face unrealistic in ways that prompts the user to reassess it, perhaps inserting strange (although not deliberately disturbing) animation. Continuing studies are required to investigate these ideas further.

6 Conclusion

Face tracking technology is available now. With advances in markerless techniques there are many situations in which it can be valuably applied. We do not believe that these "natural" interfaces inherently provide natural and intuitive interaction, considering there to be serious design challenges that must be addressed in responsible systems. We have sought to identify a number of these challenges and further work is required to test our hypotheses.

We have considered how the limitations of these systems necessitate feedback, to provide the user with a view of the machine's understanding and interpretation of the scene, aiding learning of its capabilities. We have discussed three possible feedback mechanisms; Reflective, Reviewable and Indirect. We consider that a Reflective or Reviewable interface should be implemented whenever possible. Additionally, we have described a set of scenarios where face tracking may be applied with reference to these concepts.

Given the human face as an extremely subtle communications mode, we have highlighted some means in which it can be distorted through a FHCI and considered how we might design such applications to promote a little mistrust to prevent communication problems.

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References

1. Bergeron P and Lachapelle P: 'Controlling facial expressions and body movements', in Advanced Computer Animation, SIGGRAPH 1985 Tutorials, ACM, New York, Vol. 2, pp. 61-79 (1985)
2. SimGraphics: Virtual Actor System (1994).
3. Eyematic Interfaces: FaceStation - http://www.eyematic.com
4. Seeing Machines: FaceLAB - http://www.seeingmachines.com/
5. Price M and Thomas G A: '3D virtual production and delivery using MPEG-4', International Broadcasting Convention (IBC 2000), Amsterdam, IEE Conference Publication (2000) - http://www.bbc.co.uk/rd/pubs/papers/pdffiles/ibc00mp.pdf
6. Machin D J: 'Real-time facial motion analysis for virtual n teleconferencing', Proc. of the Second Int. Conf. on Automatic Face and Gesture Recognition, IEEE Comput. Soc. Press, pp. 340-344 (October 1996).
7. Mortlock A N, Machin D, McConnell S and Sheppard P J: 'Virtual Conferencing', in Sheppard P J and Walker G R (Eds.): 'Telepresence', Kluwer Academic Publishers, Boston, pp. 208-226 (1999).

8. MPEG-4 - http://www.cselt.it/mpeg/standards/mpeg-4/mpeg-4.htm
9. Scherer K and Ekman P: 'Handbook of Methods in Nonverbal Behavior Research', Cambridge University Press, Cambridge, UK (1982).
10. Ekman P: 'Why don't we catch liars?' Social Research, Vol. 63, No. 3, pp. 801-817 (1996).
11. Darwin C (edited by Ekman P): 'The Expression Of The Emotions In Man And Animals', Oxford University Press, ISBN 0195112717 (1998).
12. Ekman P and Friesen W V: 'Facial action coding system: A technique for the measurement of facial movement', Consulting Psychologists Press, Palo Alto, California (1978).
13. Magnenat-Thalmann N, Primeau E and Thalmann D: 'Abstract Muscle Action Procedures for Human Face Animation', The Visual Computer, Vol. 3, No. 5, pp. 290-297 (1988).
14. Facial Animation Markup Language - http://www.vhml.org/
15. Nielsen J: 'Noncommand User Interfaces', Communications of the ACM Vol. 36, No. 4 pp. 83-99 (April 1993).
16. Sato Y, Kobayashi Y and Koike H: 'Fast tracking of hands and fingertips in infrared images for augmented desk interface', Proc. IEEE FG2000, pp. 462-467 (2000).
17. Jacob R J K: 'Eye Tracking in Advanced Interface Design', in Barfield W and Furness T (Eds.): 'Advanced Interface Design and Virtual Environments', Oxford University Press, Oxford, pp. 258-288 (1995).
18. Donath J: 'Mediated Faces', in Beynon M, Nehaniv C L and Dautenhahn K (Eds.): 'Cognitive Technology: Instruments of Mind Proceedings of the 4th International Conference', CI 2001, Warwick, UK (August 2001).
19. Coutaz J, Crowley J and Brard F: 'Eigen-Space Coding as a Means to Support Privacy in Computer Mediated Communication', Proc. of INTERACT'97, Chapman & Hall (1997).
20. Gleicher M, 'Animation From Observation: Motion Capture and Motion Editing', Computer Graphics 33(4), pp 51-54 (1999).
21. Bradski G R: 'Computer Vision Face Tracking For Use in a Perceptual User Interface', Intel Technology Journal, 2nd Quarter '98 (1998).
22. MIT AI Lab Vision Interfaces - http://www.ai.mit.edu/projects/vip/index.htm
23. Healey J, Picard R and Dabek F: 'A New Affect-Perceiving Interface and Its Application to Personalized Music Selection', Proc. of the 1998 Workshop on Perceptual User Interfaces San Fransisco, CA (November 1998).
24. Essa I and Pentland A: 'Facial Expression Recognition Using Image Motion', in Shah M and Jain R (Eds.): 'Motion Based Recognition', Kluwer Academic Publishers, Computational Imaging and Vision Series (1997).
25. Burford D and Blake E: 'Face-to-Face Implies no Interface', 2nd South African Conference on Human-Computer Interaction (CHI-SA2001) (September 2001).
26. Mynatt E D and Nguyen D H: 'Making Ubiquitous Computing Visible', position paper at ACM CHI 2001 Conference Workshop: 'Building the Ubiquitous Computing User Experience' (2001).
27. Cassell J and Bickmore T: 'External Manifestations of Trustworthiness in the Interface', Communications of the ACM, Vol. 43, No. 12 (2000).
28. Riegelsberger J and Sasse A: 'Face it-Photos don't make a Web Site Trustworthy', Extended Abstracts of CHI2002 (2002).