Affective Computing in Tele-home Health

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Abstract

We introduce an intelligent interface aimed at improving affective distance communications between a patient and health care provider in a tele-home healthcare context. Specifically, we investigate 1) input processing the patient's sensory modalities (or modes) via various media, 2) building (or encoding) a model of the patient's emotions and 3) adapting its output to offer the health care provider with an easy-to-use and useful assessment of the patient's emotional state in order to facilitate patient care. To further conceptualize affective computing possibilities in the home health care setting, we identify additional opportunities for application of the MOUE, such as patient use for self-readings of emotional state.

Need for Affective Computing in Home Health Care

Though on-site presence may not be mandated, the home health care provider must still exhibit cognitive and observational skills to assess patient status from a distance when using tele-home health tools. Vital sign readings and medicine reminders may be effectively communicated through current telehealth home heath care mediums, but affective state assessment may prove more challenging. Current feasibility issues may not permit home health care professionals to consider factors such as communication flow and affective assessment (aside from mental health situations) when assessing required on-site visit frequency. Hence, the computer mediated computer paradox is a relevant factor in the tele-home health care setting. As we decrease the modes of communication and freedom for expression, fewer affective clues pass through the communication process. This may hamper affective assessment.

System Limitations: The first challenge involves limitations in the system capabilities. None of the devices support the multi-modal richness of face-to-face communication, which provides "body language", voice inflection, facial expression, and contextual clues to someone's affective state. As stated by Picard (1995), "…emotional states may be subtle in their modulation of expression… When affect communication is most important, then person-to-person contact carries the most information; email presently carries the least".

The personal information appliances provide the richest range of modality (see Figure 2) such as audio, video, and possibility kinesthetic if one feels that blood pressure level can provide a clue to emotional state. However, the quality of the visual and audio representation may hamper communication. Internet-based synchronous and asynchronous communication is more restrictive than the personal information appliances (video), since free-form text is the only means of signaling emotional states. Literature indicates that emotional states may be conveyed through voice, facial expression and other physiological representations (Lisetti & Schiano, 2000). As we lose these modes, affective assessment may be subject to misinterpretation of meaning as well as deceptive intent (patient trying to hide their emotional state via inaccurate textual representation). In addition to losing modality, the scripted personal information appliance (see Figure 3) shrinks the vehicle of communication down to objective text-based responses, which limits expressive freedom.

MOUE

A MOUE (**M**odel **O**f **U**ser's **E**motions), a system which builds a model of user's emotions during interaction from observing the CMC user (e.g. patient) via multi-sensory devices, addresses some communication paradox challenges experienced in the tele-home health care setting, which we identified in the previous section. Such a system currently under development aims at:

- Identifying emotion components satisfied by its sensory observations;
- Having a database of emotion concepts for each of the most commonly experienced emotions of a given user;
- Providing feedback to the user about his or her state;
- Categorizing similar emotions and infer emotional trends;
- Instantiating its own emotion-like motivational state (future research);
- Initiating some appropriate multi-modal adaptive action from that state (future research).

MOUE (described in details in (Lisetti, 2002)) has three main components: (1) A sensory-motor apparatus performing distributed low-level processing and integrating the result into a ``perceptual interpretation of facial expression'', (2) an ontology of emotion concepts based on schema theory, built as a distributed semantic network and in which each active node represents a characteristic of the current emotion and (3) an active interface which externalizes to the user the perceived emotional state and reciprocally allows the user to correct and fine-tune the systems interpretation of his/her own internal emotional states.

Using the same terminology as Maybury and Wahlster (1998), physiological components are to be identified and collected from observing the user via receiving sensors or *medium*: camera, mouse, microphone through the human senses employed to express emotion, i.e. the different *modalities* or *modes* which refer to: **V**isual, **K**inesthetic, and **A**uditory (**V**, **K**, **A**)[1]. The system can also receive input from **L**inguistic tools (**L**) in the form of linguistic terms for emotion concepts, which describe the subjective experience associated with a particular emotion.

The overall paradigm for MOUE (Model Of User's Emotions) (Lisetti, in press) is shown in Figure 4. The system takes as *input* both mental and physiological components associated with a particular emotion experienced by the user.

Based upon our observations about affect representation (Lisetti, 2001), emotion seems to be best accounted for and represented by including *both* physiological and subjective components in a model of user's emotions. Our main approach is therefore to use the

[1] We limit ourselves to the three modalities (V, K, A) because we currently have found more emotion-relevant literature on those modalities than on the other two modes: Olfactory and Taste (O, T).

results of MOUE sensing the user's sensorimotor cues (facial expressions so far, but it could also be vocal information, galvanic skin response, breathing patterns, or heart beat) to describe a specific multi-modal emotional state that might correspond (with high probability) to the user's current state.

Utilization of facial expressions is appropriate as research on automatic facial expression recognition has shown very promising results (Lisetti, 2000) and facial expressions can be captured in less invasive manners required to capture and measure breathing patterns or heart beats. Because of the multi-modal nature of the MOUE system and its simple natural language processing abilities, it will be possible to map out user's inner states more accurately with the system's growing sensing abilities (such as breathing patterns, or heart beat).

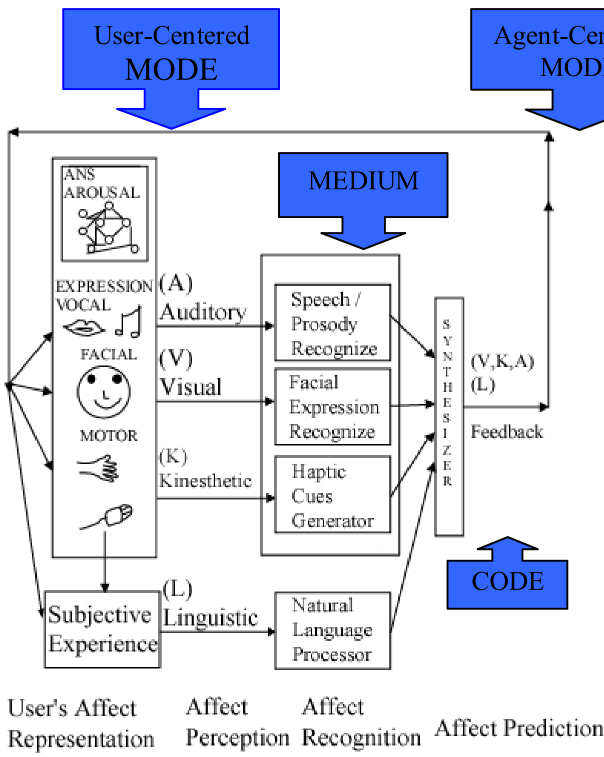

Figure 4: MOUE Paradigm: Combining AI and HCI for Affective Computing

The *output* of the system is given in the form of a synthesis for the most likely emotion concept corresponding to the sensory observations (see Figure 5). This synthesis constitutes a descriptive feedback to the user about his and her current state, derived from the user's ongoing video stream, and a selected sequence of still images.

MOUE in Tele-Home Health

The introduction of an intelligent affective interface into a tele-home health care setting holds promise of providing improved capabilities for affective state assessment and monitoring to potentially increase the quality and possibilities of tele-home health care in a cost-effective manner. A primary issue in enabling the application of this technology to tele-home health care is *acceptance*.

Given the trend toward the use of multiple and increasingly sophisticated devices, including wearable biochemical sensors that track a multitude of physiological measurements in tele-home health care (see Figure 2) (Crist et al., 1996) (Kinsella, 2000), the introduction of new sensors or added application of currently existing sensors to affective state interpretation may not seem foreign or disruptive to the existing tele-home health care atmosphere. A number of reported studies provide initial indications that clinicians, particularly home care nurses, and patients have not been daunted by the introduction of new technologies. In fact, both nurses and patients may be receptive to innovations that provide the possibility of improved patient care (Anderson, 2000; Darkins & Carey, 2000a; Whitten et al., 1997). Accordingly, tele-home health care settings provide a rich landscape for research and application of a MOUE.