Person Aware Advertising Displays: Emotional, Cognitive, Physical Adaptation Capabilities for Contact Exploitation*

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Abstract. Out-of-home-displays have become a well-established medium in public advertising. In the future however, the ever more demanding audience will not be satisfied by today's contents. This paper describes an approach to utilize the human emotional, cognitive and physical state for improving the efficiency of outdoor advertising. The paper starts with a vision of out-of-home-media in the year 2034. That followed, we present a concept to use person awareness and adaptive content to better exploit the contact with the passers-by. Finally we describe the design and techniques of our display prototype system.

Keywords: Pervasive advertising, Out-of-home-displays, Interaction techniques, Computer vision, Context-aware computing

1 Advertising Displays in 2034

In the history of out-of-home-advertising, observers have become increasingly demanding. For a long time already, the transmission of advertising messages by moving images alone had become too clumsy. The modern ad has to be at the same time aesthetically appealing, informative, touch the viewer emotionally and surprise him by an ingenious advertising rhetoric. With the emergence of interactive media, advertisements have now to be invitations to play in which observers can actively participate in.

Advertisers today use sophisticated strategies to cope with manifold requirements. Holistic campaign strategies and social engineering [1] help to tailor the ad to the informational needs of the target group. The dilemma of advertising is that it cannot be tailored to the needs of the actual audience: an audience that has received the same ad just before, an audience that has missed the beginning of the ad, an audience that is interested in getting more detailed information, an audience that is engaged in entirely different activities.

In 2034, advertising displays are aware of their ambient. This ambient consists of the physical context on the one hand; but most physical constants such as location, architecture and visibility can be dealt with beforehand. The key application area for autonomous awareness is instead the ever-changing user context in front of every

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display: the individual persons passing by, or taken the sum of them, the active environment.

In 2034, advertising displays are aware of this active environment. They know what is taking place in front of the display, how many persons have made contact with the display, what are the interactions within the group, who is attentive and who is entertained, who still can be contacted, his attention grabbed, or what has to be done to keep the passerby involved in front of the display: to exploit the contact.

2 Adaptive Contact Exploitation

Most research in the area of adaptive displays deals with information management in multi-user environments including concerns such as identity, privacy, shared use or collaboration. An example of an ambient display framework that adapts interaction principles to the user is given by Vogel and Balakrishnan [2]. Their work focuses mainly on the transitions from implicit to explicit interaction, using indications of the passer-by such as body location, orientation and hand gestures. Our approach is based on this idea. But in order to achieve a more holistic awareness of the active environment, we propose that advertising displays may react in an adaptive way to psycho-physiological states.

Computational techniques for sensing, analyzing and influencing the cognitive-emotional user state are a new field of research aiming to discover the spectrum of the observer's internal states, such as joy, anger, boredom or high mental workload. Together with physical information about the user and behavioral patterns they enable a system to become person-aware. In our scenario this person-awareness is used to extend and improve the contact of the user with the advertisement to better exploit the contact. An image of one of our sample applications and a schema of our concept of adaptive control can be seen in Figures 1 and 2.

Figure 1, Sample Application

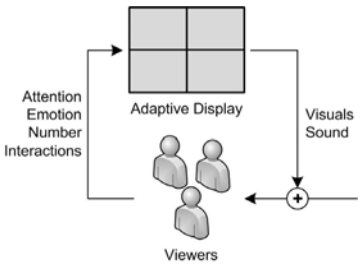

Figure 2, Adaptive Control

In our approach, we enhance advertising displays to address two kinds of adaptations: (1) adaptation to the active environment, and (2) adaptation to the individual user.

Adaptation to the active environment means adaptation to many people in front of the display and the relationships among them. An evident application adapts to the

number of passers-by in front of the display. For example, if there are too many passers-by in front of the display to realize a 1-to-1 interaction, a reactive advertisement is shown. If there is a manageable number of passers-by and possibilities for group interactions, an initial for an interactive game is given. If there's no one in front of the display, an auto-active ambient display is shown.

Adaptation to the user means adaptation to the involvement of the viewer and includes balancing the content according to the user's cognitive-emotional state. An evident application takes the gaze of the observer to detect his awareness of the content, and facial expressions to get indications if the used social technique is approved by him, or if another type of content has to be selected and put in the foreground. For example, the system can transition from informative to more entertaining content if the viewer shows indications of decreasing attention to details or emotions (like joy or anger) that may prevent an effective information reception.

3 Prototype for a Contact Exploiting Display

In order to test our approach, we designed and set up a prototype consisting of a computer vision framework to collect information about the user, a wall of luminous plasma displays showing several graphical applications that adapt to the users' cognitive-emotional and physical state, and a software framework that supports the adaptation. We chose a vision-based sensing framework as it is a convenient sensor technology in this scenario allowing to collect information about user positions, orientations, movements and facial expressions as well as about many features of the environment. Not least, computer vision operates non-invasively and supports implicit interaction. To draw attention to the display, in our sample advertisement a dynamic image of a rotating car is shown that implicitly reacts when potential audience passes the screen. The displayed content then depends on whether the viewers are recognized to be more focused and attentive or if they show emotions like joy or anger. Viewers with a more or less neutral expression are now able to explore the car from the desired viewing angle, while expressions like smiling and anger lead to a funny animation of the car. The aim is to keep the passers-by to stay. If all viewers have disappeared, the advertisement switches back to dynamic content, an auto-rotating car.

To obtain information about single viewers, our approach exploits *model-based techniques* to accurately localize and interpret the visible human faces. A model imposes prior knowledge about the face and represents important face properties via a number of expressive parameters. Such properties include the location in three-dimensional and image space, the shape of mouth, eyes, eyebrows and other facial components. We utilize state-of-the-art techniques to estimate the best model parameterization for every image with high accuracy and in real-time [3].

From the fitted model high-level information is derived. The position of the face in the image is utilized to estimate the user's *gaze direction*. This information is then applied to get indications about the viewer's direct attention on specific display regions or his content involvement. In the future, we will integrate a three-dimensional model to determine the face position in 3D space rather than image space. Furthermore, we plan to use rotational and transitional velocity to gain

information about head gestures giving indications on the viewer's focal awareness or situational involvement.

To determine a *facial expression*, a classifier exploits the model parameters to obtain the current shape of the mouth or the opening degree of the eyes. In addition, muscle movement is determined from the motion of particular facial feature points. We experiment with facial expressions to get information about viewer states such as joy, anger and surprise. For a detailed overview about this research topic we refer to the work of Pantic et al. [4].

The number of users is obtained from the number of visible faces in the image. In the future, we will complement these vision techniques by a *person tracking* application to maintain the association with a moving passerby.

To support such complex user-centric adaptive applications, we are also developing a framework that is based upon the paradigm of component-based software engineering [5]. The framework supports the adaptation of the behaviour of single components via parameter adjustment. This facility is especially useful for our computer vision applications as these techniques often need to be adjusted for specific conditions or requirements. Furthermore, structural reconfiguration replaces one component by another (for example a component for auto-rotation of a car by one for user control) to form an efficient and flexible base for the developed applications.

4 Prospects and Future Work

We have shown a vision of pervasive advertising displays that adapt to the emotional-cognitive and physical state of the audience. Our first prototype is able to adapt content to facial expressions and to positions of individual viewers. The next step is to extend the adaptation capabilities of our system. A first presentation of an early prototype at the FET09 exhibition produced promising feedback of the audience. On the part of advertisers, content that makes use of the proposed adaptation capabilities has to be created. By the year 2034, predefined target-group-specific advertising content will not be enough. In the future, observers will be even more demanding: they will expect that advertising displays ingeniously adapt to their internal state.

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