Proxemic Peddler: A Public Advertising Display that Captures and Preserves the Attention of a Passerby

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ABSTRACT

Effective street peddlers monitor passersby, where they tune their message to capture and keep the passerby's attention over the entire duration of the sales pitch. Similarly, advertising displays in today's public environments can be more effective if they were able to tune their content in response to how passersby were attending them *vs.* just showing fixed content in a loop. Previously, others have prototyped displays that monitor and react to the presence or absence of a person within a few proxemic (spatial) zones surrounding the screen, where these zones are used as an estimate of attention. However, the coarseness and discrete nature of these zones mean that they cannot respond to subtle changes in the user's attention towards the display. In this paper, we contribute an extension to existing proxemic models. Our Peddler Framework captures (1) fine-grained *continuous proxemic measures* by (2) monitoring the passerby's *distance* and *orientation* with respect to the display at all times. We use this information to infer (3) the passerby's *interest* or *digression of attention* at any given time, and (4) their *attentional state* with respect to their *short-term interaction history* over time. Depending on this attentional state, we tune content to lead the passerby into a more attentive stage, ultimately resulting in a purchase. We also contribute a prototype of a public advertising display – called Proxemic Peddler – that demonstrates these extensions as applied to content from the Amazon.com website.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces —interaction styles

General Terms

Design, Human Factors.

Keywords

Proxemic interactions, attention, advertising, pervasive displays.

1. INTRODUCTION

Public electronic displays are now common in our everyday lives, where they are often exploited for advertising purposes. In contrast to static paper posters, most work as a multimedia billboard, where they loop text, still images, animations, and/or videos. Most are also one-way: they broadcast information only, where there is no opportunity for passersby to interact with its content.

However, a few interactive advertising displays are now appearing, typically as research or commercial prototypes. Of these, the majority responds to explicit interaction, where people can interact with the displayed content, e.g., via a cell phone or direct touch (see §2). Even with this added interactivity, content is still usually presented in a loop; this loop is broken only *after* the person has decided to explicitly interact with the system. The problem with this approach is that there is no guarantee that a passerby actually sees or attends the displayed content. Nor is the display aware of how the passerby 'reacts' to the content shown if s/he does look at it. Thus, an advertisement shown on the display may be ineffective, where it captures only a small part of the potential market. Advertisers are not blind to this, and they usually mitigate this problem by (1) using market research to design catchy ads and (2) considering locations and times where the target group is expected to be at least in the display's vicinity.

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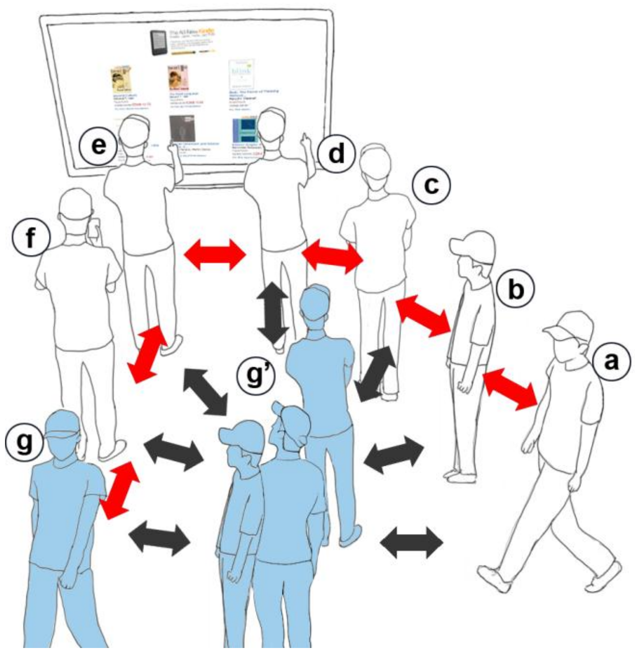

Figure 1. A passerby in various different attentional states with respect to a public display.

In contrast, there is a good understanding of how vendors, peddlers and sales staff attract and maintain people's attention in order to sell products. Depending on the situation and culture, they shout their wares, wave products around, offer bargains, entice people to come closer, and even walk up to people to draw their attention and engage in conversation. Regardless of the strategy, what is common in all cases is that the salesperson always considers the person's attention and reaction to their pitch. For example, if a person appears to be interested, the salesman will further try to maintain and even increase the person's interest.

Within advertising and marketing, this strategy is commonly referred to as AIDA [1] [16]: attract **A**ttention, maintain **I**nterest, create **D**esire, and lead customers to **A**ction. That is, a good salesman (1) takes the initiative to attract attention, (2) deploys appropriate techniques to do so, (3) watches people's feedback and responds to maintain interest and create desire, and (4) gives them easy opportunity to act on that desire.

Ideally, a public display should be designed to leverage the AIDA model. However, it can only do this effectively if – like a salesperson – it can infer attention and interest of passersby and tune the content accordingly. As discussed in §2, various public displays now try to do this. They monitor the presence or absence of a person within a few discrete proxemic (spatial) zones surrounding the display [18][11][15]. They infer increased attention, interest and desire for interaction as people move into zones closer to the display. However, the coarseness and discrete nature of these zones mean that they cannot respond to subtle changes in the person's attention towards the display.

In this paper, we contribute the Peddler Framework, an extension of the Audience Funnel framework [11] that considers the nuances of attracting and maintaining interests of passersby. New aspects include:

- *Continuous proxemic measures,* where the system monitors and responds to the passerby's fine-grained *distance* and *orientation* with respect to the display at all times (Figure 1a-g).
- *Reacquiring interest after digression of attention,* where the system recognizes a passerby's decreased interest and tries to reacquire his attention has digressed elsewhere (Figure 1g-g').
- *Attentional state* with respect to the passerby's *short-term interaction history* over time, where the system responds to the passerby's path through the interaction sequence, rather than just the instantaneous proxemic relationship.

Depending on this attentional state, we tune content to lead the passerby into a more attentive stage, ideally resulting in a purchase. We also illustrate and contribute a prototype of a public advertising display – called Proxemic Peddler – that demonstrates these extensions as applied to content from the Amazon.com website (as shown in Figure 2) as well as the state diagram that implements it (as shown in Figure 3).

2. RELATED WORK

Our work leverages prior research in the areas of interactive billboards and displays, especially those that exploit distance as an implicit measure of attention. It further builds on general principles of (visually) attracting attention and motivating interaction.

2.1 Interactive Billboards

As illustrated by the sampling below, various experimental commercial billboards now use innovative techniques to detect the presence (and sometimes rough position) of a passerby. They use that information to alter their visuals and audio to attract and maintain attention to the advertised product.

Smart Vending Machine. A beverage vending machine in a Tokyo subway station uses a camera and face recognition software to infer – with 75% accuracy – whether a person is present, that person's age (within a decade) and gender [13]. Based on that inference, it displays and recommends particular drinks.

[1] More recent versions of the AIDA model are somewhat more complex as they have more phases. However, this simpler original versionis an appropriate starting point for the work described in this paper.

Nikon Billboard. A very large billboard in a Seoul subway station displays a group of journalists photographing passersby as if they were celebrities [4]. The flashing camera lights and sounds, and cheers of a crowd are triggered automatically whenever a passerby walks on a red carpet in front of the billboard. The unexpected element of (visual and audio) surprise directly engages the passerby and creates an opportune moment of engagement.

The *Adobe CS3 Billboard* is another large billboard that detects a passerby's continuous position (via infrared sensors) as one walks along its length [14]. The passerby's position and continuous movement dynamically influences the displayed animation, which uses elaborate visual effects to attract that person's attention.

2.2 Proxemic Interactions in Ubicomp

Proxemic interactions occur when a device exploits fine-grained knowledge of nearby people to mediate interactions in a ubiquitous computing environment [1] [5]. Along this line, various researchers have suggested models that characterize proxemic relationships, where they divided the area in front of a display into a series of discrete regions to indicate particular proxemics zones [6]. Progressive zones were typically associated with increased engagement, where the content displayed as well as the style of interactions permitted depended on what zone the user was in.

The *Reactive Environment* [3] offered perhaps the simplest model, where it merely detected a person's presence or absence within a specific region surrounding a device or display. The *Vision Kiosk* used the people's presence information to operate in either "attraction" or "interaction" mode [22]. The *Hello.Wall* system modeled the region as three zones to match the likely interest and physical possibilities of what the person could do from each zone [15]. From far to close distances, these were: an *ambient zone* for peripheral awareness, a *notification zone* when people attended the display more closely, and a *cell interaction zone* where people could interact with the display via handheld devices. Vogel et al. modeled proxemics as four zones surrounding a display, ranging from *ambient display*, *implicit interaction*, *subtle interaction*, and *personal interaction* [18]. They also correlated a person's movement through these zones as beginning with peripheral implicit interactions and progressing to more attention-demanding explicit interactions. Ju et al. further developed an implicit interaction framework that mediated implicit to explicit interactions, where they confirmed that foreground interactions require a higher degree of focus and consciousness compared to background interactions [9]. Michelis et al.'s *Audience Funnel Framework* further described the path a user takes to reach the display: attracting attention and motivate the user to interact with the display [11]. They also add an important phase for advertisers: the *follow-up* phase. Greenberg et al. reconsider proxemics as a continuous *vs.* discrete measure, where they further detail five dimensions of proxemics that can be captured and exploited: *distance*, *orientation*, *movement*, *identity*, and *location* [5].

2.3 Visual Attention and Motivation

Attracting attention and motivating interaction is key to our work, and thus deserves a brief summary. We focus primarily on the dynamics of visual attention as applied to HCI, as visuals are the primary communication channel of public displays.

Previous work can be broadly categorized into two groups. *Calm Technology* states that digital technology should primarily work at the attention's periphery (*calmly*), but should also afford people the opportunity to easily (and explicitly) shift their attention to the foreground if needed [19]. Public billboards, as described in §2.1 are the antithesis of calm technology: their goal is to actively shift a person's attention from peripheral to central. *Attentive User Interfaces* are interfaces that are sensitive to a person's attention [17], where the interface somehow senses and infers the user's attention and react accordingly based on a predefined model. Most of the models and systems described in §2.2 are examples of such interfaces, where they use proxemics to model attention.

People's attention can shift in several ways [21]. *Goal-driven* attention shifts occur in situations in which people purposely shift their attention, while *stimulus-driven* attention shifts occur when users involuntarily shifted their attention to the stimuli source [20]. In the case of public displays, both strategies can be applied to accomplish the two important goals: (1) draw the user's attention (e.g., through *stimulus-driven* shifts), and (2) motivate interactions by the user (e.g., through *goal-driven* shifts). In Proxemic Peddler (§4), we chose techniques that make use of *stimulus-driven* attention shifts to attract (or reacquire) a person's attention in a *calm* way. Once we detect the person's attention (i.e., through an *Attentive User Interface* approach), our framework uses techniques that make use of *goal-driven* attention-shifts to motivate a person to move forward. Our framework always switches between these two depending on the current attention level.

Huang et al. found that people generally only spend a few seconds to determine whether a public display is of interest [8]. Consequently, they proposed ways to make a display more noticeable to passersby, such as recommending that important information is presented in a brief manner. However, their methods are still passive (i.e., the billboard waits for people to take initiative). Müller et al. presented several more aggressive ways of attracting attention to public displays by leveraging people's biological, psychological, and social properties [12]. These include *behavioral urgency*, *Bayesian surprise*, *change blindness*, and the *Honey-pot effect* (the systems in §2.1 exploit several of these methods).

When people interact with public displays in busy or crowded environments, their interactions can be categorized into peripheral *awareness activities*, *focal awareness activities*, and *direct interaction activities* [2]. However, researchers found that users do not transition between these phases unless they are motivated to do so [2,11]. Thus motivational techniques can be applied, such as *challenge and control*, *curiosity and exploration*, *fantasy and metaphor*, and *collaboration* [12]. If used appropriately, these techniques can motivate people to briefly interact with a public display, which may increase the advertisement's effectiveness.

In summary, attentional and motivational techniques used by public displays need to be targeted to the situation, and have an immediate effect if they are to be affective. Thus, having a mechanism to dynamically adjust these techniques is essential.

3. THE PEDDLER FRAMEWORK

Prior research (see §2.2 and §2.3) mainly focused on how displays can helpfully assist users to access information. Yet advertisers have a different goal. As mentioned in the AIDA strategy [16], they want to attract and maintain the passerby's attention to the public display, ultimately resulting in interest in the product or even action such as buying the product through the display's interface (if supported). If they lose the passerby's attention, they will have a vested interested in trying to recapture it.

We present the Peddler Framework to address this different goal. As described shortly, our framework extends the Audience Funnel Framework [11] to incorporate continuous proxemic measures including distance and orientation [5], additional states including digression and loss of interest, and the passerby's interaction history, all with the goal of pursuing the AIDA strategy effectively.

Michelis et al.'s Audience Funnel – introduced in §2.2 and described in more detail here – covers six interaction phases a person may be in. Figure 1a-f illustrates these phases, where its letters match the text below describing each phase. Each phase indicates increased attention and motivation of the passerby.

a) *Passing by* relates to anyone who can see the display.
b) *Viewing & reacting* occurs once the person shows an observable reaction.
c) *Subtle interaction* happens if the person intentionally tries to cause the display to react to their movement and gestures.
d) *Direct interaction* occurs when the person moves to the center of the display and engages with it in depth.
e) *Multiple interactions* occur when the person re-engages with the display, and
f) *Follow-up actions* happen after interactions with the display are completed.

While these phases are relevant, the model and systems designed around it generally assume a linear path of progression. Yet this is unrealistic: first, a passerby's attention may change subtly while remaining in a zone, where the zone's characterization of their attention and behavior is no longer correct. Second, a passerby may get distracted or lose attention at any given time within a phase, where they may either return to a prior phase, or abandon the sequence entirely. In either case, the advertising system could try to reacquire that attention. And third, if the passerby's attention is reacquired, the system should recognize that the passerby has returned to a phase and perhaps take a different action.

3.1 Continuous Proxemic Measures

Previous systems divide the space in front of a display in discrete proxemic zones and are thus only aware of the passerby's presence in such a zone. This sub-division is a rough indicator of how interested a user is. Yet considering the movement of a user in front of the display as a binary shift will lead to sudden changes on the display when the user moves from one zone to another. On the other hand, while the passerby remains in one zone, the display will not change, even though the person may exhibit other signs of decreasing or increasing interest. If not catered to, the person may leave before fully exploiting all possible interactions.

A more realistic representation of the transitioning process is a *continuous* one that monitors not only *distance* but *orientation*. For example, if a person is tracked as moving forward or backward, this may indicate increasing or decreasing interest, even though the distance covered may be small. Similarly, one's orientation (e.g., facing towards or away from the display) is suggestive of interest. The red arrows in Figure 1 illustrate this, where they suggest continuous monitoring of a person moving within that space, rather than discrete entering and exiting of zones. If one's movement and orientation is tracked continuously (e.g., a transition begins when the user starts to move and ends once the user stops), the display can react immediately to that person's inferred attention level. Thus, the display can show subtle changes – possibly 'guiding' the person toward the intended goal. Providing such continuous feedback also serves as training for first-time users – a target group of particular importance to advertisers.

3.2 Reacquiring Interest after a Digression

Another important aspect is that people may digress from the sequential path defined by the Audience Funnel. Attention, once acquired, can be easily lost. For example, the person may be losing interest, or may be distracted by other events in the environment. Thus, the display should track people's waning attention, and act on that by trying to reacquire that attention. A *digression phase* and the degree of digression is suggested when a person

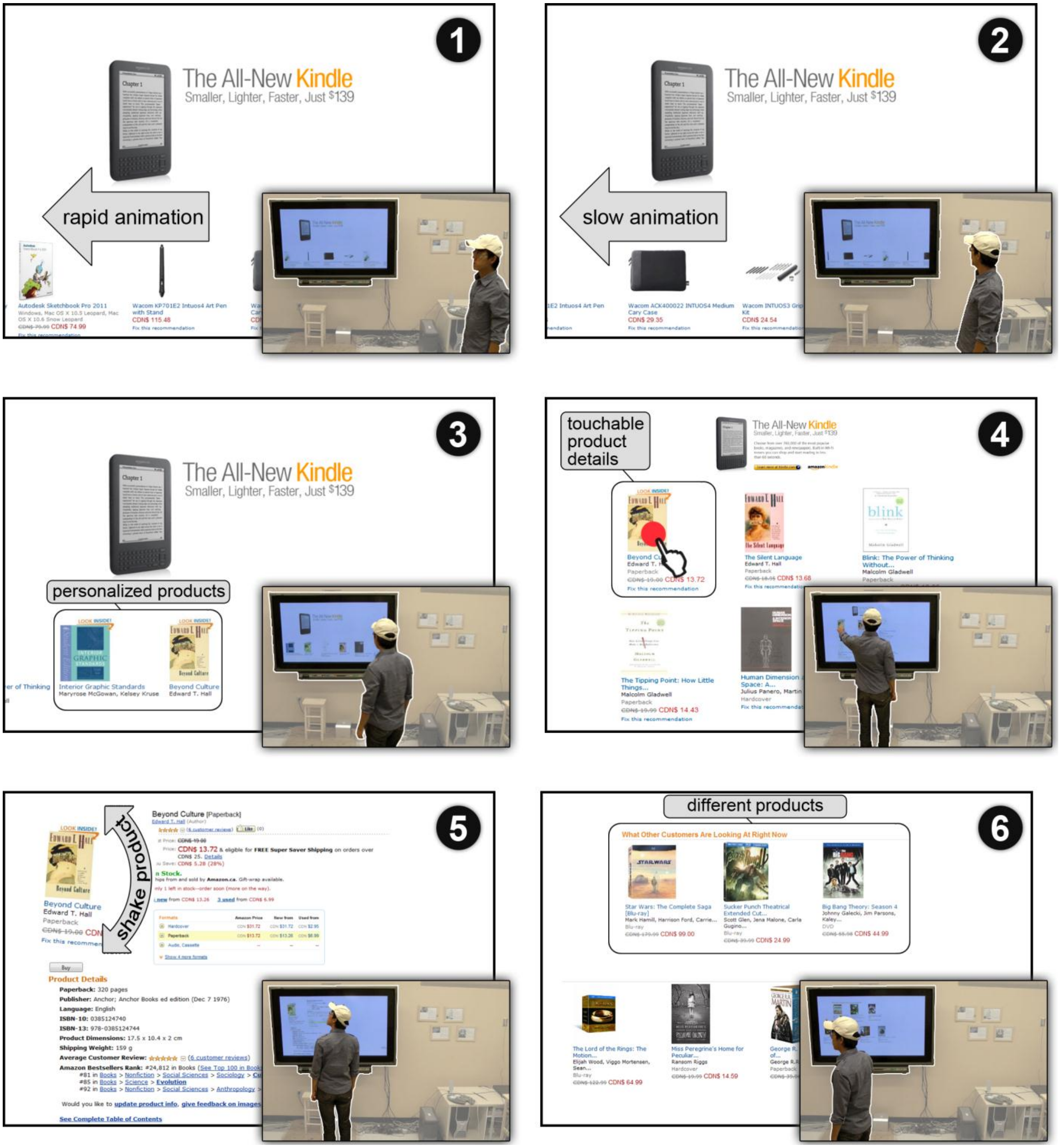

Figure 2. The storyboard of the Proxemic Peddler. Annotations describing interactive elements are in grey boxes and arrows.

pauses the interaction, turns away from the display, and/or moves further away from the display (see §3.1). The black arrows in Figure 1 illustrate this: the person (colored and labeled as g') is shown in various states of digression, until he eventually leaves (g). If the display realizes that he has entered the digression phase, it could react to that, such as by attempting to re-engage them.

3.3 Interaction History

Previous frameworks only consider what zone a person is in, where they just assume that they arrived in that zone from the earlier one in that sequence along a linear path. However, the user's interaction history over time is important, as it tells us much about their attentional state. For example, the meaning of a person in the *viewing and reacting phase* differs considerably if they had entered it from the *passing by* phase (indicating increased engagement) *vs.* from the *subtle interaction* phase (indicating decreased engagement). Similarly, repeated entries and exits into a phase should be taken into account, to avoid repetitious actions. Thus, knowledge of the interaction history is crucial for adapting the display's content to the user's attention at that particular moment in time. The interaction history enables the system to know the path that the user took to arrive at the current phase. With this, the system can compare previous phases with the current one to derive a tendency of the person's interest. The interaction history further compensates for people re-entering a phase after they have digressed. For example, when returning to a phase the system can resume where it left off (or modify what it shows) rather than start from the beginning.

4. THE PROXEMIC PEDDLER

We prototyped a public advertising display called the Proxemic Peddler, which in turn is based on the Peddler Framework. We envisioned Proxemic Peddler as advertising a variety of products from a large online marketplace, where purchases can be made directly from it if desired. Our example is based on Amazon.com, where we took and modified materials from their web site to envision how books could be marketed in such a system.

Figure 2 is a storyboard of a person moving through selected stages while interacting with the Proxemic Peddler (the inset figures), as well as how the display reacts to him (the annotated larger figures). Figure 3 is a state diagram that reflects how the system will respond to particular actions by that person. Finally, a high-resolution video illustrating the system can be previewed online at http://grouplab.cpsc.ucalgary.ca/Publications/2012-ProxemicPeddler.PervasiveDisplays

The first four figures in Figure 2 show the 'ideal' sequence. Fig. 2.1 reflects the passing by phase (see also Fig. 1a): the screen shows a rapid animation of a flow of products at its bottom third, where the animation is intended to attract the attention of a passer-by. In Fig. 2.2, the system detects that the person has slowed down and/or is looking at the display (the viewing and reacting phase), and thus slows down the animation to allow for better visibility of the displayed products (see also Fig. 1b). In Fig. 2.3, the person has moved closer to the display reflecting the subtle interaction phase (see also Fig. 1c): the system responds by revealing personalized products that person may be interested in. Fig. 2.4 is the direct interaction phase (see also Fig. 1d): the display shows a detailed description of the product, where the person can now touch the product of interest (e.g., to purchase it).

The remaining two figures show the display's reactions to digression. Fig. 2.5 illustrates a slight digression, where the system infers the person has momentarily lost interest because they are looking away from the display without changing their position (see also Fig. 1g'). It responds by shaking the currently shown product in an attempt to regain the person's interest. Finally, in Fig. 2.6 the person is slowly moving away (see also Fig. 1g). The display again tries to recapture his attention, but in this case by showing different products at a large size at its top.

5. IMPLEMENTATION

Proxemic Peddler tracks three important proxemic variables as defined by Ballendat et al. [1] and Greenberg et. al. [5]: (1) the person's *identity* to better select a subset of products of his or her interest, (2) the *position* of the person in front of the display, and (3) the person's *orientation* or, more precisely, the person's direction of view. It does this using the Proximity Toolkit [10], which uses the Vicon motion capture system (www.vicon.com) provides both absolute position and orientation of people, the relative distance between the person and the display, and the orientation of a person's head towards the display. It also identifies the person, using additional metadata, to create the products of interest based on a mixture of that person's shopping history and the flagship products the store is trying to sell.

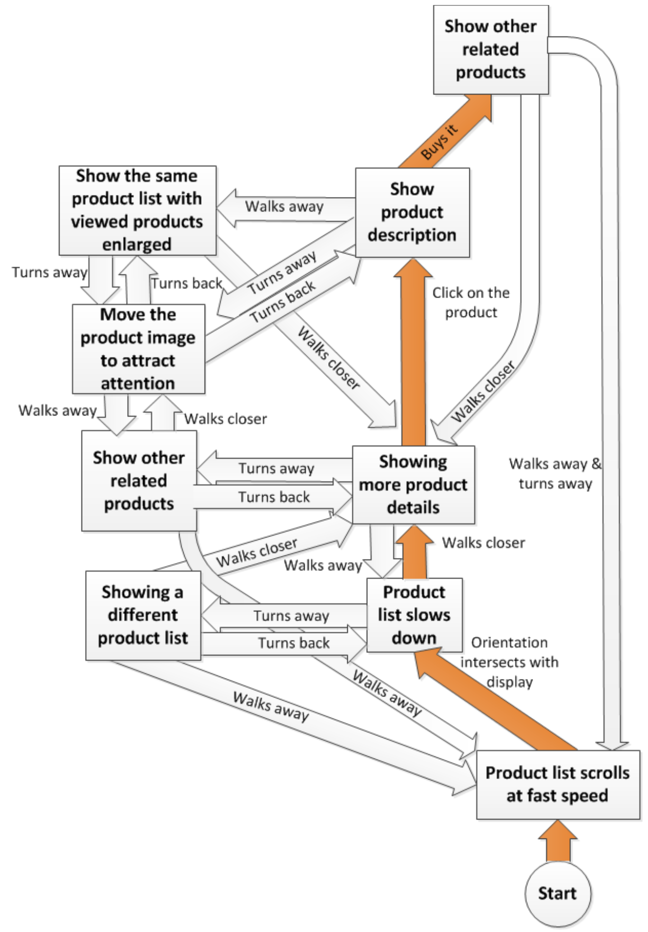

Figure 3. State diagram & internal event flow of the Proxemic Peddler. Orange arrows denote the 'ideal' interaction path.

We capture a person's direct interaction at the display via a 52" wall-mounted display with a SMART DViT overlay (www.smarttech.com). The software was written in C# and Microsoft's Windows Presentation Foundation (WPF) framework, and runs on a computer attached to the display. Software receives all events from the Proximity Toolkit through socket connections.

The system implements the Peddler Framework as a state diagram, shown in Figure 3. The 'ideal' sequential path for the person is marked in orange; all other phases are a result of digressions and attempts to recapture that person's attention. Interaction history is reflected in this state diagram as particular sequences and loops contained within it. Of course, more complex and nuanced state diagrams are possible.

Proxemic Peddler is a running prototype. It is limited in the number of people it can detect at a time, and it requires those people to wear markers. Our current design only reacts to one person at a time. Even so, we expect it could be modified to handle a larger crowd by, for example, showing the set of products of interest to the largest possible subset of people close to the display. Alternately, it can focus on a particular individual that is showing the most attention (much as a market peddler does). While all this make Proxemic Peddler clearly impractical for real deployment, it suffices as a proof of concept. Still, we expect that routine development and lower-cost technologies (e.g., the Kinect) will make real-world deployments feasible in the near future. We also recognized that the distance and orientation is just an estimation of attention. There are other context of user may be missed. However, they are a good first approximation. The particular techniques are reasonable ways to attract attention, but professional marketers are likely to develop their own methods as stimuli.

6. DISCUSSION

Advertising is considered by some as an undesired application of HCI. Indeed, a cynical view of our work is that we can apply our framework to create systems that has potential to unpleasantly demand a person's attention, i.e., mimicking an over-aggressive peddler. While it is beyond the scope of this paper to talk about effective advertising, a few issues relevant to our system are worth discussing.

Involving people. In our prototype, a person's attention is drawn from the moment the person glances at the display while passing by, to the various states as they move and orient towards and away from it. From the person's point of view, our design intent was to draw that person's attention in a subtle way (§2.3). However, attention-drawing methods have to be chosen carefully. For example, other methods may draw more attention, but may also be annoying. As an extreme example, the movie Minority Report envisioned a futuristic advertisement yelling out the person's name, which is not only rude but an invasion of that person's privacy. On the other hand, being too subtle may result in a failure to capture people's attention. Proxemic Peddler tried to balance these extremes. It used animation to capture and try to regain attention (§2.3 *stimulus driven*). Once acquired, it tracked each and every motion of the user, where it continuously slowed down the animation and displayed increased detail of personalized content as the person approached it (§2.3 *goal driven*). This emphasized the product and its legibility as a means of retaining attention and affording interaction. Subtle animation and product changes were also used to reacquire attention when a person digressed.

Letting go. When drawing the user's attention fails, the system (and the designer respectively) faces the choice of either trying to regain attention or 'letting the person go'. Proxemic Peddler takes a conservative approach, where it attempts to regain the user's attention only once (e.g., by shaking products that were of interest previously), which is unobtrusive enough to not interrupt a person who decides to move onto something else. What to do may also depend on context. One approach could compare the importance of the display's message with the person's cost of shifting attention from his current task: the system would only interrupt the person if the benefit outweighed the cost [7].

7. CONCLUSIONS & FUTURE WORK

In this paper, we presented the Peddler Framework, which extends existing frameworks for large public display interaction. The framework models the *display's* goals as opposed to the *user's* goals. With our extensions, a display can keep constant track of the user's actions, compare them to interactions that happened right before, and react accordingly by (1) continuing to encourage users to move closer, or (2) regaining the user's attention. We then applied this framework to design the Proxemic Peddler, a digital advertising display based on these principles

In the future, we plan to extend the existing prototype in several ways. First, we want to investigate solutions for multiple users (some of which we already stated before) such as split-screens, mixed recommendations, or selecting one target customer out of a group. Second, we plan to use alternative tracking technologies that allow for an easier deployment in rather crowded places (e.g., Microsoft's Kinect). And third, we want to deploy a display in a public space to see how people would react to such systems with varying attention-demanding techniques.

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