

Empathic Interaction with a Virtual Guide

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Abstract

The Empathic Tour Guide System is a context-aware mobile system, including an ‘intelligent empathic guide with attitude’, offering the user a seamless, temporally and spatially dependent, multi-modal interaction interface. It will consist of two virtual agents each possessing a contrasting personality, presenting users with different versions of the story of the same event or place. An Emergent Empathic Model with Personality is proposed as a mechanism for action selection and affective processing. The system will mould to the behavior of the users and facilitate their movement, applying story-telling techniques which link the memory and interests of the guide as well as the visitor to the spatial location so that stories are relevant to what can be immediately seen, creating personalised communication. Multisensory systems will be integrated with the PDA, adopting wireless technology. Detection of the user’s current physical position will be performed by a Global Positioning System. This paper presents a review of related work, the proposed system, consideration of the challenges in system design and development as well as a discussion on future work to be carried out.

1 Introduction

The appearance of intelligent computing environments equipped with modern technologies poses new challenges for the design of computer-user interfaces. In such environments, more human like communication methods will play the key role, replacing the classical input devices like mouse and keyboard (Kruppa, 2004). The better computational agents can meet our human cognitive and social needs and the more familiar and natural they are, the more effectively they can be used as tools (Dautenhahn, 1999). This new approach to interaction focuses on the social and emotional dimension of computer technology, challenging the traditional conceptions of intelligence and the design of intelligent systems where AI is modelled solely as problem solving, the internal manipulation of symbols representing items in the real world.

In this paper, an Empathic Tour Guide System (ET Guide) is proposed to address the frustration that usu-

ally occurs in interaction with an emotionless computerised system that does not react intelligently to the user’s feelings. The main aim of this research is to implement context-aware, chatty, emotional and persuasive intelligent agents with personality in an Augmented Reality (AR) environment. The goal is to go one step further in the development of existing location-aware adaptive systems (Abowd et al., 1997; Sumi et al., 1998; Not et al., 1998; O’Grady et al., 1999; Höllerer et al., 1999; Malaka and Zipf, 2000; Bertolletti et al., 2001; Baus et al., 2002; Almeida and Yokoi, 2003; Ibanez et al., 2003; PEACH, 2004) by making interaction more natural and interesting.

According to Tozzi (2000), one of the most striking features of historical investigation is the coexistence of multiple interpretations of the same event, depending on the storyteller’s perspective, hence, the idea of agents with different personalities to narrate the story. This research moves away from the concept of a guide that has it reciting facts about places or events

to that of an ‘empathic guide with attitude’ that persuades the user through improvisational story-telling. The agent needs to continually model its user and almost needs a deep cognitive model of the user. Thus, the focus of this research is on natural interactivity.

The ET Guide will be implemented on a PDA, taking advantage of expanding technologies such as Wi-Fi wireless hotspots, GPRS (general packet radio service) and bluetooth access points, freeing the user from carrying the traditional heavy and bulky devices. Tourist information is location-dependent by nature, thus this location-aware system allows us to link electronic data to actual physical locations, thereby augmenting the real world with an additional layer of virtual information.

The main emphasis of this research is the development of an empathic model that expresses personality. It is essential to bridge the gap between the ‘lower’ and ‘higher’ level of cognition and action in order to synthesize the desired expressive behaviors. For narration, an improvisational personalised story-telling technique will be adopted. Besides that, this research also involves the creation of a multimodal interaction interface and the integration of mobile computing technologies as well as experimentation with overlaying techniques.

2 Related Works

Recently, many research projects have explored the new possibilities of location-aware systems for augmenting the environment to provide guidance to users in their everyday activities. A growing field tries to provide guidance to tourist during a visit. Likewise, ET Guide will be a tourist guidance system, with a new feature - the ‘empathic guide with attitude’!

Cyberguide (Abowd et al., 1997) project, started in 1995, is a series of prototypes of a mobile hand-held context-aware tour guide, where the tour guide plays the role of cartographer, librarian, navigator and messenger. The context awareness achieved by Cyberguide can only detect the user’s physical location and crude orientation, without taking into consideration the user’s interests. Besides that, the project does not utilize any life-like animated character.

HyperAudio (Not et al., 1998) and HIPS (O’Grady et al., 1999) are other innovative systems for delivering context sensitive information to users. In these projects, multimodality helps to get round the static constraints of the environment as a medium by dynamically changing the user’s perception and the user’s physical location. This feature, plus user modeling based on the history of interaction, visitor atti-

tude, physical environment and visiting path are some desirable features for the ET Guide.

MARS (Höllner et al., 1999) is a testbed that employs four different user interfaces allowing indoor and outdoor users to access and manage real world spatial information. Next, in 2000, the DEEP MAP (Malaka and Zipf, 2000) project began. The system is able to generate personal guided walks for tourists through the City of Heidelberg and to aid tourists in navigation. It takes into consideration personal interests and needs, the social and cultural backgrounds of the tourist as well as other circumstances when generating the tour. Similarly, the ET Guide needs to take into account these factors to achieve personalisation.

While none of the above systems employ a life-like animated character, C-MAP (Sumi et al., 1998), is an attempt to build a personal mobile life-like assistant that provides visitors touring museums and open exhibitions with information based on their location and individual interests. However, each animated character possesses only four actions - suggesting, thinking, hurrying and idling which it switches according to its internal state without the need for intelligent processing. Additionally, this system lacks voice guidance and the agent acts only as a machine agent with the future plan to extend its role to an exhibitor, an interface secretary as well as a mediating agent.

PEACH (PEACH, 2004) is a project to enhance the appreciation of cultural heritage through the development of a personal guide, featuring a life-like character that can accompany an individual during a museum visit and subsequently adjust the delivery of information to the visitors interests. Nonetheless, the system is restricted to an indoor museum environment. Currently, the system personalises information by simply relating to exhibits that the user has visited.

Almeida and Yokoi (2003) attempts to shape dialogue interactions between an interactive gesture-choreographed conversational character and the user in a guided tour to an online virtual exhibition of a XVI century Portugese ship. The user evaluation showed that the interaction was enjoyable and the tour guide was effective in motivating users to explore and learn more about exhibition topics.

Virtual tour guide research has also been carried out in the area of virtual environments. Ibanez et al. (2003) proposed storytelling in virtual environments from a virtual guide perspective. This system constructs stories by improvising taking into account factors such as the distance from the current location to a destination, the already told story at the current moment and the affinity between story elements and the guide’s profile. In general, this work brings us a step

nearer to the creation of an ‘intelligent guide with attitude’.

Geist (Braun, 2003) shows explicitly the correlation of human-like communication or interaction story structures and the users enjoyment and fun with the application. Within the Geist System, the history of the City of Heidelberg, Germany and the Thirty Years War is shown in a way that the audience receives an immersive, dramatic and action rich experience with a high factor of fun and enjoyment. The DELCA (2004) Ghost Project is motivated by the belief in achieving high quality agent based assistance without demanding visualization requirements. This project brings the realisation that the ET Guide does not need to apply all modalities at all time, reducing its technical requirements.

The SAGRES (Bertolletti et al., 2001) system is a virtual museum that seeks to build a new educational environment by providing information available in the museum through the web. Software agents were used to incorporate personal assistance to SAGRES’s users to ensure that they do not get lost during navigation due to the large number of links available. Some other related works are the Kyoto Tour Guide project (Doyle and Isbister, 1999), eMoto (Fagerberg et al., 2003), Mobile Reality (Goose et al., 2002), the REAL project (Baus et al., 2002), Handheld History (Handheld, 2004), etc.

From this discussion, it is very clear that AR, Mobile and Context-Aware Tour Guide applications are mushrooming. All these systems share a common goal, that is to provide user with context-aware information. Some even personalise the information. However, something is missing in all these applications - an Empathic Model and Empathic Interaction!

According to Nass et al. (1994), the individual’s interaction with computers is inherently natural and social. Because affective communication occurs naturally between people, it is expected by people when they interact with computers. Although the tour guide systems presented earlier integrate life-like animated agents, none of the agents possess a real empathic model. These agents react to the users’ actions based on prescribed statements and predefined behavior. Hence, their reactions can be quite rigid, lacking dynamism in the presentation of information. This dynamism in interaction will form the heart of ET Guide.

3 Empathic Models

Artificial intelligence researchers have long wished to build creatures with whom you would want to

share some of your life whether as a companion or a social pet. Traditional conversational characters with their reactive, context-free conversation however, lack goals and motivations for interaction, leading users to interact for only a short period of time and increasing the potential for unmet expectations regarding the character’s intelligence (Almeida and Yokoi, 2003).

Thus, researchers on character development are switching their attention to the design of motivational structures, emotional and personality traits and behavior control systems for characters to perform in context-specific environments with well-defined goals and social tasks (Doyle and Isbister, 1999; Lester and Rickel, 2000). Animators too have felt that the most significant quality in a character was appropriately timed and clearly expressed emotion (Bates, 1994). The famous Bugs Bunny animator, Chuck Jones said that it is the oddity, the quirk, that gives personality to a character and it is personality that gives life.

Emotions represent an important source of information, filtering relevant data from noisy sources and provide a global management over other cognitive capabilities and processes, important when operating in complex real environments (Oliveira and Sarmento, 2003). Emotions also play a critical role in rational decision-making, in perception, in human interaction and in human intelligence (Picard, 1997). Picard, lays out the evidence for the view that computers, if they are to be truly effective at decision making, will have to have emotion-like mechanisms working in concert with their rule-based systems. A machine, even limited to text communication, will be a more effective communicator if given the ability to perceive and express emotions. In other words, both empathy and personality are primary means to create “the illusion of life”, permitting user’s suspension of disbelief.

This awareness led to the development of emotional models. Cañamero (1997) proposed an architecture that relies on both motivations and emotions to perform behavior selection. The work of Velásquez (1998) is inspired by recent findings in neuropsychology and that relies on the use of computational frameworks for what we call Emotion-Based Control, control of autonomous agents that relies on, and arises from, emotional processing. The model integrates perception, motivation, behavior and motor control with particular emphasis on emotions as building blocks for the acquisition of emotional memories that serve as biasing signals during the processing of making decisions and selecting actions.

Aaron Sloman (2001, 2003) on the other hand,

proposes a much more complex architecture, integrating high-level aspects of cognition influencing lower ones in a three-layered framework comprising of a reactive layer, a deliberative layer and a meta-management layer. Wehrle and Scherer (2001) argued that it might be useful to distinguish two classes of computational models of emotion: black box models and process models.

The OCC (Ortony et al., 1998) model is one of the most used appraisal models in current emotion synthesis systems, working at the level of emotional clusters. This model proposes that emotions are the results of three types of subjective appraisals: the appraisal of the pleasingness of events with respect to the agents goal, the appraisal of the approval of the actions of the agent or another agent with respect to a set of standard for behavior and the appraisal of the liking of objects with respect to the attitudes of the agent.

The ‘Psi’ theory of psychologist Dietrich Dörner (Dörner et al., 1988; Dörner and Hille, 1995) provides a framework for agents focusing on emotional modulation of perception, action-selection, planning and memory access, uniting work from several areas of AI. The ‘Psi’ theory is unique in that emotions are not defined as explicit states but rather emerge from modulation of the information processing and action selection. They become apparent when the agents reflect their interaction with the environment, resulting in a configuration that resemble emotional episodes in biological agents. Dörner’s agents react to the environment by forming memories, expectations and immediate evaluations. They possess a number of fixed but individually different parameters such as resolution level, selection threshold, activation and rate of updating. These parameters with built-in motivators produce adaptive complex behavior that can be interpreted as being emotional.

Other models of action selections include (Blumberg, 1996; Oliveira and Sarmiento, 2003; Araujo, 2004), etc. Obviously, all approaches to affect study offer different insights. The decision to follow one or the other depends greatly on the specific goals and purposes of these models and the application in which it will be implemented. The model of interest in this research is the ‘Psi’ model.

4 Role of Empathy in The Guide

The phrase ‘empathic guide with attitude’ means a guide that does not only show emotions during interaction, but at the same time try to invoke empathy in the user. Example of other empathic invoking agent

research is VICTEC (2004).

Empathy is a psychological concept that describes the ability of one person (“observer”) to achieve information in the “inner state” of another person (“target”). Most contemporary empathy researchers agree that two different aspects of empathy have to be distinguished: the cognitive and the affective aspect. In this research, we are looking more at the cognitive empathy or “perspective taking” that occur when the outcome of an empathic process is that the observer tries to understand how the target feels in a given situation (Schaub et al., 2003).

The guide will tell stories based on his own experiences and point of view. The guide attempts to persuade the user to think in the way they think, that is, to put the user in their shoes. By invoking empathy, the guide makes the user see an event in a deeper sense.

Different stories from different guides force the user to analyse and find an explanation of why different historical interpretations exist. By seeing things from a particular perspective coupled with his own knowledge and understanding, a user will be able to analyse, enquire, reflect, evaluate and use the source of information critically to reach and support conclusions. This type of learning is the attainment target of the UK National History Curriculum (NHC, 2004).

5 The Proposed System

5.1 The System Components

The ET Guide will consist of two emotional virtual agents each possessing a contrasting personality, presenting users with different versions of stories of the same event or place. A multi-sensory system which includes visual sensors, a GPS, Global Positioning System and audio sensors are to be integrated with the PDA, using wireless communication. Figure 1 shows the proposed system components.

In each scenario, before the tour starts, the virtual tour guide will first extract some information from the user: the user’s interests, time constraints, distance constraints, etc. Then the guide will suggest a place to visit and plan a route, in such a way either that there are more places of interest which might attract the user’s attention along the way or that it is the shortest route possible. The system will mould to the behavior of the users, facilitating their movement within the space by aiding orientation and proposing suggestions about the subsequent best route as well as interpreting the implicit intentions of the user’s movements. On the way to the proposed destination, the tour guide will draw the user’s attention

ET Guide System		
Perception (Image capture)	Emergent Empathic Model With Personality (Empathic Guide Agent's Brain)	Tracking (Position and orientation)
Speech (Verbal interaction)		Scene Augmentation (Text, Visual, Audio)
GUI (Normal interaction)	Interactive Storytelling System (Narrative Construction)	Database (Stores information)

Figure 1: The Proposed System Components

to other landmarks, describing them in accordance with the user's interest, applying a story telling technique which links the memory and interests of the guide as well as the visitor to the spatial location so that the stories are relevant to what can be immediately seen. Users can ask questions and additional situation-specific information will be presented coherently or at least a hyperlink to the Internet will be provided.

Detection of the user's current physical position and orientation is vital in order to augment the user's reality. Computer-generated graphics, audio or other sense of enhancements will be overlaid on the real scene in real-time to eliminate the abstraction gap between the provided information and the mapping of these data to the real world. The hand-held unit will not always carry around with it the entire information associated with the area the tourist is visiting. Rather, the information should be provided on demand and relative to the position and orientation of the tourist. In this case, a server is essential due to the limited memory space on the PDA.

Information about the places can be historical as well as current and two-way communication is desired. The user is allowed to interact normally or verbally with the system and receives a respond by means of text, graphics or audio. Normal interaction can occur through the usual GUI interface where the user is presented with menu selection, button press, touch sensing, etc. Verbal interaction will make interaction more natural as it is the most natural human modality. However, it has to be noted here that only a simple verbal interaction system that recognises a few keywords will be implemented.

5.2 The System Architecture

It is desirable to have a modular approach in the system architecture design as proper decomposition of

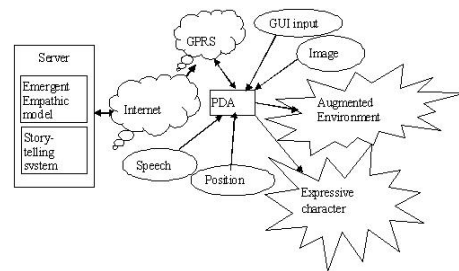


Figure 2: The Overall System Architecture

the components will simplify system development as well as provide extensibility. The design and development process will be iterative to improve functionality and to achieve the most cost-effective way for implementation.

The system will principally consists of a SQL server providing location-related information, the guide profiles and user profiles. The information on the server is accessible through the Internet and wireless connection will be employed allowing retrieval of appropriate context information in real-time. Web-Services which is method-based and has reusable feature will be adopted to allow communication between the server and the Internet.

A GPS system will be used for user location detection. Orientation will be predicted based on the combination of user's previous and current location. The current plan is to use Visual Studio.net framework as the development environment.

5.3 The Affective Model

The novel element of this research is the Emergent Empathic Model with Personality. The 'Psi' model serve as the basis for its design. This model is very flexible where cognitive processes can adapt appropriately to various circumstances through various parameters and built-in motivators. The architecture is able to determine whether immediate action is required or more detailed planning has to be carried out. The member/part relationship links in the 'Psi' model are useful for structuring and constructing interesting stories as it accommodates hierarchical organization of information. This hierarchical organisation is a mechanism for memory building and retrieval leading to the formation of associative memory. Figure 3 shows the initial design of the Affective Model.

In this architecture, motivation is represented by the needs and aims, emotions are reflected by the modulating parameters, their causes and influences, while cognition is represented by informa-

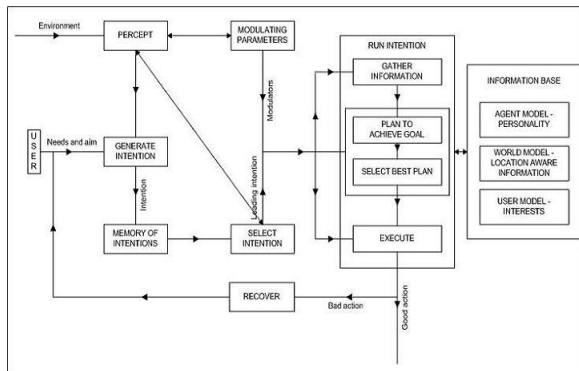


Figure 3: The Affective Model

tion processes in GENERATE INTENTION, SELECT INTENTION, RUN INTENTION and PERCEPTION as well as in the memory of intentions and other environmental factors.

Functionally, the agent will perceive the environment continuously and generate intentions based on the acquired information and user needs. These intentions together with some built in motivators are stored in a memory of intentions. Next, the agent selects an intention considering the current situation and decides autonomously whether exploration for more information is essential, or to design a plan using the available information or run an existing plan. By doing so, it adapts its behavior according to its internal states and the environmental circumstances. Each execution of intention will produce a feedback into the system and recovery will be performed when necessary.

5.4 Possible Application Domains

Since the ET Guide is a mobile context-aware application, it can be handy to generate tour descriptions of various outdoor tourist attractions. It would be even more interesting if it is implemented in historical environments with more stories to tell or on battle fields where usually there exist different versions of story depending on which side the storyteller comes from. However, for evaluation purpose, the system will be implemented within the compound of Heriot-Watt University where a small prototype is to be tested.

6 Consideration and Challenges

The biggest challenge of this research is in keeping the attention of the user high and generating a long

term memory effect. The hypothesis here is that an empathic agent with personality, can produce the illusion of life, make interaction more realistic and natural as well as present the user with a more engaging and memorable visits, holding attention and maximising the absorption of new information. Information presentation based on user context and empathic interaction make the user feels that the system cares, giving a sense of human-human communication.

Next, what is the relevant set of emotions for this application? How can these best be recognized or expressed or modeled? What is an intelligent strategy for responding to or using them? This research is looking at emerging emotions resulting from modulation of behavior. This approach gives more colors and variations to the emotions that can be experienced. In order to avoid a mismatch between the complexity of the agents appearance and its behavioral and interactive potential, the tour guide agents will possess cartoon-like attributes, reducing the demand on behavior accuracy and interaction complexity.

In addition, appropriate ontologies need to be established for the agent model, the world model and the user model to ensure that information can be extracted efficiently. As people's preferences differ wildly, the system needs to take into account the special interests of each user to automatically propose appropriate presentation. Since in the ET Guide, there is no mechanism for detecting users emotional state, the guide agent can only make rough prediction of the user's affective states from the input obtained through speech or the GUI interface.

Technical aspects raise some issues of concern. The major issue with GPS tracking is accuracy. As for the interaction, it is essential to determine the right means to be adopted. How much visual, audio or GUI interaction should it contain? Different means for expressing emotions other than using animation also need attention due to the limited resources on the PDA, for example the idea of ghost in the DELCA Ghost Project.

In terms of scene augmentation, accurate overlaying of graphics is not necessary. What is important is a synchrony between the different sense of enhancements on the real environment. In other words, a presentation has to appear at the right place and at the right time.

Finally, user evaluation is important in verifying the usability of the ET Guide. Users should play a vital role throughout the development of this system to ensure that a functional and usable system that meets their requirements is produce.

7 Future Works

Basically, the development of the proposed system will be carried out in an iterative and rapid prototyping manner. It will be divided into three main iterations: the heart, the intermediate version and the final complete system. The heart of the ET Guide is the Emergent Empathic Model with Personality. Here, the Wizard of Oz technique (Salber and Coutaz, 1993) or other evaluation techniques can be applied to identify a sound design solution. The plan is to evaluate the system at the end of each iteration so that refinement is possible.

During the final iteration, all proposed system components will be merged, which includes the Emergent Empathic Model with Personality, the Interactive Narrative System and the multiple modalities for interaction and presentation. A final user evaluation will be carried out to test the hypothesis, especially, the degree of natural interaction, user friendliness of the interaction interface, effectiveness of the information presenter and the degree of user engagement to the system.

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