INTERFACE AGENTS AS VIRTUAL TUTORS

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ABSTRACT: Interface agents are parts of computer programs that, in general, offer dedicated assistance to users with their computer-based tasks but they can be also used for teaching as presented in this paper. Most interface agents are designed to customize themselves by learning from the interaction with the user and by creating the user profile. In this paper we present an experimental model of an interface agent intended as a virtual tutor. After a brief introduction of the approached topics, the history and related work are presented in section 2. The rational and approach section describes the way in which such interface agents can be implemented by taking into account also the *“digital ethics”* and *captology* (computer/agent persuasiveness) aspects. Subsequently the next section presents a possible (still experimental) model for a *virtual tutor*. Conclusions and future work are closing the paper. On short, this paper aims at showing how a virtual tutor can help students in the process of learning and the benefits from this human-computer interaction.

KEYWORDS: Interface Agents, Computer Persuasiveness, Digital Ethics, Virtual Tutor, Human-Computer Interaction (HCI)

1. INTRODUCTION

In artificial intelligence, an intelligent agent is an autonomous entity which observes and acts upon an environment (i.e. it is an agent) and directs its activity towards achieving goals (i.e. it is rational) [16].

Since the agent is a new concept in the computer science, its features are still a subject of controversy. For methodological reasons, its defining features are divided into two groups (controversial and non-controversial).

The non-controversial features (relatively widely accepted) are [7]:

- *Autonomy*. They can act without anyone else’s intervention (human or agent) and have a certain degree of control upon their own actions and internal status;
- *Communication ability*. Agents usually interact with other agents (by means of an inter-agent language) and with people by means of the interface;
- *Reactivity* (as a response to stimulus). Agents must be capable to respond correctly to what they perceive from the environment (stimulus from other agents, from the users, etc.);
- *Proactivity*. Agents must demonstrate teleological behaviour and have initiative. The source of initiative lays in a good knowledge about a certain domain. The proactive characteristics cover a large area (of continuously growing intelligence) from the implementation of simple algorithms (basic knowledge) to the application of refined strategies, adapted to hostile contexts (true intelligence);
- *Continuity*. The agents are perennial. That is to say they are permanently active (launched in execution) but can have different statuses: execution, pending, suspended.

As stated in [7], the terms "pro-activeness" and reactivity are not antinomian: the first has as an antonym "the lack of intention expressed by planning" and the second "passivity".

Agents are commonly able of using multiple channels of communication, including written text, speech, facial expressions, and/or body language. Agents can act autonomously to complete operations without precise directions from the user, and, potentially, they can team up with other types of software agents (this feature not being of importance in the research presented herein). Interface agents are generally some applications that are often supported by knowledge bases. More refined applications may employ artificial intelligence, machine learning, and natural language processing technologies.

The paper continues with *the history and related work* section. *The rational and approach* section describes the way in which such interface agents can be implemented by taking into account also the *“digital ethics”* and *captology* (computer/agent persuasiveness) aspects; also the *Belief-Desire-Intention* (BDI) model is introduced in the same time. The further section presents a possible (still experimental) model for a *virtual tutor* and *conclusions and future work* complete the paper.

2. HISTORY

Only humans and some animals are capable of true emotions that may alter their beliefs, desires or intentions. Therefore, the interface agents are only able to emulate or to simulate it. The emulated emotion can help in the teaching process but because this approach is *too slippery* to be endeavoured only by computer scientists without the help of educational psychologists and sociologists, only some aspects will be pointed out in this paper.

The related work followed three main targets: anthropocentric interfaces, captology and pathematic agents. The interface agents described in [1], [5] and [6] were designed for medical informatics, in [2] for orality in HCI, captology for anthropocentric systems and therapy [3], [4] and [8]. Other general aspects regarding them were presented in [9], [10] and the ethical features of the agents were covered in [11], [12] and [13].

Some mechanisms were adopted unmodified (as developed in the related work) and others were obtained by refining the existing ones. All of them proved their potential in experimental models for their initial purposes and are easily adaptable for a virtual tutor.

Other researches of the authors illustrated the necessity of anthropocentric designs ("user-pulled") and revealed the dangers of current Information and Communication Technology (ICT) designs ("technology-pushed"). Since the gap of humanists and technologists is deepened because of insufficient innovative use of new agent-oriented technology potential, an affordable manner to "invent new Computer-Aided x" application domains was proposed in [14] as *Computer-Aided Semiosis*.

As stated in [14], anthropocentric approaches for interface agents became common in IT. However, despite an emerging consensus that context does matter, human factors in different environments are still ignored or undervalued. The main macro-architectural features looked-for being flexibility and user-friendliness. An immediate corollary is: anthropocentric interfaces are crucial for any applications involving intensive HCI like applications making use of interface agents. To meet the challenge, the HCI community developed methodologies for incremental anthropocentric system design. Two approaches can be observed [14]: consultative design (let decision-making power to technicians, users being simply sources of information with little or no direct influence) and cooperative design (strongly involves selected users giving them the chance to influence the final system). Anyhow, the design of truly anthropocentric systems has to be carried out by interdisciplinary teams including psychologists, teachers, software engineers, mathematicians, system analysts, and specialists of the particular fields involved.

Some principles of "anthropocentric design" are [14]:

a) work must be easy for humans, not for computers (interface complexity should be the burden of the system);
b) the shift from interacting with an instrument towards interacting with an assistant has to be acknowledged and promoted;
c) anything visible to the user regarding system behaviour or structure, excepting the interface, is useless and might become harmful;
d) the design should stimulate users in adopting new working styles and/or acquiring new skills.

3. RATIONALE AND APPROACH

There are different behavioural models for intelligent agents. One of these models is the BDI model. A BDI agent is a particular type of bounded rational software agent, imbued with particular mental attitudes [17]:

- *Beliefs* represent the informational state of the agent, in other words its beliefs about the world (including itself and other agents). Beliefs can also include inference rules, allowing forward chaining to lead to new beliefs. Using the term belief rather than knowledge recognizes that what an agent believes may not necessarily be true (and in fact may change in the future).
- *Desires* represent the motivational state of the agent. They represent objectives or situations that the agent would like to accomplish or bring about.
- *Intentions* represent the deliberative state of the agent - what the agent has chosen to do. Intentions are desires to which the agent has to some extent committed. In implemented systems, this means the agent has begun executing a plan.

For the case of the interface agent designed as a virtual tutor, this model can be adapted as follows:

- The beliefs must include the information about the subjects the student is interested in learning;
- The main desire of the virtual tutor must be to able to help the student in accomplishing his/her goals (subject understanding and learning in a pleasant way);
- The intentions must include a learning plan.

In order to be successful in tutoring a student (an user), such an agent must make use (depending on the age of the student) of the entire arsenal of a real-life tutor. Some of these methods:

- *persuasiveness* (to convince the student that learning is fun, useful, important, mandatory, etc.);
- *confidence* (the tutor must act with confidence in the presence of the student);
- *emotions* (ranging from happiness to anger, depending on the feedback it receives for the student);
- *tricks* (rewarding the student for a good answer or learning by playing interactive games);
- *confidentiality* (decency and other related notions);
- *subliminal messages* (a signal or message embedded in another medium, designed to pass below the normal limits of the human mind's perception) [18].

To validate the ethic rigorousness in the context of using the above mentioned methods and especially for the subliminal messages, we are proposing an adapted version of an "ethical potentiometer" described in [7] and [13].

This ethical potentiometer has 5 positions (depicted in Figure 1) ranging from not using subliminal messages to using them without warning the user at the beginning of a tutoring lesson:

a) EC1: subliminal messages are not admitted;
b) EC2: subliminal messages are admitted (as standard messages) but the user can easily see them and eliminate them if he/she wants;
c) EC3: the user can clearly see the messages, but cannot eliminate them;
d) EC4: the user is warned that subliminal messages may be used but he/she can neither actively perceive them nor eliminate them;
e) EC5: the messages are transmitted subliminally (without user knowing or acceptance).

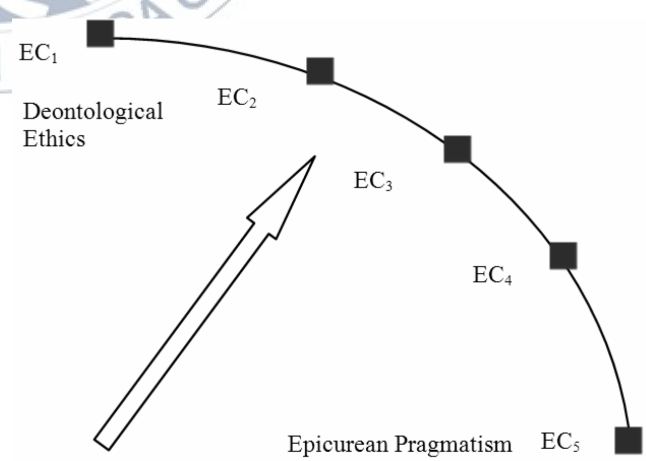

Figure 1. Ethical Potentiometer (adapted from [7])

A tutoring interface agent can make use of subliminal messages for some (hopefully) exceptional cases when dealing with difficult learners (e.g. undergraduates), totally unmotivated students or students with learning disabilities.

Moreover, like the rest of nature, humans are *multimodal* (i.e., they use a blend of concurrent communication means based on at least two of the main interaction channels: *visual*, *auditory*, and *haptic*). Whilst nature was *multimodal* from the very beginning, ICTs become so too (multimodal communication becoming affordable). Hence, anthropocentric interfaces *must be multimodal* [14]. The best way for an interface agent to be multimodal it must have *biomimetic characteristics*. *How else could an agent to communicate with a human as a social interactant, alive and intelligent, if it does not look alive?* As presented in [7], simulating aliveness does not oblige anthropomorphism and an animated object *can* suggest it.

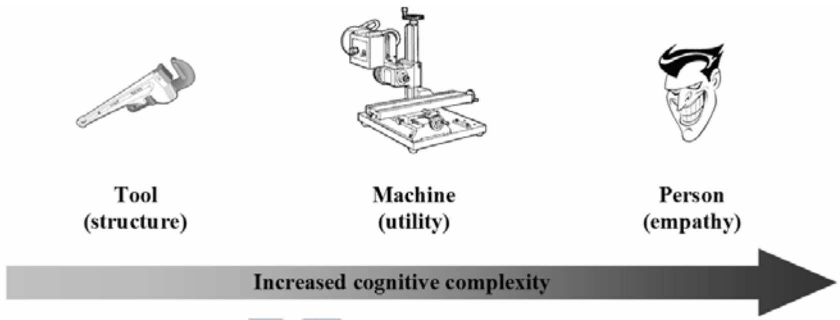

Figure 2. Intentional stances (adapted from [7])

Other aspects that one should take into account when designing and modelling interface agents are regarding Daniel Dennett's *intentional stances* [15]. These stances are:

- *physical* - at the level of physics and chemistry. At this level, the system is considered as a *tool* and for using it one should consider its structure (how does it work?);
- *design* - at the level of biology and engineering. At this level, the system is considered as a *machine* and for using it one should consider its *utility/architecture* (what it can do?);
- *intentional* - at the level of software and minds. At this level, we are concerned with things such as belief, thinking and intent; the system is considered as a *person* and the expectancies regarding its behaviour are based on its *motivations* (what does it want to do?).

Because of the fact that an interface agent designed as a virtual tutor must have biomimetical characteristics, the users (in this case, the students) will tend to regard it intentionally. This represents a plus because a human-tutor is also regarded intentionally.

4. EXPERIMENTAL MODEL

Since it is hard designing an interface agent from scratch, we used the Microsoft Agent Technology which has the following main advantages:

- is a quick and easy way to enhance any application;
- the agents are having numerous features including speech, animations and character movement;
- supports multiple characters on the screen at once;
- sounds and voice-recognition.

There are different types of agents designed by Microsoft (representing different metaphors – Figure 3: a magician, a robot, a genie, etc.) and others designed by other companies (Oscar the cat, Max the dog, James, Claude the bear, etc.) – Figure 4. In choosing a character suitable for a virtual tutor a more human-like appearance is preferred because it would be much more likely to be accepted as a tutor and trusted like one by a student. For this reason we used the character illustrated in Figure 5.

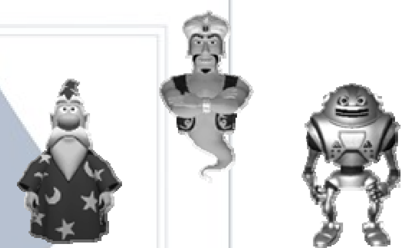

Figure 3. Interface Agents designed by Microsoft

The experimental model was designed to assist and help students in the field of algorithms and computer programming. The application is able to:

- provide information in written and spoken form;
- interact with student while presenting the information (e.g. asks the student to provide examples);
- test and evaluate the student and based on his/her results to adopt the teaching method;

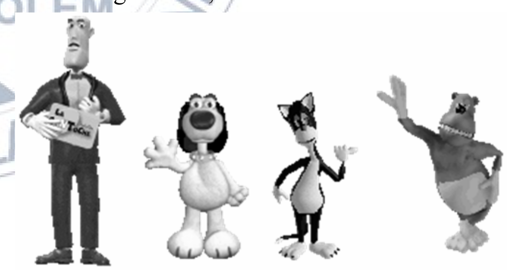

Figure 4. Interface agents designed by other companies

The challenge of implementing such an agent is not so much for software developers, but for methodologists and educational psychologists because of the following aspects:

- lessons must by converted/adapted from the classic style of teaching to this new approach;
- other information besides the subject matter must be included (special questions, interactive examples, etc.)
- creating an adaptive behaviour for the virtual tutor depending on the feedback received from the student.

Figure 5. Human-like interface agent intended as virtual tutor

Another benefit of using an interface agent implemented using Microsoft Agent Technology is that the application can have besides the main module some parts designed as Windows Services (process that can run in background) and they can track user's actions in order to determine how much time he/she is dedicating to other activities than studies. Moreover, the application can pop up messages indicating that "it's time for study".

5. CONCLUSIONS AND FUTURE WORK

Anthropocentrism and transdisciplinarity are sine qua non requirements; aiming at driving ICTs towards the users, not dragging humans by technology. This becomes achievable just because ICTs are powerful enough to afford user-centred interfaces, enabling users to interact with ICTs or with each other as they intend to, and, moreover, to allow users to adapt the interfaces as they desire.

In designing interfaces the leaders must be the domain experts, not the software developers. In other words, a virtual tutor agent should be designed by a transdisciplinary team guided by specialists of the application domain (first of all methodologists and educational psychologists but – depending on the problem – also specialists from specific curricula).

The nature of the experimental model at this point does not permit drawing clear cut conclusions as regards end user evaluations, but the approach based on such interfaces is in the current trends of the artificial intelligence and modern IT.

All the mechanisms proposed herein are operational and proved their efficiency in models based on multimodal intelligent interfaces using pathematic agents – as virtual therapists in medical captology as presented in the related work section.

The examples presented in this paper are not difficult to implement by software specialists and can be easily implemented on usual computer configurations.

As regards the future work, we intend to further develop other experimental models as extended versions of the mechanisms that will meet the e-learning requirements.

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