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ENHANCED HUMAN-AGENT INTERACTION: AUGMENTING INTERACTION MODELS WITH EMBODIED AGENTS

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ABSTRACT

The popularity of software agents demands for more comprehensive HAI design processes. The outcome of this requirement can be observed on latest developments supporting autonomous technological products, which are slowly becoming a reality: self-driving cars, military agents, space exploration robots, autonomous vacuum cleaners, virtual sales-people, emotional robots and even embodied artifacts acting autonomously in order to support daily human activities.

The increasing usage of agent technology has significantly expanded the horizons for software agent designers, creating the opportunity to empower humans with the help of software agents. Modern software agent designs have stirred developments towards a more human-like approach; at the same time, these have improved the holistic integration between human mental processes and technological progress, where embodied agents seem to have the lead on this new interaction paradigm.

This investigation studies established principles, implementation and evaluation of software agents and agent-based interactive computing system, considering benefits and disadvantages described in developing investigations about the topic of interest.

RESEARCH BACKGROUND

The definition of a software agents calls for developments able to execute commands autonomously and generate proper responses, based on the situation and according to the change of conditions.

All definitions of software agents describe the basic characteristics a software agent should have: autonomy, reactivity, pro-activeness, social ability, among many others.

Human-Computer Interaction (HCI) both studies the collaboration between humans and computers, and enables the theory of cognition to play an important role in understanding the interactions between people and the ever changing field of computers.

Human-Agent Interaction (HAI) mainly focuses on the systems, models, applications and methodologies which make it possible for humans and agents to collaborate, negotiate, interact efficiently and, in certain advanced environments, even become peers at a very abstract level.

RESEARCH BACKGROUND

Social interaction research focuses on either fully virtually embodied agents (e.g. embodied conversational agents) or fully physically embodied agents (e.g. robots). Both areas have augmented their agent capabilities for social interaction using ubiquitous and intelligent environments.

Agents have a strong influence while interacting with humans, experts have reinforced their studies on strict and continuous evaluation and application of social psychological concepts.

These have been used as guidelines for the agent behaviors during interaction. Moreover, certain aspects of human cognition and communications skills have also been simulated using agents.

HAI design should be ubiquitous in order to address, quickly and precisely, the issues concerning human requirements, values and cultural background.

RESEARCH BACKGROUND

Modeling helps agents adapting to the social environment by virtue of the human cognition knowledge and technology, shifting the system design away from the technique oriented implementation.

Humans react socially to computers, this being the driving force behind large research initiatives in the areas of HCI and Human-Robot Interaction (HRI).

Software agents and robots have usually been seen as distinct artifacts of their respective domains, modern investigations consider them as particular instances of the same notion of agent.

Both the virtual and robotic domain have started moving away from the edges by embodying their agents in ubiquitous environments, that is, environments that are “augmented" with digital sensors and devices.

RESEARCH ISSUE

HAI shortcoming: when humans are interacting with agents, expectations are always extraordinary, making it harder for agents to keep up with the tough requirements.

The interactions between human and agent may lead to dead-locks, miscommunication, problems with turn taking and so forth.

HAI must consider not only the design of systems where humans interact with agents, but also the study of the interactions types and styles that emerge when humans and agents work together.

HAI design should focus on improving the interactions between users and agent-based systems, by making those systems more operational and receptive to the user demands, ways of reasoning and in general to human specific characteristics.

RESEARCH ISSUE

Poorly designed agent interaction model can have devastating results; a design which breaks the human protocol may easily create conflicts or propagate negative feelings towards the entire system.

An excessive amount of suggestion and information from the agent could increase people cognitive load, causing exhaustion during interaction and agent critical failures.

Defective design of human characteristics will hinder the usability of such agent-based interaction system, extinguishing the benefits of HCI.

RESEARCH ISSUE

Need of a greater studies on long term cognitive and social effects of agent technology based on usability challenges, describing how software agent technology could serve the interest of humans and how it might enhance human cognitive or social capabilities based on different interaction models.

HAI designers are mainly focused on creating a highly and cooperating interaction experience for both humans and agents, and on actions taken by them in a given point of the interaction to be highly related to the previous ones.

It is necessary to consider the fact that people intentionally assign human characteristics to artifacts they interact with, and even more so in the case of embodied agents.

SIGNIFICANCE OF THE RESEARCH

Studies established principles for designing, evaluating and implementing intelligent agents and such agent-based embodied interactive systems.

Attempts to investigate the cognitive interplay between humans and embodied agents from a behavioral perspective.

Tries to incorporate psychological approaches into agent design, in order to develop social competence for agents and to enhance the efficiency of collaborative work.

The reasoning of this investigation goes along with latest achievements to model HAI, considering how to perceive the actors, how to interpret their behaviour and then update existing models in a dynamic manner, responding and adjusting the interaction accordingly.

SIGNIFICANCE OF THE RESEARCH

Aims at elaborating on existing models which empower agents with predictive capabilities.

Studies existing theories that explain human behaviors and processes, and combine them with data which is accurate enough to allow for parametrization and adjustment of the real-time agent models.

There is an enormous amount of research describing how to model software agents, considering goals and preferences for agents to be able to interact with humans, and how they could learn about humans and to adapt to their preferences.

OVERVIEW OF THE MAIN IDEAS

There is a considerable amount of complex algorithms surrounding the concept of embodied agents: multimodal input recognition (i.e. utterances, gestures, gazes and vocal interactions), natural language understanding and generation, dialogue management, planning and cognitive capacities, emotion modelling, prosodic speech generation, non-verbal behaviour, etc.

Multimodal and active interaction management remains useful as an essential aspect for effective interaction and collaboration between humans and agents.

One of the main goals for the Agent Designers: to develop believable embodied agents making use of synchronised gaze, facial expression, gesture, body posture and speech, and to evaluate agents in order to determine the aspects of the agents that are important for HCI.

OVERVIEW OF THE MAIN IDEAS

Multimodal gesturing strategies and agent appearances are also important factors to consider; different gesturing strategies can be implemented for spatial references.

The minimum expectations is for an agent to be able to display a range of accurate facial gestures and to combine them dynamically as needed to produce more complex expressions.

In the case of multimodal dialogue system, input methods may include speech recognition and gestures association; the output may combine manufactured speech, non-verbal behaviour, common gestures and direct control of the underlying application.

STRENGTHS AND LIMITATIONS

The level of engagement in the interaction can be compromised by the capabilities participants have in spoken dialogue, also by how successful the agent is at locating and tracking the position and gaze direction of the user, interpreting and responding to nodding behaviour during a conversation, and pointing and looking at objects in the environment.

Extreme caution is necessary when dealing with deceptive body language.

STRENGTHS AND LIMITATIONS

A wide range of socially intelligent behaviors can be implemented based on embodied agents, displaying attentive listening behaviour, responding to non-verbal cues of the user, and using expressive facial displays where appropriate.

Socially intelligent embodied agents can be compared against other type of software agents; socially neutral versions that use no facial display and do not respond to or exhibit social cues.

The results may indicate how users rate the socially intelligent embodied agent version as more reliable and friendly than the neutral version.

The impact of embodied agents on an interaction can be measured through the participant physiological state.

COMPARISONS AND CONTRAST

The similarity between several HAI models studied relies on the impact of an expressive embodied agent within its context or the entire system, including specific aspects of agents in isolation.

We can compare whether participants are able to perceive the intended prosodic or affective content of spoken output based on the body language of the agent.

A significant contrasting point is the influence facial displays have on user perception and how congruent speech and visual cues may be preferred to conflicting cues on these two channels, this can correct facial displays and enhance participant ability to perceive stress in speech.

Have been demonstrated how participants are able to identify the intended user-model evaluation based on the motions of a talking embodied agent, and that they prefer outputs where the user model expressed in speech matches the facial displays.

ISSUES, CHALLENGES AND TRENDS

HAI experts have continuously supported their researches on user psychology, socio-technology and modeling design, in an effort to understand cognition in the broader context of socio cultural environments, in which software agents will always exist.

The challenges of human social behaviors have been extensively considered in sociology and psychology; models developed in social sciences frequently rely on the understanding of a human observer.

The interaction between human and agent (HAI layer) and the interaction between agents (AAI Layer) acts as a typical implementation of the Service Oriented Architecture (SOA), together with the HCI design, where users can access independent services without knowledge of the services platform implementation.

ISSUES, CHALLENGES AND TRENDS

Agent internal data structures are being used to record information about the state and history of the environment, one of the best known measured agent architecture is the beliefs, desires and intentions (BDI) system.

Agent reactive architectures present themselves with no states; where the behaviors of purely reactive agents can be simply described as a function and entirely based on the present.

Reactive architectures can be considered as a stimulus-response model in which reactive agents do not take past events into account and cannot foresee the future.

As a mix of both types of architectures, studies show the hybrid architecture, which attempts to combine the best of the reasoning and reactive ones.

ISSUES, CHALLENGES AND TRENDS

Current agent functionality components seem to be continuously embedded in domain layers, supporting consistent design methods for autonomous agent behavior, methods which use rule-based algorithms where an agent action is triggered by certain conditions, and best actions are dynamically selected based on the predefined rules and actual circumstances.

The importance of the user-centered design (UCD) methodology is significant, also presented as the basis for human modeling of agents by consistently pairing simple observable actions with inputs, or making the causes and rules governing an agent behavior transparent, or making the purpose, capability and reliability of the agent available to the user.

CONCLUSIONS

Embodied agents are generally preferred over virtual characters. However, one must always take into account the nature of the task the agent is required to perform.

Some studies have indicated that physical embodiment alone raises user expectations, suggesting that embodied agent can be negatively perceived in comparison with a virtual character, even in a physical setting if tactile interaction is restricted.

Most studies either treat the software agent as either a virtual character or physically embodied, ignoring the ubiquity aspects.

CONCLUSIONS

Efforts towards the creation of anticipatory user interfaces seem to be strong.

UI which are human-centered, built based on naturally occurring multimodal human communication, enabling computer-based devices to anticipate human needs, and opening the possibility of greatly challenging issues regarding interaction between technology and humans.

Mixed reality agents (mixed domains between embodied and virtual agents) have so far only reported findings of preliminary studies and have not dedicated revisions to inform the grounding of mixed reality agents in a theoretical framework, or even just to validate the feasibility of the approaches that currently exist.

Perceived intelligence, trust and credibility of a system are increased when a reliable embodied agent interface is used.

CONCLUSIONS

The embodiment perspective represents an exponential progression towards a more reliable level of HAI; embodied agents can take full advantage of their embodiment nature and navigate around a lot of engineering challenges commonly associated with human-agent environments.

This area has numerous potential application scenarios and fascinating implications, the ubiquity and the adaptability of these agents also open the possibility to explore new interesting scenarios.

Thank you for your time and undivided attention….

For questions, a complete list of references and access to the full manuscript, please email me at: serafinbento@gmail.com

The capacity to learn is a gift; the ability to learn is a skill; the willingness to learn is a choice.
Brian Herbert.