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ACCEPTABILITY IN INTERACTION: *From robots to Embodied Conversational Agents*

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Abstract: This paper will propose extending the traditional definition of system acceptability to take into account significant interaction between a man and a real or virtual system. We introduce the notion of “socially credible” which describes the need of emotions and personality in intelligent environment. This notion is measured by experiments using a plush robot Emi and a virtual embodied conversational agent

1 INTRODUCTION

The rapid development of modern information technologies, information systems, and intelligent environment brings both opportunities and challenges to contemporary organizations. One of the major problems of these technologies is understanding the various factors that impact user acceptance. Indeed, no matter the qualities of the intelligent environment, if it remains unused because it is perceived as not being useful by the user, then the developed system does not reach its goal.

In this paper, we focus on the factors usually used to approach the issue of technology acceptance. As will be shown, they are no longer sufficient when considering if with significant human interaction. By significant interaction we mean, interaction with an intelligent environment which changes the quality of human life: for instance at home for disabled people. In this case, the problem is not to perform a task but to “feel good”. This interaction introduces a new dimension which is no longer functional but psychological. The issue then is creating an intelligent environment that is “socially credible”.

In this paper, we will introduce the traditional parameters of acceptance: utility, usability, and social acceptance. These parameters are enough to model the acceptance of systems used for a short time, but we will explain why it is necessary to introduce a new parameter. In a second part, we will

propose our implementation of social credibility based on knowledge and value representation, and on interaction based on emotion and personality. Finally we will report some preliminary experiments on a robot and ECA to illustrate the approach.

2 INFORMATION TECHNOLOGY ACCEPTANCE

In this first section, we want to introduce the major models of acceptance technology and discuss their limits.

2.1 Technology acceptance model

The Technology Acceptance Model, first introduced by Davis in 1986, proposes that application usage and adoption can be predicted based upon the factors of perceived ease of use and perceived usefulness, Davis 1989.

Based on this first work, Nielsen proposed in 1993 a model of acceptability (figure 1) and stated that “User interfaces are now a much more important part of computers than they used to be”.

In this model, the fundamental points are utility and usability which imply that the intelligent environment in which the human is living must be well constructed from a technical point of view. In

robotics or virtual environment, this means that the system must provide functions that are efficient and sure.

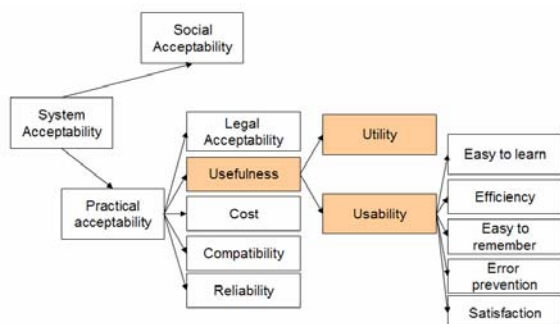


Figure 1: J. Nielsen 93 Acceptability model.

In this model the “social acceptability” box is mentioned, but not really developed.

2.2 Theory of Planned Behavior

In his work Ajzek, 1985, introduced the theory of planned behavior from which a description of social acceptability can be derived (figure 2).

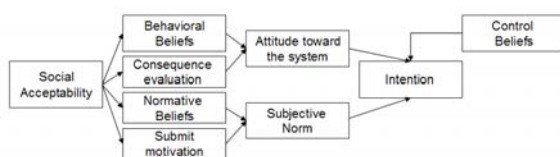


Figure 2: I. Ajzek theory of planned behaviour.

Venkatesh, 2003, proposed to unify the Unified Theory of Acceptance and Use of Technology (UTAUT). His work was based on eight models that had been reviewed, including the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model combining the technology acceptance model and the theory of planned behavior, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory.

Here again, this approach is limited. The limitation is that the model does not take into account significant interaction that a human can have with the intelligent environment, including a companion robot.

2.3 Socially credible

For a system to be credible in everyday interaction, it is necessary to take into account the human specific dimension: emotion and personality. This

means that a single device cannot be used successfully by everybody because each of us is different.

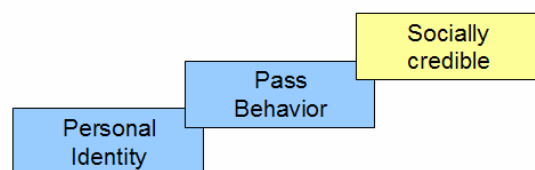


Figure 3: Human identity and feelings

It is then necessary to deal with the personal identity and the history of the person which has already been described in works on social psychology, but also to build an intelligent system which can be perceived as a social creature having its own identity and personality. We will propose some ways to implement this and some preliminary experimentations will be presented in the next sections.

2.4 Acceptability in interaction

Based on the three previous approaches, it is possible to create one final model in which we have added the socially credible factor, in figure 4.

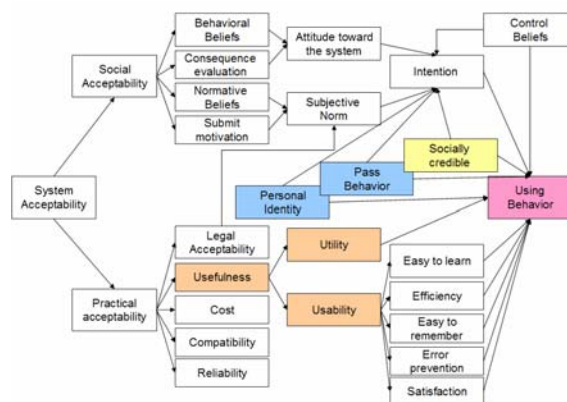


Figure 4: full model for human acceptability for systems with interaction

By introducing this aspect into the model, we must consider how such credible social interaction can be realized. The next section will provide the four main parameters used in our projects.

3 BUILDING SOCIAL CREDIBILITY

If a system is socially credible, interaction with it then gives the feeling that it is a kind of “human species”. For this, the system must share some human knowledge and values and must be able to express things with personality and emotion.

3.1 Sharing knowledge

The knowledge shared with the human is divided into three levels.

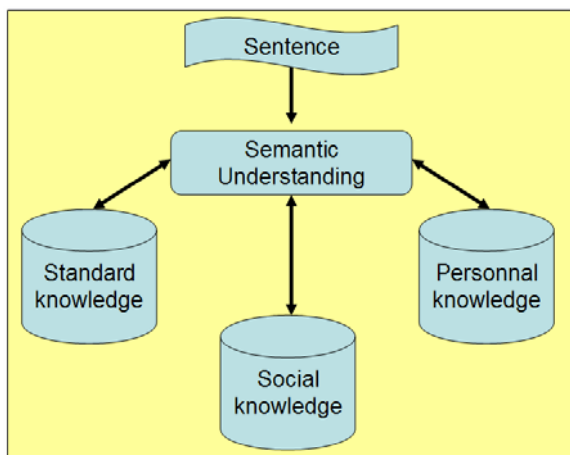


Figure 5: three kinds of knowledge

The first level is connected to standard knowledge. This is the first data base to develop and this is currently an active research area. Moreover, this level often generates an action on the environment from the robot. This part of the knowledge is implemented in all the personal robots and is used to understand the meaning of everyday sentences.

The second level requires the robot to search for information to understand the sentence. This means that it must have access to social knowledge and in this case, the internet is a good means for carrying out this type of research. The difficult part here is to filter all the information to obtain what is relevant.

The third level requires that the robot to learn the personal history of the human from the human. This is possible only by a dynamic acquisition of information. The sources of this information can be multiple: family, doctor, friend, neighbor. This personal knowledge is the fundamental source of having empathy for someone.

3.2 Sharing values

Working on the semantic of the sentences is not enough to provide social interaction. For instance, if the robot tells the human: “You are right and I agree with you” then different levels of the impact of this sentence on the human can be distinguished.

On the first level, the robot expresses that it agrees with the action performed “because it is the right action at the right time at the right place”. But this does not build empathy it is just sympathy, a good friend approving your action.

On the second level, the robot expresses empathy by saying that it feels the same emotion as the human and that it is sharing it. Here, the robot shares the emotion associated to the action performed by the human. This second level is empathy, but is very limited in time; it is only focused on the local action.

On the third level, the same sentences can mean that the robot agrees to the fact that the human is reliable, offering security “because it is the right action at the right time at the right place”, and humans always like this. This means that the robot feels confident with the human. In this case, the empathy is enduring. The reason is that the underlying message is the sharing of values with the human.

To build this kind of interaction, for each kind of knowledge standard, social and personal, we must build “meta semantic information” where a list of values must be coded.

What kind of values can we retrain?

D.L. Liedner & al., 2006, look for the link between information technology acceptance and culture. For this purpose they show that some cultural values can be retained which we believe provide the good departure point to code the knowledge as described previously.

Those values are:

Equality	Subordination
Progressivism	Conservatism
Community	Isolation
Sympathy	Antipathy
Emotionality	Sensibility
Optimism	Pessimism
Freedom	Enslavement
Superiority of culture	Inferiority of culture
Deterministic	Uncertainty
Objective	Subjective
Neutrality	Partiality
Progress	Retreat
Adventurous	Routine

Glamorous	Dull
Known	Unknown
Order	Chaos
Friend	Enemy
Mythical	Factual
Rationality	Subjectivity
Virtuosity	Basic needs
Aesthetic	Practical

With this list of values, the idea is to code all the words of the used language between the human and the robot by a static value or a function on the model used to code emotions, Le Tallec & al. 2009.

3.3 Emotion in communication

In the EmotiRob project, we already coded emotions in sentences and we believe that through the same ideas it might be possible to code values defined in the previous section.

Coding emotions in a sentence

The language is coded as follows, Le Tallec & al. 2009:

<noun> coded by a static emotional number « à priori »

Wolf = -2 very negative emotion

Mother = +2 very positive emotion

<adjective> coded by a function

Pretty = $X \rightarrow X + 1$ this adjective increases the positive number of the associated noun

<verbe> coded by a function

Break(X, Y) = $(X, Y) \rightarrow -Y$ breaking something inverse the broken thing

Have(X, Y) = $(X, Y) \rightarrow X * Y$ the friends of friends are friends ...

With this kind of knowledge representation, it has been possible to test 178 sentences manually coded by 5 different people. The response of the system is more than 90% in accordance with the reference sentences.

The idea behind the language is to allow for expressive communication between not only software agents, but also between humans and agents. This language takes into consideration aspects, such as expectations and conditions of success, among other characteristics that are present in human communication. In Berger 2005, the conditions of success and satisfaction are explicitly defined, as well as the elements from the conversational background. The thirty-two formalized conversation acts are:

assertives: confirm, deny, think, say, remember, inform and contradict;

commissives: commit oneself, promise, guarantee, accept, refuse, renounce and give;

directives: request, ask a question, suggest, advise, require, command and forbid;

declaratives: declare, approve, withdraw, cancel;

expressives: thank, apologize, congratulate, compliment, complain, protest, greet.

Connected to these five classes of behavior, Berger 2006 defined some logical rules to know when one of them has to be applied.

3.4 Personality in communication

Personality is expressed in the computation of the emotions. Thus a computational model of emotion is developed in Dang 2008.

Definition of emotion: an emotion is the process that characterizes the human body's response to a stimulus or event.

By *stimulus* or event we mean: external changes in the environment of the body, absence of external changes in the environment although one was expected, and internal body changes.

By *human body response* we mean: physiological changes inside the body, external expressions of the body and also ... no change.

Based on this definition, we propose the following model in Fig.6.

In this model, Sensation is the basic starting point. The sensation is generated by an event, something which really exists or not, but which generates a physiological change in the body and/or by sending subjective information (from Intuition) to the sense-organs: touch, hear, sight ... This sensation will be processed in two ways.

First, the Physiological Interpretation will directly interpret this initial signal into a body reaction (the heart races ...) and will also alert the Behavior module.

On the other hand, the Cognitive Interpretation will interpret the signals received from Sensation into cognitive information about the environment situation.

The Behavior will then calculate the response from the information coming from the perceptions based on the Internal Cognitive State. This response is sent to the Body where the physical reaction will take place.

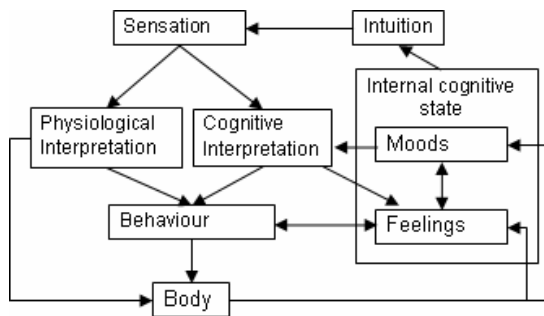


Figure 6: the Grace model of emotion

The MBTI model of personality, proposes four categories to build personality. Our model completely covers these four categories. The first one is the attitude split between Extraversion (E) or Introversion (I). In the generic model this particular feature is integrated in the Mood and Behavior modules. Secondly, the perception category of the MBTI is completely covered by the generic architecture. The Sensing is constructed with the two Interpretation modules and the Intuition by the Intuition module. Then, the third category is decisions: Thinking (T) or Feeling (F). We cover these two approaches by the way that the Behavior module of the generic model is coded. The last category of MBTI - Judging (J) or Perceiving (P) can be coded at the Interpretation level. In fact, it is a level of interest for the sensation that will be used. For instance, a sensation directly concerning a person will be more interesting for someone who is Perceiving.

4. EXPERIMENT

In this part we want to report on the introduction of a part of the socially acceptable parameters defined previously, in real systems: one robot and one ECA.

4.1 On Emi robot

The Emi robot is a fully autonomous robot designed in the ANR EmotiRob project to build emotion interaction with children.

A full description of the robot and its realization can be found in Saint-Aimé 2010. It is a 10 degree-of-freedom robot: 2 for the eyebrows, 4 for the mouth, 2 for the head and 2 for the body (pan-tilt).

In this first experiment, we wanted to measure the recognition of emotion on the Emi robot (figure 7). For this experiment, children around 10 years of age were the human users who, for a series of sentences given, determined the emotion expressed by the robot. We used the Wizard of Oz technique to

make the children believe that EmI understood the dialog.

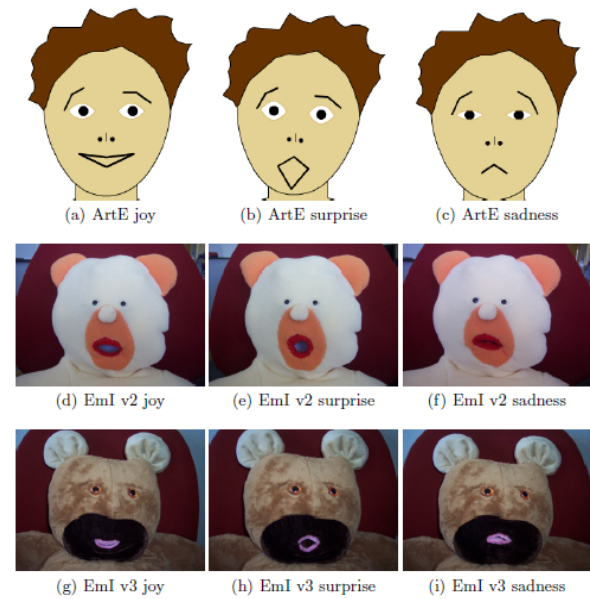


Figure 7: Emi robot and simulator

Saint-Aimé 2010 shows that the emotion recognition is very good and that the behavior of the robot is credible. For this result, one question remains unsolved which is determining the part that human expectation has within the result. Indeed, the human can see in the robot what he is expecting even if it is not the real intention of the robot.

4.2 On ECA

The general goal of researchers in the field of Embodied Conversational Agents (ECAs) is to develop interactive systems that are more natural and easy to use, and closer to the human user. ECAs must be *credible* or “believable”; the most general of these terms is used to describe anything we accept as true, even in the absence of absolute proof. Ortony, 2003, said that a major issue is how to make an agent a *believable* agent. Bates, 1993, explained the crucial role of emotion in a believable agent. Thus, ECAs must be endowed with refined communicative capabilities and the challenge is to build ECAs, which are capable of reasoning about emotions, of predicting and understanding human emotions, and of processing emotions through reasoning and during interaction with a human user.

In the ANR CECIL project (Complex Emotions in Communication, Interaction, and Language), we endowed an ECA with the capabilities to express its emotions by means of different modalities including

facial expressions, gestures, and language. We merged the speech act theory, emotion theory, and logic.

We used logic in order to provide a systematic analysis of expressive speech acts, that is, speech acts that are aimed at expressing a given emotion (e.g. to apologize, to thank, to reproach, to rejoice, to regret, to deplore, etc.). A description of the expressive speech acts can be found in Guiraud 2011. We put forward a *Multimodal Conversation Language* that enables agents to form expressive dialogues, mainly deliberative dialogues, such as negotiation, advice seeking, bargaining, and setting up appointments. Part of the thirty-two expressive conversation acts described in Berger 2005 has been used to constitute this language. We are currently testing the language on small dialogue scenarios between the Greta ECA (figure 8) and a human user. A preliminary evaluation of this experiment shows that the agent communicates its emotions during the interaction and tends to be “credible” with regard to the human user.



Figure 8: Greta ECA see Guiraud 2011

5. CONCLUSIONS

In this paper we propose to discuss social credibility for human acceptance of intelligent environment. We propose to implement this with three different levels of shared knowledge, value representation in knowledge and with emotion and personality expression in communication. We report on some preliminary experimentation in this field.

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