

“Tangible Influence”: Towards a new interaction paradigm for computer games

Marco Vala, Ana Paiva and Rui Prada

IST-Technical University of Lisbon and INESC-ID
Av. Prof. Cavaco Silva, IST, Taguspark
2780-990 Porto Salvo , Portugal
{ana.paiva,marco.vala,rui.prada}@inesc-id.pt

Abstract. As AI techniques become more widespread in computer games, and the area of synthetic characters matures, avatars in such computer games also tend to gain autonomy and become more clever. However, this autonomy may bring also some change in the interaction between users and game characters. Players may become less in charge of their characters and lose the power of complete motion or behaviour control. On the other hand, characters may become more clever exhibiting much more interesting autonomous actions and behaviours. This paper presents, defines and discusses the concept of “*influence*”, as an alternative to “direct” control of game characters, describing how influence can be achieved in computer games. To illustrate the notion of “*influence*” we will present a game called FantasyA where players interact with it by influencing the emotions of their semi-autonomous avatars using a tangible interface called SenToy. We show how “*influence*” was built into this game, the role of SenToy as an influencing device, and the reactions of the users to this type of control.

1 Introduction

Gaming is a highly relevant application area for Intelligent Agents and Synthetic Characters. Nowadays, computer games invade our life bringing us a set of new experiences, driving us into first person fantastic adventures. Although purely fictional, characters in such games have a personality, likes and dislikes, that pulls us into the story and make us feel part of it. As AI techniques become more widespread in computer games, and the area of synthetic characters matures, avatars in such computer games also tend to gain autonomy and become more clever. However, those AI techniques are going beyond the control of payer's opponents, as they are also becoming part of the avatar's behaviours. That is, instead of mindless bodies acting on behalf of the player, computer games characters are gaining life and autonomy. However, this autonomy does not come without some change in the interaction mode. Players become less in charge of their characters and lose the power of complete motion and control. On the other hand, characters may become more clever, less lame and deeper,

exhibiting much more interesting actions and behaviours. But, do players buy it? Do they accept not to control completely their characters? What kind of control is the most appropriate in such case?

This paper presents and discusses the concept of "*influence*", as an alternative to "direct" control of characters, describing how influence can be achieved in computer games. We will describe what is "*influence*" and where does it stand in range of possible types of communication between synthetic agents and humans. To illustrate the notion of influence we will present a computer game called FantasyA where players interact in the game by influencing the emotions of they semi-autonomous avatars using a tangible interface called SenToy.

We show how "*influence*" was built in this game, the role of SenToy as a tangible influencing device, and the reactions of the users to this type of control. Finally we will provide some discussion on the topic.

2. Interacting with Characters by Influence

About a decade ago, N. Negoonte [8] introduced the notion of "delegation" as a new paradigm for human/computer interaction. By contrast with direct manipulation, the idea of delegation is inspired by the image of an English butler, where instead of directly controlling all the actions in the interface, the user delegates some of his, perhaps more boring, activities to an interface agent that is clever enough to execute them autonomously. Although it took some time to catch its momentum, interface agents are now becoming more established and trustworthy as a human computer interaction medium. Still, trusting the agents and accepting not to control every aspect of the interface is something that many users are reluctant to do. The same happens to computer game's players. The idea of an avatar as the image of oneself (*Your digital you* [10]) in a virtual world that performs as one would responding to all the demands of the user is being challenged by work such as [10], [2] or [7]. However, most games do not allow for the user to delegate activities and rely mostly on direct control of the avatars.

Computer games that use characters follow several interaction patterns that we should consider:

- Action Games - the player completely controls a single avatar using either a first person (e.g. Unreal Tournament, Quake) or a third person view (e.g. Tomb Raider)
- Sports Games- the player usually controls a team of virtual athletes switching between avatars together with the ball (e.g. FIFA Soccer, NBA Live)
- Adventure Games the player guides characters (usually one) through a predefined storyline (e.g. Monkey Island, Grim Fandango)
- Role Playing Games - the player goes through several quests controlling one or more characters with well defined roles and abilities
- Real Time Strategy Games - the player acts as a god controlling multiple characters at a time in order to achieve a certain objective (e.g. Warcraft, Age of Empires)

Clearly most of these games do not allow for the user to delegate activities and rely mostly on direct control of the characters.

Action / Sports Games explore in depth the idea of avatar as the image of oneself in the virtual world, and require accurate control (aiming, dodging, passing, shooting) which the player is definitely not willing to share. But as for the team, every player would like to have an interesting cooperative play which leaves some room for the concept of "influence". Should the player be able to indirectly control other characters while in control of a specific avatar? Indeed. In FIFA Soccer the player can instruct computer controlled characters to run forward so that s/he is able to do a through pass and perhaps be alone in the face of the goalkeeper when s/he takes control of the character which received the ball.

Adventure / Role Playing Games have characters which are an interesting mixture between the player's image of oneself and the actor in the story. The player feels as if it is inside the story and assumes the character's goals and objectives. But s/he is constantly reminded that s/he is controlling somebody else's body which is not willing to pick that nasty tarantula or to jump over a cliff. In a way the player has less control over the character than in action/sports game but it still decides which action to do next. Characters act always the same way leading to repetitive and tedious interactions. Wouldn't it be more challenging to let the character's personality take control in certain occasions? The problem would change from what should I do with the character to what should I do to make the character do something. And that is one difference between control and influence.

In *Real Time Strategy Games* the player does not see himself in any particular character. S/he plays the role of god who has absolute control over all characters and their lives, personalities or interests do not have any special meaning. Games like Warcraft or Age of Empires have characters with very limited autonomy and can only make small decisions like which path to follow to reach some place in the world (path-planning) or to hold still or engage the enemy at sight (defined by the stance). More intelligent behaviour like running away towards the next city if the enemy sighted is stronger would be welcome, especially if the player isn't looking at that particular spot of the world at that moment. Majesty is a good example of an RTS with autonomous characters where the player can only "influence" their behaviour and where the ability of delegating tasks clearly changes the way players interact with the game.

2.1 Influence

If characters in a computer game become autonomous and interact with each other and with the players in an intelligent fashion, actions of such characters can be seen as social actions. Considering both players and characters in a game as a society of agents (humans and artificial), we can follow Conte and Castelfranchi's work [3] on cognitive and social actions as a base to describe the social relations established within the society.

This approach leads to a notion of influence that is a result of the heterogeneity of the agents (certain agents can influence other "weak" agents where the "weak" agents adopt the "strong" agents' goals and state of mind). In our case, such heterogeneity comes not only from the presence of the human agent with more capabilities than our

synthetic characters but also from the autonomy of the character itself (the user's digital self [10]).

Given this basic concept, two main questions arise. The first one is related to the effectiveness of the *influence*. *Influence* cannot always succeed in controlling the behaviour of the characters, otherwise it would be reduced to direct control. So, when do we say that influence is effective? The second question is architectural and is related to the types of properties that our agents must have in order to be able to be influenced by the user (rather than purely controlled by him). By answering these two questions we will be led to a more concrete definition of a semi-autonomous avatar.

Influence is not direct control: When the user controls directly the character it bypasses any kind of decision making on the part of the character and determines all the actions it is about to execute. Differently, with influence, the user's digital self (the character) gains brains and acts autonomously as well. So, the user will try to "convince" the character to a certain behaviour by influencing its mental state. Note that such influence may or may not succeed and the character may do the behaviour we want or may decide otherwise. This indirection, at first annoying for some users, becomes a challenge later on in the interaction (as we will see in the results obtained). For example, the situation where the user may want the character to be aggressive and act accordingly may not succeed even if the user influences the character to become angry. The character by itself may decide that it is better for its own goals to be defensive and cautious.

What kind of influence? Influencing different aspects of the state of mind: Although Conte and Castelfranchi consider the mechanism of influencing a cognitive one, nothing prevents us from considering the influencing at an emotional level as well. Indeed, influence, specially influence from the user to the agent, can be done on different attitudes. For example, the interaction can be designed so that users may influence the interests of their characters or even their emotions (as we have done with FantasyA and SenToy).

Constraints on the agent's properties and architecture: Influence, as here described, presupposes autonomy on both parts, that is, users and agents. Thus, our agents must have their own goals and mental states. That is, for that autonomy, characters must have an internal state, which may include beliefs, goals, emotions, etc, explicitly managed and reasoned upon, leading to some goal oriented behaviour independently from the user's control. This allows for the agent to be in control, but still be able to be influenced. On the other hand, building a character that admits control from several different sources may also require an hierarchical architecture with different control levels. For example, the architecture developed by Badler et. al. (see [2]) supports both graphical and language control.

3. Using SenToy as an Influencing Device for FantasyA

In FantasyA, users play the role of an apprentice wizard who is challenged to find the leader of her/his clan in the land of FantasyA where the game takes place. The game has an introductory phase, where the four clans (the ways of air, earth, fire and water), and the duels are explained. Then the player is placed in the "FantasyA World" where s/he will engage in exploration in order to find her/his leader. In our first prototype

characters can only challenge and duel wizards of other clans and the game itself develops in duels taking place in a battle arena built for the effect.

The main different between this game and many other computer games is that players "influence" their characters by emotional control using a tangible interface (SenToy) for that effect. Characters in the game have sufficient autonomy to act even when such control is against their goals.

3.1 Influence with SenToy

To "influence" the character players use SenToy, a wireless tangible interface with sensors in its body that allows the user to control the emotions of the character. The user must express appropriate gestures with the doll representing one of the following six emotions: anger, fear, surprise, gloat, sadness and happiness. SenToy is equipped with three sets of sensors: the accelerometers, which measure the acceleration that the SenToy is subjected to; analogical sensors, used to determine the limbs position; and digital sensors, used to indicate whether the hands of the doll are placed over the eyes or not. Since the emotions cannot be obtained directly from the rather complex data received from the SenToy sensors, a signal processing module was required and implemented so that the adequate patterns of movement can be detected.

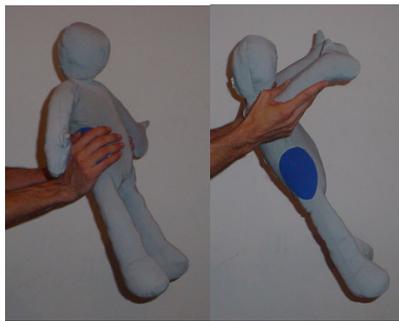


Figure 1. First prototype of SenToy

The SenToy recognizes six different emotions (happiness, sadness, anger, fear, gloat and surprise) as described bellow (see Figure 2).

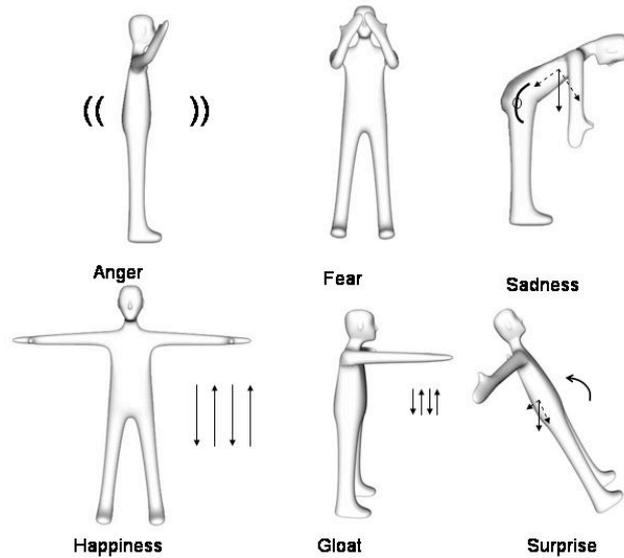


Figure 2. Gestures of SenToy

Each of these gestures are performed as:

Anger: The most general form of shaking the doll is to move the doll back and forward in short but fast movements. These movements cause accentuated variations of the acceleration value given by the accelerometer on the X axis.

Fear: To detect the gesture associated with fear, the user must put SenToy's hands placed over the eyes, independently of the arms position.

Happiness: To express happiness with SenToy, usually the user makes the doll dancing and/or jump up and down as a continuous movement. For these movements, the variation of the SenToy's position is predominantly on the X axis, with wide and rhythmic variation.

Sadness: The sadness emotion is expressed by bending the doll forward, almost to the horizontal plan.

Surprise: The surprise emotion has an asymmetrical sequence of rules, corresponding to the movement of jumping back, and laying inclined backwards with its arms open slightly to the back.

Gloat: To express gloating the user has to perform the same gestures as happiness and at the same time point the right arm to the front. This gesture was inspired in cartoon's expressions.

These gestures are used by the user as the indirect mechanism to influence the character's behaviour. Note that users may relate emotions to behaviour but, as expected, such link does not succeed all the time.

3.2 Influencing and Action Cycle

Characters in the games must act. It is the action selection of the agents that will determine the dynamics of the game, and therefore its gameplay.

In direct control, users shortcut the action decision and the process of deciding what to do is given to the user's control. So interaction and action are linked. However, to achieve influence in FantasyA, we had to design the interaction process in phases, separating the influence phase from the action phase. This is required so that, due to the indirect control, the influence phase can have an immediate feedback to the user in order for him to understand the action to be performed.

Let's consider a duel situation. To begin with, both characters are ready and placed in the arena for the duel to start. In the duel each character will cast spells that damage the opponent or defend themselves against the opponent. There are several offensive and defensive spells and each type can be further parameterized. The goal is to get the opponent endurance level equal to or below zero and at the same time keep its own endurance above zero.

- *Influence phase* – In this phase the player can influence the emotional state of his character. As soon as a new emotion is raised in the character, the influence phase ends and the character may cast a new spell. In FantasyA this phase is done with SenToy. If the emotional state is not changed by the player the influence phase ends after a few seconds (and an appropriate spell is also cast taking into account the current internal emotional state of the character).
- *Decision and Action Phases*- After the influencing, agents decide whether to follow the suggested state of mind, and from then, select the appropriate action, or reject it. That is, action selection is separated from the influencing process. In FantasyA this means that the agent decides the spell to cast and executes it as a result of a new emotional state being triggered.
- *Reaction phase* - When the action is performed, the result affects both characters, that will react to it. A new emotional state will then be appraised for both characters, in particular for the controlled character.
- *Permanent effects phase* - Certain spells, such as heal or weaken, have longer influence in the character, in what we call the permanent effects. The changes on the endurance levels are made and then the combat continues with the next player action. Note that is phase was necessary to give some continuity to the game and to maintain the gameplay.



Figure 3. A Duel

The phases described make a player's turn. Figure 3 shows on the left Alveggha's turn (the air character) in the moment when her influence phase has finished and she is casting a spell. On the right, it is Veronya's turn (the fire character), still in the influence phase.

3.3 Feedback on the Influence

Given that influence is not always effective, how does the player know that his or her character is acting under his influence? Indeed, the behaviour of the agent will depend not only on its emotional state but also on some internal variables that define the agent's state of mind. Therefore, we need to provide immediate feedback to the player.

In fact, in FantasyA one of the major aspects of the system is that any emotional state of the character is shown as expressive body movements portraying all the six different types of emotions. The body expression is an essential mechanism in the system for the user, although not completely in control, to interact with his or her character perceiving the response to the influence process. This problem was taken care not only with proper animations of the six emotional states, but also with an extension where the animations produced are generated by bending in real time all the characters actions with the current emotion posture. For example, to express an happy attack the character posture happy is blended with the attack animation. The body expression module of FantasyA has been described in detail elsewhere (see [11] for more details).

4. Autonomy and Semi-Autonomy of the Characters

In the case of a computer game, the relation with the characters' autonomy and the user control is a serious issue and needs perfect equilibrium to keep the users engagement high. Our approach was to give the character an emotional dimension that the user could control and restrict the user accessibility to direct combat actions (e.g. spells). However, the characters had to act in a believable and sufficiently clever way for players to accept and understand their behaviour. It was important for us to create believable behaviour that would follow to certain extent the emotions induced by the user. In fact, characters in FantasyA select the action to perform based on the following elements: the character's current emotional state; the character's model of the world (duel); the opponent's emotional state; some personality parameters that are associated with the clan the character belongs; and some physical properties of the agent which includes the endurance level.

In this section we will first describe how the action decision works and how characters react emotionally to battle events.

4.1 Autonomy and Action Decision

The action selection of a character is influenced by emotions in two ways: (1) because the character's own emotions influence its action tendencies and decisions; and (2) because the character has to take into account the emotions of the opponent as well.

For the action selection mechanism, we decided to base our work on action tendencies that would guide the selection of the action to perform. However, some of the emotion theories, such as for example the well known OCC [9], while carefully addressing the appraisal process and how an emotion becomes active in an individual, leave out the effect that such emotion has in the behaviour of the individuals. Further, given the limited choice of actions we had (several aggressive or defensive spells parametrized in different ways) it wouldn't make sense to explore deeply other more complex emotion theories (such as Scherer's theory for example). So, we have relied on three different emotion theories (Lazarus [6], Darwin [4] and Ekman [5]) to extract the relations between the emotion states and actions in the game.

Using these theories we have defined a set of action tendencies for our six emotions which then inspired the *first-level action selection rules* for our agents' behaviour. These rules were implemented in Jess and can be translated into:

```
If EMOTION = "Happiness" then Character take an offensive behaviour
If EMOTION = "Sadness" then Character take a defensive behaviour
If EMOTION = "Gloat" then Character take an offensive behaviour
If EMOTION = "Surprise" then Character take a defensive behaviour
If EMOTION = "Anger" then Character take an offensive behaviour
If EMOTION = "Fear" then Character take a defensive behaviour
```

However, the behaviour of the agent does not depend solely on the its own emotional state. It also depends on the opponent's emotional state as well as other internal factors. So, the *first-level action selection rules* have to be latter combined with the rules that depend on these other factors.

However, the influence of the others' emotions in an agent's own behaviour is even a more difficult to address. There is not much research on the effects of emotion communication, but research on empathy, emotional contagion and social referencing [1] provided us with some hints on how to address the problem. Empathy and emotional contagion suggest mechanisms for transmitting emotions to others, while social referencing has been defined as the *process of using another person's interpretive message, or emotional information, about an uncertain situation to form one's own understanding of that situation* [1].

In our scenario the two agents' goals are opposite, and thus we can assume that if a situation is good for the opponent it will certainly be bad for the agent. Following the social referencing theory we can evaluate the situation and decide what to do based on the current emotion of the opponent. Thus, in order to appraise the situation, the agent must model the opponent's intentions. Given that the opponent decides what to do also depending on its emotional state, the agent models the emotional state of the opponent and simulates its action tendencies. This simulation is done following a mechanism similar to the one discussed above for the agent's own emotions. For example, if the opponent is happy this should mean that it feels comfortable about the current state of the duel and will attack, therefore the agent should defend to counter the opponent's confidence in the attack. In fact, based on the opponents emotions the agent predicts the opponent's next action and reacts accordingly.

Finally, we also considered that the reaction to the expectations on the opponent's actions depends on the personality of the agent. In the example above we described

the behaviour of a cautious agent, but if it were more aggressive it would respond to the attack tendencies of the opponent with counter-attacks and not defenses. This element of personality in the characters increases the richness of characters, their believability, autonomy, and thus, game-play.

4.2 Emotional Reactions and Emotional Influence

After acting, both characters react emotionally to the results. The emotional reaction depends on the action itself, its results (e.g. if it succeeded or failed) and on the previous emotional state of the character. Similar to OCC [9], where the appraisal mechanisms activate emotions on individuals according to event that she perceives, in FantasyA the emotion state creates an "action expectation" on the character based on the action tendency that the emotion has. This means that an angry character expects to attack her opponent and that attack to succeed. Characters will react differently to the action result if the action taken and its result was within her expectations or not.

5. Study and Results

We conducted a study to evaluate our approach to the presented problems. The items we wanted to check include the interaction issues associated with the notion of influence, and also some entertainment issues about the game. The study was developed in two different phases, first just with SenToy and afterwards with FantasyA and SenToy.

5.1 Emotional Reactions and Emotional Influence

The SenToy evaluation was made with a group of 34 subjects: 8 kids, 12 high-school students and 14 adults, from ages 9 to 45 - with the average age of 21.8. The subjects were introduced to the SenToy without any explanation of the gestures that it recognizes, and were asked to express each of the six emotions using it. The results were obtained through video analysis and some questionnaires. Tables 1 and 2 resume the results obtained.

Table 1. Number of subjects that could successfully express an emotion using the *SenToy*. Note that in case of gloat a very similar gesture was used with a very significant value.

Emotion	N. Succ.	Emotion	N. Succ.	Emotion	N. Succ.
Happy	22	Sad	16	Gloat	1(16)
Anger	28	Fear	10	Surprise	14

Table 2. The SenToy questionnaire results. Q1: "Did you like the Doll?" (Not like it 1 - Love it 7). Q2: "How easy was to express the emotions?" (Hard 1 - Easy 7).

Question	Kids	Students	Adults	Mean
Q1	6.1	4.8	4.4	4.9

Q2 5.8 3.8 4.7 4.7

Latter, after the first experience and when the recognized gestures were explained, all the subjects could easily manipulate the SenToy. We concluded that SenToy can be a good interface to express emotions but it would be improved if alternative gestures for some of the emotions were provided.



Figure 4. One session of FantasyA's evaluation

5.2 Evaluation of FantasyA

The evaluation of FantasyA was conducted with 30 subjects: 8 kids, 12 high-school students and 10 adults - from ages 9 to 38 - with an average age of 20.6. The students and kids play computer games in an average of 10 hours per week, while adults almost didn't play at all. We run 15 sessions of 50 to 90 minutes each. Subjects were working in pairs and played an average of 20 duels in each session (Figure 4 shows the room layout and subject placement). The subjects were given two sheets with the game rules, but not with the emotion rules behind the combat logic. The results were obtained from three sources: video observation, open-ended interview and a questionnaire. The questionnaire included several questions focusing on three different aspects: the SenToy influence, the characters expressions and the game play.

In general the character expressions were well accepted and understood but the more exaggerated were better perceived. On the other hand the game logics seem too complex but some subjects got a few ideas about how influence worked. Some users were able to understand the indirection mechanism (see the following comment).

"I believe that you should check somewhat what the other guy [the opponent] does. What he expresses. [...] Yes, because he is probably expressing the same things as our guy is. Then you react to that. But we did not do that very much. [...]"(adult player).

Finally, and about the entertainment aspect of the game we got a complete success! All subjects were very pleased with the experience and some would even like to buy the game. One adult player said: *"This was a different game, enormously funny!"*, and one kid even asked *"It was a fun game that I hope will be released on the market sometime"* (13-year old).

6. Conclusions

In this paper we presented the concept of influence and how it was implemented in FantasyA and SenToy. The results show that influence can be an alternative to direct control of characters in games. However, the evaluation has also shown that we need to keep the balance between indirect and direct control of the avatar and that timing is very important. In fact, in FantasyA players are too much time inactive so one next improvement is to make a faster game cycle and even explore the idea of two influence phases one for attack and another for defense. However, in general, influence was a great success.

References

1. M. S. Atkins. Dynamic analysis of infant social referencing. Master's Thesis. Eberly College of Arts and Sciences at West Virginia University, 2000.
2. R. Bindiganavale, W. Schuler, J. Allbeck, N. Badler, A. Joshi and M. Palmer. Dynamically altering agent behaviours using natural language instructions. In *Proceedings of the International Conference on Autonomous Agents (AA'2000)*, ACM Press, 2000.
3. R. Conte and C. Castelfranchi. *Cognitive and Social Action*, UCL Press, 1995.
4. C. Darwin. *The Expression of Emotions in man and animals*. 3rd Ed. By Paul Ekman, Oxford University Press, 1872/1998
5. P. Ekman. *Emotion in the Face*. New York, Cambridge University Press, 1982.
6. R. Lazarus. *Emotion and Adaptation*. Oxford University Press, 1991.
7. I. Machado, A. Paiva and R. Prada. Is the wolf angry or just hungry? Inspecting, modifying and sharing character's minds. . In *Proceedings of the International Conference on Autonomous Agents (AA'2001)*, ACM Press, 2001.
8. N. Negroponte. Agents: From direct manipulation to delegation. In J. Bradshaw, editor, *Software Agents*, MIT press, 1997.
9. A. Ortony, G. Clore and A. Collins. *The Cognitive Structure of Emotions*. Cambridge University Press, New York, edition 1988.
10. S. Penny, J. Smith, P. Sengers, A. Bernhardt and J. Schulte. Traces: embodied immersive interaction with semi-autonomous avatars, *Convergence*, 7(2), 2001.
11. M. Vala, M. Gomes, and A. Paiva Affective Bodies for Affective interactions. In *Animating Expressive Characters for Social Interactions*, Eds. L. Cañamero and R. Aylett (in print), 2004.