www.icgst.com

Maze: A videogame that adapts to the user's emotions according to his behavior

[a,b]Ana Lilia Laureano-Cruces, [b]Emmanuel Hegmann-Gonzalez
[a]*Departamento de Sistemas, Universidad Autónoma Metropolitana – Azcapotzalco, San Pablo 180, Mexico City, Mexico.*
[b]*Posgrado de Ciencia e Ingeniería de la Computación del IIMAS-UNAM, Edif. Anexo IIMAS, 3er piso Universidad Nacional Autónoma de México (UNAM)*
Ciudad Universitaria, Coyoacán, México, D.F. C.P. 04510
clc@correo.azc.uam, e.hegmann@uxmcc2.iimas.unam.mx,
http://www.azc.uam.mx/, http://www.iimas.unam.mx

Abstract
Affective computing is related to the emotions and one of its areas of application is the entertainment industry. This work presents a videogame that attempts to adapt itself to the emotional state of the user. The game consists of finding a way out of a randomly generated 3D labyrinth. The game analyzes the user's movements, based on which it chooses actions to help the user, calm him down or attract him, using a variety of multimedia contents. These contents are handled independently from the game, so that the user may personalize them and adapt the game to different themes.

Keywords: *affective computing, human-computer interfaces, multimedia, videogames.*

1. Introduction
Emotion plays an important role in the way we see the world, in our interaction with other people and in our decision-making process [4, 5]. Affective computing is related to, arises from or influences our emotions. Affective Computing was divided into two research areas [10]:

- The emotions and human-computer interaction.
- Simulation of emotions (emotions synthesis).

The first line of research focuses on recognizing emotions in the user to be used as feedback to the system, which can also be expressed as emotional to improve the interaction and communication with the user.

The second line of research focuses on systems that seek to simulate emotions to build robots or agents that are more realistic, not only in appearance but also in their behavior. Our investigation is located in this line of research.

Paolo Petta and Robert Trappl [9] commented on the low probability that exists in reaching an intelligent autonomous behavior by failing to consider emotions. Moreover, they mention that the emotional interpretation can be an incentive towards the evolutionary development of cognitive abilities of greater sophistication.

To summarize, affective computing is an inter-disciplinary area that involves using computer systems to recognize, interpret and simulate human emotions [10, 13]. One of its applications is developing human-computer interfaces. A computer that can recognize users' emotions may better communicate with them and better understand their needs. This concept also applies to videogames.

One of the aims is to establish the capacity of realism of people's behavior and this behavior is aligned with the user's actions. This will create a group of behavior patterns based on the emotions generated from the interaction between the user and the videogame's characters. Bearing this idea in mind, a videogame was developed whose architecture permits the integration of an individual affective model, so that the history of actions may be considered. This feature has repercussions on a configuration of goals that becomes dynamic (concentrating on the videogame's characters) that is totally dependant on the person playing [1].

There are many types of videogames and in each one the system's interaction with the player is different. For example, in car races the player must have good reflexes and the ability to use the controls. In military strategy games, the player must have the ability to plan and manage the game's resources. So the unanswered question in this work is to what extent does the videogame depend on the person who plays it?

In a race game, the user may choose the level of difficulty, the number of opponents, the color of the car, scenery and, perhaps, background music. Nevertheless, once these variables are established, the game's dynamics remain the same, irrespective of the player's characteristics, personality or mood.

This work presents a videogame that attempts to adapt itself to the user's emotional state. To do this, it analyzes the user's movements during the game, based on which it takes certain actions.

Section 2 describes the overall idea of the videogame. Section 3 explains how the program attempts to recognize the player's emotions. Section 4 explains the actions that the program instigates in response to the emotions of the user that it senses. Section 5 gives a number of examples of how the program may be used, and Section 6 includes conclusions and the work to be done in the future.

2. The videogame

The aim of the game is to find a way out from the labyrinth shown in Figure 1. The green square represents the player's starting position and the red square is the way out. Both are established randomly.

Figure 1. A 10x10 cells maze (aerial view).

The labyrinth is created by a depth-first search algorithm [14] that creates a labyrinth without cycles. To add cycles to the labyrinth created, some of its walls are deleted randomly.

The game allows the player to establish the size of the labyrinth. Figure 1 shows one that has ten cells on each side, although tests were carried out on labyrinths of up to 250 cells on each side. The limit of cells is determined by the capacity of the computer on which the game is played.

The labyrinth changes each time the game is played, although the program has the facility for the user to establish the random number generator seed, so that the user can use the same labyrinth several times.

The game was programmed in C++ language using the Ogre3D graphics engine.

3. Recognizing emotions

In this work, the user's movements were used in an attempt to recognize four different emotions: *interest*, *boredom*, *confusion* and *desperation*. These types of emotions are those that people experience when they spend a long time at the computer; with regard to education-applied systems, it is important to keep the player interested. The main aim of detecting the user's possible emotions is to create an interaction that increases productivity, removes stress and keeps the user interested. There have been many studies on this subject and one of the conclusions reached is that this type of intelligence should be included in these types of interfaces to create more effective involvement [8-12].

In order to recognize these emotions accurately, an analysis needs to be made of the user's psychological data, such as heart and respiratory rate, facial expressions and posture. Only using the user's movements during the game substantially restricts the system's recognition capability, but it is a first level of approximation that does not require the user to use any special devices to be able to play. At this point, design concentrates on the cognitive structure of emotions, the biological aspect being left to one side [7, 11].

The program totals the player's movements at 30-second intervals. In order to measure displacement, the system adds up the time the player keeps the scrolling keys pressed and divides the result by thirty. The user may be displaced at twice normal speed if he keeps the *Shift* key pressed. While the player keeps this key pressed, the program double the time the player keeps the scroll keys pressed. Therefore, the maximum displacement value that can be measured is two, which happens when the user keeps the scroll keys pressed for thirty seconds, also keeping the shift key pressed. An interval of thirty seconds was chosen for two reasons:

1. Users do not move consistently when they play, so very short intervals tend to cause measurements to change abruptly, whereas longer intervals make it possible to estimate the user's average movements more precisely.
2. At the end of each interval, the program analyzes the movements recorded and takes action according to the analysis. Therefore, an interval of thirty seconds makes the program take two actions every minute, which means that the system can explore the labyrinth uninterruptedly for most of the time.

Nevertheless, the user may change the time of this interval by editing a text file, without needing to alter the program code.

The user may rotate during the game using the mouse or the keyboard, so the program measures the user's rotation in pixels. The number of degrees rotation is calculated by multiplying rotation in pixels by 0.15.

This constant is arbitrary and was chosen so that the user could rotate at a moderate speed.

In order to analyze the relation between the user and his mood, three people were asked to play the game for three-and-a-half minutes and to try and experience the four emotional states to be recognized; in other words, each person played for a total of fourteen minutes. As the program adds up the user's movement at 30-second intervals, 28 displacement and rotation values were recorded for each user, making a total of 84 values for the three users. Figure 2 includes a graph that shows these values.

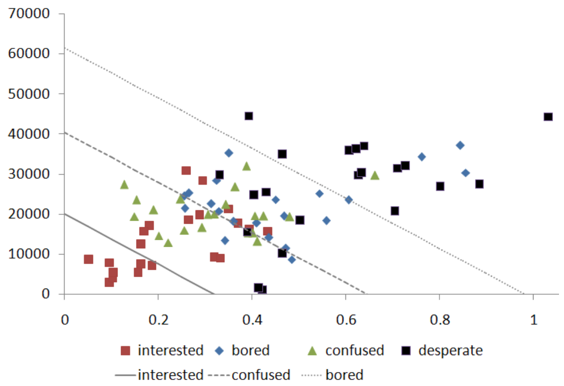

Figure 2. Displacement (horizontal axis) and rotation (vertical axis) of the three players who played the game. Details of the test are described in the text.

During the first version of the project it was decided to use three parallel lines to differentiate the four emotions, as shown in Figure 2. The area under the unbroken line was classified as *interested*; the area between the unbroken line and the broken line was classified as *confused*; the area between the broken line and the dotted line was classified as *bored*; and the area above the dotted line was classified as *desperate*.

4. Actions

In order to establish the actions that the program takes in response to each estimated emotion of the user, an evaluation structure was prepared based on the OCC Theory [7] shown in Figure 3. This technique has previously been used on systems for a variety of purposes [1, 2 and 4].

Figure 3. Labyrinth evaluation structure.

Each square of the structure represents an aim and the main (central) aim of the program is to keep the user interested. This aim is maintained while the game lasts, so it is a cyclic aim. This is indicated by the letter C in the bottom right-hand corner of the aim.

The three aims on the right define the actions that the program may take to achieve the main aim; in other words, these aims are *facilitators* of the main aim. This is indicated by the letter F on the links that connect these aims to the main aim. As these aims provide access to another they are called *active aims*. This is indicated with the letter A in the corner of these aims.

The three aims to the left of the main aim define events that make it difficult to accomplish the main aim. These aims are *inhibitors* of the main aim, indicated with the letter I on the links that connect these aims to the main aim. These events are a consequence of the player's emotional state and the program has no direct control over them. That is why they are *aims of interest*, indicated with the letter I in the corner of these aims.

The mechanism of recognizing emotions, described in the previous section, seeks to identify the occurrence of the main aim and the inhibiting aims. Based on this recognition, the program will decide which facilitating aims it will try to achieve, as described in Table 1.

Table 1. Actions that the program takes for each of the player's emotions

Emotion	Action
interest	attract
boredom	attract
confusion	help, attract
desperation	calm down, help, attract

In the case of *confusion* and *desperation*, the program may select from a number of actions and the one selected is chosen randomly in order to achieve a more diverse playing experience.

To attract the user, the program, creates a multimedia distraction in a section of the labyrinth. It then displays the user a message inviting him to head towards the distraction, and it draws markers in the labyrinth to guide him there. The current version of the program uses images such as multimedia distractions, including photographs of well-known places or works of art. Nevertheless, the capacity of the graphics engine used makes it possible to extend the program to incorporate videos, audio and 3D animation.

To help the user, the program shows him messages and draws markers in the labyrinth to guide him towards the way out, but not to take him their.

To calm the user down, the program displays messages suggesting that he does not get desperate and to continue looking for the way out. Future versions of the program may include changes to the background music so as to help calm the user down.

The game is structured so that the user may change the dialogue and multimedia content, editing text files that are not part of the program, without having to change the program code. This means that the game may be adapted to various styles, such as suspense, science fiction or education, and make the program a videogame generator.

5. Examples of use

Figure 4 shows a scene in which the game seeks to draw the user towards a multimedia distraction. The program displays a message that describes the distraction and draws blue markers to guide the player towards it. The figure also shows a multimedia distraction that, by pure coincidence, is on the way to the other distraction.

Figure 4. An example of the *attract* action.

Figure shows how the game helps the user to find the way out, by displaying messages and drawing white markers in the labyrinth.

Figure 5. An example of the *help* action.

In Figure 6, the game has detected that the user is desperate and shows him a message to calm him down.

Figure 6. An example of the *calm down* action.

6. Conclusion and future work

The videogame developed in this work attempts to adapt itself to the user's emotional state by analyzing his movements. The adaptation to the user, in addition to the flexibility of the game to display various dialogues and multimedia contents, and to create labyrinths with various levels of difficulty, means that the videogame may be adapted to a variety of audiences and themes.

The current version of the program still needs a number of extensions to incorporate video, music and animation into the multimedia contents. These extensions will be added in the future.

You can find the game and a user guide (in Spanish). In this place: http://delfosis.uam.mx/~ana/

Acknowledment: This work is part of the Soft Computing and Applications research within the Emotions research section; funded by the Universidad Autónoma Metropolitana, also recognize the enthusiasm of Emmanuel Hegmann-Gonzalez (CVU: 254155), supported by (CONACYT). Student in the Postgrado en Ciencia e Ingeniería de la Computación at the Universidad Nacional Autónoma de México.

References

[1] Acevedo-Moreno, D. (2008). *Diseño de una Arquitectura para Incorporar Emociones en Videojuego*. Tesis de Posgrado en Ciencia e Ingeniería de la Computación-IIMAS-UNAM. México. Recuperado de http://delfosis.uam.mx/~ana/ en mayo 2009.

[2] Laureano-Cruces, A.L., de Arriaga, F., Garcia-Alegre Sanchez, M. (2001). Cognitive Task Analysis:a proposal to model reactive behaviors, In Journal of Experimental & Theoretical Artificial Intelligence. 13(2001)227-239. ISSN: 0952-813X. Ed. TAYLOR & FRANCIS.

[3] Laureano-Cruces, A., Velasco-Santos, P., Mora-Torres, M., Acevedo-Moreno, D. (2009). Hacia Interfaces Inteligentes. el Libro Científico: Avances de las Mujeres en las Ciencias, las

Humanidades y todas las disciplinas. Sustentabilidad, Aire, Agua, Fuego y Tierra, pp. 237-246. ISBN: 978-607-477-212-8CYAD/UAM-A.

[4] Laureano-Cruces, A., Ramírez-Rodríguez, J., Mora-Torres, M., de Arriaga, F. & Escarela-Pérez, R. (2010). “Cognitive-Operative Model of Intelligent Learning Systems Behavior”. Interactive Learning Environments. ISSN: 1049-4820. UK. Vol. 18, no.1, pp 11-38.

[5] Loewenstein, G. y Lerner, J. S. The role of affect in decision making. Davidson, R. J., Goldsmith, H. H., y Scherer, K. R., eds., Handbook of Affective Science, Series in Affective Science, cap. 31, págs. 619–642. Oxford University Press, Oxford, New York, 2003.

[6] Loewenstein, G. F., Weber, E. U., Hsee, C. K., y Welch, N. Risk as feelings. Psychological Bulletin, 127(2):267–286, 2001.

[7] Ortony, A.; Clore, G. L.; Collins, A. (1988). The Cognitive Structure of Emotions. Cambridge University Press.

[8] Partala, T., Surakka, V. (2004).The effects of affective interventions in human-computer interaction. Interacting with Computers, 16(2). pp. 295-309.

[9] Petta P., Trappl R. (2001). Emotions and Agents. ACAI2001, LNAI 2086.

[10] Picard, R. W. (1995). Affective Computing. MIT Technical Report Num. 321.

[11] Reeve, J. (2001). Motivación y Emoción. ISBN: 978-970-10-3788-1. McGraw Hill

[12] Velasco-Santos, P., Laureano-Cruces, A. Mora-Torres, M. y Sánchez-Guerrero, L. (2008). La Importancia del Diseño de una Interfaz en el Proceso de Enseñanza-Aprendizaje. En XXI Congreso Nacional y VII Congreso Internacional de Informática y Computación de la ANIEI. Memorias en CD, ISBN 978-970-15-14388-2, pp. 108-113. http://delfosis.uam.mx/~ana/

[13] http://www.computer.org/portal/web/tac (retrieved on December 20, 2010).

[14] http://en.wikipedia.org/wiki/Maze_generation_algorithm (retrieved on December 20, 2010).

Biographies

Ana Laureano-Cruces was born in Mexico City. She obtained a bachelor’s degree in Civil Engineering, a Master’s degree in Computer Sciences, and a Doctoral degree in Science at UNAM. She has been full-time professor at Universidad Autónoma Metropolitana since 1989 and guest professor at Universidad Nacional Autonoma de Mexico since 2003. She has more than 70 publications in the field of artificial intelligence. Between 1998 and 2000, she was a guest researcher at the Departamento de Sistemas del Instituto de Automática Industrial del Consejo Superior de Investigaciones Científicas de Madrid. Her principal research areas are: Multi-Agent Systems, Intelligent Systems applied to Education, Expert Systems and Behavioral Analysis and Affective Computing.

Emmanuel Hegmann-Gonzalez is currently a student of the MSc in Computer Science at the National Autonomous University of Mexico (UNAM). His main research interests are artificial intelligence and computational neuroscience.