CONTROLLING AN INFLUENCE ON A USER IN A RENDERING ENVIRONMENT

KONTROLLE EINES EINFLUSSES AUF EINEN BENUTZER IN EINER WIEDERGABEUMGEBUNG
MAÎTRISE D’UNE INFLUENCE SUR UN UTILISATEUR DANS UN ENVIRONNEMENT DE RESTITUTION

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a method of controlling an influence on a user in a rendering environment. The invention also relates to an apparatus for controlling an emotionally adaptive system.

[0002] The invention also relates to a computer program.

BACKGROUND OF THE INVENTION

[0003] Saari, T. et al., "Emotional regulation system for emotionally adapted games", Proceedings of FuturePlay 2005 conference, 13.-15.10. 2005, Michigan State University, USA relates to an approach to build emotionally adapted games based on a user-controlled emotional regulation system. It discloses a system design for including emotional regulation in a gaming engine. The engine continuously monitors user input. This input data is then processed and transferred to the layer that handles the game's internal logical state. The proposed emotional regulation can be implemented as a middleware system that runs in parallel to the actual game engine. The input processing layer of the game engine can receive a data flow of captured and pre-processed biofeedback sensor data. The real-time signal processing may consist of different forms of amplifying, filtering and feature selection on the biofeedback signals. This data flow may directly influence the state of the game world, or it can be used by the emotional regulation sub-module of the emotion feedback engine. This module consists of the rules of emotional balancing for different player profile types and game-related explicitly set preferences controlled by an "emotion knob". The output of the emotional regulation engine may then be applied to various different levels of the actions of the game engine:

   i) the logical state of the world may be re-directed,  
   ii) the actions of the synthetic agents may be controlled,  
   iii) the kinetics of the game may be altered and  
   iv) the rendering of the game world may be changed.

The first two options are more related to high-level and story-related structures of the game, whereas the last two are more directly related to the selection of presentation of objects within the virtual environment.

[0004] A problem of the known system is that it is too simplistic to assume a player’s emotional response based on physiological and performance-related parameters, because every player is different and players differ with respect to skills, preferences and emotional responses over time.

[0005] The document 'TIMO NIKLAS MARKO JARI SAARI RAVAJA TURPEIÑEN LAARNI KALLÍNEN ET AL: “Towards emotionally adapted games” PROCEEDINGS OF PRESENCE 2004, 13 October 2004’ describes a gaming personalization system to facilitate desired emotional states of players. Measuring signals that characterize a user’s emotional state is described, which signals would verify to the system whether a desired psychological effect has been realized.

SUMMARY OF THE INVENTION

[0006] It is desirable to provide a method, apparatus and computer program for implementing an emotionally adaptive system that tailors the level of system feedback to the individual user such as to bring the user in a desired mental state.

[0007] This is achieved by the method according to the invention as defined in claim 1.

[0008] The method is based on the insight that different users are brought into different mental states by a particular level of a particular aspect of system feedback, that this relation is also time-dependent, and that a particular mental state can be characterized by different signals representing one or more physiological conditions of the user (hereinafter: emotion signals) for different users and over time. By obtaining the user’s self-reports and data representative of accompanying emotion signals over a last period before the accompanying self-report, the method obtains data that link mental states to emotion signal values. Thus, a control loop that uses the emotion signal(s) as input can be implemented to control the emotional state of the user. By contrast, the prior methods merely control the emotion signal itself, whereas the user may set (static) limits. In the gaming domain, the method recognizes that adapting the working of a game based on in-game (performance-related) data, in order to optimize the player’s enjoyment is too simplistic. This is because many different types of players exist: Achievers, Explorers, Socializers and Killers. Different players have different skills, preferences and emotional responses when playing games. Not every player enjoys an optimal performance/challenge level. Therefore the method recognizes the need to measure the player’s emotional responses, and that a player’s interpretation of the data is required for success. In so doing, the method allows one to take account of multiple dimensions of emotionality, one common model being based on the dimensions valence and arousal. Valence information is provided by the user’s self-reports, whereas arousal information is comprised in the emotion signals. An alternative selection of one or more dimensions determined by signal data and one or more dimensions determined by users’ self-reports is possible.

[0009] In the present context, emotion signals are signals that enable an inference of a user’s physiological state to be made, which are independent of performance-related parameters (in the case of a gaming environment) or, generally, of the explicit user input information provided to the system implementing the rendering environ-
ment. Emotional states include mental states representative of stress and a high workload.

[0010] In an embodiment of the method, the data corresponding to a user’s desired emotional state include thresholds corresponding to switch points at which the user switches between emotional states.

[0011] An effect is that both the extent and the location of an emotional state relative to feedback levels are represented by the data. Closed loop control based on such data is more stable, because fewer adjustments are required to stay within the state as represented by the “model of the user” that is established by the data. The method takes account of the fact that some users may be relatively impervious to changes in the level of a particular aspect of feedback. If that is the case, then adjustments in feedback level for that aspect need be made less frequently. Especially in embodiments in which the apparatus implementing the method switches state in response to e.g. user feedback, the number of switches may be reduced if the feedback level is kept in the middle of the range corresponding to the desired emotional state. Establishing thresholds allows one to find the middle of this range. When a change in state is actually desired, then having thresholds for each aspect of system feedback allows one to select the appropriate aspect to change, for example the one for which at least one threshold is closest to the current level.

[0012] In an embodiment, at least in a calibration mode, the user’s self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompanying self-report are obtained and a level of at least one dimension of the system feedback is constantly changed.

[0013] Thus, in this mode, one is able to find the boundaries of an emotional state by going through a range of feedback levels, rather than staying at the first level that corresponds to the desired emotional state.

[0014] In a variant of this embodiment, a next level of at least one dimension of the system feedback is selected from a scanning sequence database.

[0015] An effect is to avoid repetition of values as the range of feedback level values corresponding to an emotional state is being determined. One can discover the range relatively quickly on the basis of a sequence representing a suitable and efficient search strategy.

[0016] In an embodiment, the user’s self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompanying self-report are stored in a database.

[0017] This allows one to make an accurate model of the user, but also to re-make this model if necessary, based on multiple data points.

[0018] In an embodiment, the user’s self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompanying self-report are obtained in a calibration mode, in which they are used to train at least one classifier for predicting the user’s emotional state from at least one signal representing one or more physiological conditions of the user.

[0019] An effect is that one need not obtain a large number of self-reports and accompanying signal sections. Signal levels can be measured and an emotional state inferred even if the particular level measured has not previously been encountered.

[0020] In an embodiment, the user’s self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompanying self-report are obtained in a calibration mode, and a switch is effectuated to an adaptive mode, in which the steps of determining whether the desired emotional state is reached and, if the state is not reached, adapting the system feedback provided by the rendering environment correspondingly are carried out continuously.

[0021] An effect is that the user is not prompted for self-reports in the adaptive mode, so that the experience of the system feedback in the rendering environment is uninterrupted.

[0022] A variant of this embodiment includes remaining in the adaptive mode for as long as no new user’s reports are provided.

[0023] Thus, as long as the system is able to keep the user in the desired emotional state, the user’s experience of the rendering environment is uninterrupted. An indication from the user that the level of system feedback is no longer correct triggers a switch to a calibration mode, in which the ranges of system feedback levels corresponding to a desired emotional state are re-established. This method takes account of the fact that a user of a gaming environment may learn over time, and that users of a rendering environment can generally become used to, or even bored by, particular levels of feedback. The user is able to signal this, whereupon the environment is adapted.

[0024] According to another aspect of the invention, there is provided an apparatus for controlling an emotionally adaptive system as defined in claim 11.

[0025] The apparatus may be configured to carry out a method according to the invention.

[0026] According to another aspect of the invention, there is provided an emotionally adaptive system, comprising products for rendering feedback effects and an apparatus according to the invention.

[0027] According to another aspect of the invention, there is provided a computer program including a set of instructions capable, when incorporated in a machine-readable medium, of causing a system having information processing capabilities to perform a method according to the invention.

[0028] The invention will be explained in further detail.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]
with reference to the accompanying drawings, in which:

Fig. 1 is a schematic block diagram of a system comprising products for rendering feedback effects and an apparatus for controlling the system;

Fig. 2 is a conceptual diagram of a system with an emotional adaptation loop;

Fig. 3 is a schematic diagram illustrating a user-product interaction model;

Fig. 4 is a flow chart of a method of controlling an influence on a user in a rendering environment;

Fig. 5 is a diagram illustrating an example of a user-system interaction model in the form of game speed vs. time;

Fig. 6 is diagram corresponding to that of Fig. 5, but over a longer time period;

Fig. 7 is a diagram illustrating the development over time of user reports and feedback level as obtained using the method of Fig. 4; and

Fig. 8 is a diagram illustrating a further example of a user-interaction model, typical for atmosphere creation products.

DETAILED DESCRIPTION

[0029] Fig. 1 illustrates in outline a generic emotionally adaptive system 1 including one or more rendering products and a control apparatus. The system includes a processor 2, main memory 3, a further memory unit 4 for hosting one or more database, at least one input unit 5, at least one user input device 6, a display device 7 and an input/output unit 8 for obtaining emotion signal data representing one or more physiological conditions of a user in response to an influence caused by system feedback of the rendering environment provided by the emotionally adaptive system 1. The system 1 further includes an interface 9 to external rendering devices 10-12.

[0030] The proposed system architecture and functionality may be applied to a wide range of emotionally adaptive products, e.g.:

- Computer gaming systems;
- Home theatre systems (both for movies and TV programs);
- Atmosphere creation products: for instance, for Philips Living Colors products, emotion signals can be gathered e.g. by integrating sensors in the furniture of the (living) room and by means of a wireless device (e.g. bracelet measuring heart rate and skin conductance);
- Photoframes; and
- Music players.

[0031] The processor 2 may be a well-known central processing unit (CPU) suitably arranged to implement the emotionally adaptive system 1 and enable the operation of the device as explained herein.

[0032] The main memory 3 may be a known RAM (random access memory) memory module. The processor 2 may be arranged to read from the main memory 3 at least one instruction to enable the functioning of the device 1.

[0033] The processor 2 is coupled to the input unit 5 for obtaining media content by recording the media content, receiving the media content, etc. Depending on the implementation, the input unit 5 will comprise a photo camera for taking pictures, a video camera for shooting a film, a personal video recorder (PVR), a TV tuner, a computer equipped with a network card for connecting the computer to a data network, or any other device suitable for obtaining the media content. In one embodiment, for example, the input unit 5 receives video data in a known manner from a video content broadcaster, e.g. using digital video broadcasting (DVB) specifications, video on demand systems, Internet radio systems, etc.

[0034] The user input device 6 will generally comprise at least a keyboard, e.g., a well-known QWERTY computer keyboard and a pointing device and possibly a remote control unit. For example, the pointing devices are available in various forms such as a computer (wireless) mouse, light pen, touchpad, joystick, light-pen, trackball, etc.

[0035] The display device 7 may be any conventional means for presenting video information to the user, for example, a CRT (cathode ray tube), LCD (Liquid Crystal Display), LCOS (Liquid Crystal on Silicon) rear-projection technology, DLP (Digital Light Processing) television/Projector, Plasma Screen display device, etc.

[0036] The media content/item/document processed by the emotionally adaptive system 1 comprises at least one of, or any combination of, visual information (e.g., video images, photographs or graphics), audio information, text information, and other digital data such, e.g., meta-data according to the MPEG-7 standard. Such meta-data may be used to describe and search digitized materials by means of sampling, as well as by using lexical search terms. The media content may be stored on different data carriers such as an audio or video tape, an optical storage disc, e.g., a CD-ROM disc (Compact Disc Read Only Memory) or a DVD disc (Digital Versatile Disc), floppy and hard-drive disk, etc, in any format, e.g., MPEG (Motion Picture Experts Group), MIDI (Musical Instrument Digital Interface), Shockwave, QuickTime, WAV (Waveform Audio), etc.

[0037] The processor 2 is configured to execute a software program to enable the execution of the steps of the method outlined herein. In one embodiment, the software enables the apparatus comprised in the emotionally adaptive system 1 independently of where it is being run. To enable the apparatus, the processor 2 may cause the software program to be transmitted to the other (external) devices 10-12. These external devices 10-12 are connected to the processor 2 through the interface 9 using an existing technology, such as Bluetooth, IEEE 802.11 [a-g], etc. In one embodiment, the processor 2 interacts with the external device in accordance with the UPnP (Universal Plug and Play) standard.
Ideally, an entertainment product continuously adapts its working to the present user. Since emotions play an important role in the user-product interaction, entertainment products should become emotionally adaptive, i.e. continuously adjust their working to the user's emotional state/responses, in order to optimize the experience. As a first step towards personalized experiences, many manufacturers nowadays make their products customizable (e.g. a mobile phone of which the keypad colors can easily be changed by a user). A logical next step will be product-adaptability:

Instead of a user changing the product's behavior (working, looks, etc.) before or after usage (i.e. off-line), the product will change its own behavior continuously during usage (i.e. on-line), as shown in Fig. 2. In Fig. 2, the emotionally adaptive system 1 provides system feedback 13 in the form of settings for various devices forming a rendering environment to a user 14. This feedback brings about a change 15 in experience, behavior and emotional state of the user. The change 15 manifests itself as changes in measurable parameters, also referred to herein as emotion data 16, which are provided as input to the system 1. The emotionally adaptive system 1 gathers and analyses the data (step 17) and takes appropriate action (step 18) in the form of an adjustment of the settings of the products for providing the system feedback 13.

Regarding system feedback, a number of product features can be adapted, such as audio, visual and haptic effects. Regarding emotion data, a large number of emotion measurement techniques are possible.

In the methods outlined herein, we distinguish between emotion signals (measured continuously, such as heart rate, skin conductance level and keyboard pressure) and user reports (provided every now and then by the user). Emotion signals are measured passively, in that they require no cognitive effort from the user. User reports are provided actively, in that they require cognitive effort from the user as well as active input.

A specific implementation of the emotionally adaptive system 1 is based on a selection of signals related to emotions and on an application-specific model.

Emotion signals according to one embodiment comprise signals representative of physiological responses. Measured parameters include one or more of the blood volume pulse level, the blood volume pulse amplitude, the heart rate, the heart rate variability, the respiration level (i.e. relative chest volume), respiration rate, respiration-heart rate coherence, skin conductance level, number of skin conductance responses (per unit time) and muscle activity or amplitude (e.g. of the corrugator supercili or zygomaticus major). Heart rate variability is quite closely correlated to emotional responses for most people. Emotion signals according to another embodiment additionally or alternatively include parameters representative of haptic responses. A suitable parameter to measure is the keyboard pressure. Emotion signals in yet another embodiment additionally or alternatively measure behavioral responses, e.g. by video analysis, such as to characterize movement, in particular unconscious movement unrelated to the system feedback or the logic behind the content being rendered. The degree of fidgeting by the user can be quantified, for example.

The choice of emotion signals comes down to the question of how to measure the user's emotional state given the current application context. Emotional states and responses depend on the application. Different application behavior evokes different emotional responses. The usefulness of different emotion signals should be assessed for the application under development. For instance, in a computer game, keyboard pressure may be useful, but for a home entertainment system this cannot be used. Therefore, as a first preparation step, one should investigate the most promising emotion signals given the targeted application context. Furthermore, it should be investigated how the user can easily provide the system with user reports (which are further explained below).

Another aspect of the implementation of the emotionally adaptive system 1 concerns the type of system feedback:

How should the system 1 respond to (changes in) the user's emotional state?

Many user-product interaction scenarios are expected to have a generic form as displayed in Fig. 3. The dotted lines represent the borders of an individual's desired emotional state (the optimal product experience). As an example, in Fig. 3, two feedback features F1,F2, also referred to herein as dimensions of the system feedback, are used for adaptation. Two optimal feedback settings (areas 19,20) are shown. In theory however, there can be any number of dimensions of system feedback that are adapted, and there can be a different number of areas corresponding to optimal feedback settings.

As a next implementation step, it is necessary to create an application-specific interaction model from this generic user-system interaction model (Fig. 3). For creating the application-specific model, the type of system feedback needs to be decided upon. For instance, in a home theatre environment, we can think of optimizing the volume or intensity of Ambilight effects. In a gaming example, game speed might be used as a feedback parameter to be adapted.

When the preparatory steps have been taken, the suitable emotion signals and application-specific model may be integrated into a system architecture. The proposed system works as described below with reference to the flow chart of Fig. 4.

During product usage, the user's emotion signals are measured continuously.
Initially, the system 1 is in the calibration mode (step 21), during which the level of system feedback constantly changes, e.g., increases or decreases in feedback. Alternatively, the system could offer discrete levels of feedback, going in discrete (e.g. 10, 30, 60, 30, 10), potentially random (e.g. 10, 100, 20, 30, 95) steps through levels.

These changes may be controlled by user reports that the system receives (step 22). Any single feedback dimension (e.g., the two effects as mentioned in Fig. 3) can be changed independently of the other. For every dimension, this is gone through, two "explicit" user-report types: "I find this too much" and "I find this not too little" report, because the user probably liked the system feedback level. Otherwise (s)he would have reported so. Alternatively, the user could be offered either just one ('experience OK' or 'experience BAD') feedback control, or many. In fact, any number of feedback controls (one or larger) could be implemented, although small numbers will be preferred for usability.

After every user report, this user report plus the accompanying emotion signals are stored (step 23) in a database 24 (e.g. storage of the mean values of heart rate and keyboard pressure over the last seconds before that user report). Also, the direction of the system feedback is changed (as part of the step 21 of operating in the calibration mode), for instance from an increasing feedback strength to a decreasing feedback strength (an illustration of this is provided in Fig. 7, to be discussed in more detail below). Alternatively, especially for the 'no continuous feedback alternative' mentioned above, the next system feedback level can be randomly chosen, or selected from a database containing known 'scanning' sequences. Potentially, the next system feedback setting could be selected to avoid repetition of very similar settings, or settings that have already been offered.

After the step 23 comprising storage of the data, at least one classification algorithm tries to classify, i.e. predict, (step 25) the most recent user report of step 22 based on the most recent emotion signals and the data that have previously been entered onto the database 24. This classifier can be based on neural network principles or alternative machine learning techniques known to a person skilled in this field.

Next (step 26), the system checks the classifier's most recent predictions, e.g. the five most recent ones. In case the classifier has an accuracy that meets a minimum threshold (e.g. four out of the last five predictions correct), the next system mode will be the adaptive mode (step 27). If not, the system remains in the calibration mode. It should be stressed that this check can be implemented in a number of ways:

- As suggested above, when the previous X trials have shown Y successes (Y being smaller than X);
- An automatic switch to adaptive mode after a certain amount of time or interaction events;
- Alternatively, the system could periodically switch between calibration and adaptive modes on periodic, preset or randomly selected times.

In the adaptive mode, the system feedback is continuously adapted to the user's present emotion signals. The system remains in the adaptive mode as long as the user does not provide new user reports. If a new user report enters the system, all the above steps 22,23,25,26 are taken again, to see whether the system still has sufficient predictive power. Optionally, the set of stored classification prediction successes could beemploi-d on receipt of user feedback in the adaptive mode, as this signals that the adaptation was apparently unsuccessful (due to a change in user preference or other causes).

The application of the method of Fig. 4 to two embodiments will be described in the following.

**Embodiment 1: Home theatre system**

In this embodiment, a home theatre system that includes Ambilight and haptic feedback (through a number of small vibromotors in the user’s chair) is envis-aged. Ambilight is a lighting technology that allows the emotionally adaptive system 1 to change the ambient lighting conditions, in particular according to the results of an analysis of the audiovisual content being rendered simultaneously. Thus, in this embodiment, the external devices 10,11,12 include lighting devices and tactile feedback devices of the kind mentioned above.

In this application context, the user is expected to sit in a chair, in front of a television. Therefore, the devices 8 for capturing emotion data may be integrated into the chair (e.g. measuring the user’s posture, skin temperature and respiration patterns) and television (e.g. a camera that captures the user’s facial expressions and pupil diameter). The two user reports "this is too much system feedback" and "this is too little system feedback" can be implemented by two buttons on the home theatre system’s remote control, or alternatively in one of the chair’s armrests.

The level of Ambilight and haptic effects are used as system feedback parameters to be adapted. These are grouped into different patterns (i.e., Ambilight effects and haptic effects to events in a movie).

The system starts in the calibration mode. This is communicated beforehand to user John. John is told that the system feedback level will start at a minimum level and will increase throughout the movies he watches, until he indicates that the current level of feedback has become too high. From that point onward, the system feedback level will decrease until it reaches a point where he indicates that the level of system feedback has become too low, etc.

The level F of one dimension of system feed-
back is illustrated in Fig. 7. A first time interval M1 corresponds to a first movie rendered on the home theatre system. A second time interval M2 corresponds to a second movie rendered on the home theatre system.

[0061] The first movie John watches is a scary movie including a number of frightening scenes which are enhanced by the Ambilight and haptic system feedback. The first "enhanced" scene is accompanied by a system feedback patterns at level 1 (i.e., hardly any feedback, since 1=lowest intensity and 100=highest intensity). In case John presses the "too much" button on his remote control, this implies that he finds the minimum level of system feedback already "too much". In that case, John is asked to confirm the turning off of the system feedback functionality. However, John hardly notices the system feedback at level 1 and thus does not press a button. A few scenes further, the system feedback level has increased to level 15. John starts to notice the system feedback but finds it still not enough. After 60 minutes, the system feedback level is at level 65. "Wow, this is cool stuff!", John thinks.

[0062] However, at minute 80 in the movie the feedback has increased to level 76. He finds this amount of feedback a bit too overwhelming (distractive) and thus presses the "too much" button. This "too much" report plus John's mean emotion signals over period 79.50-80.00 (i.e. 10 seconds) are stored in a database. The following scenes are accompanied by system feedback at decreasing levels. However, 30 minutes later, the system feedback is at level 50, which John finds not enough, so he presses the "too little" button. This "too little" report plus his emotion signals over period 109.50-110.00 are added to the database 24 (Fig. 4). Besides that, the emotion data over the period right in between his two most recent reports (i.e. period 94.50-95.00) is stored as "this is ok" in the database 24. Since John did not press a button here, it is assumed that he liked the system feedback at this point. After that, the system feedback level starts to increase again.

[0063] After the movie, the system estimates the amount of extra data-points needed for accurate classification. A progress bar shows the current amount of data vs. an estimation of the amount of needed data. A couple of days (and a few movies) later, the system has obtained sufficient data for correct classification. From that point onwards, the system applies a feedback level that matches John's current emotion signal values. That is:

- When the emotion signals are similar to that of a typical "too much" report of John, the following enhanced movie scenes will be accompanied by a decreased level of system feedback.
- When John's emotion signals match his pattern of "too little", the next scenes will have a higher level of feedback.
- When his emotion signals match the pattern of "this is ok", the amount of system feedback will remain unchanged.

[0064] The embodiment described below has been built and tested in detail by the applicants. The computer game Pac-Man is used as an example embodiment.

[0065] The player (call him Jack) sits in a chair, in front of a display device 7 in the shape of a Personal Computer monitor, and plays Pac-Man using the input device 5 (keyboard). Therefore, many emotion signals can be used such as posture, skin temperature, facial expressions, pupil diameter, mouse- and keyboard pressure, etc. The two user reports "this is too much system feedback" and "this is too little system feedback" can be implemented by any pair of keys (of the keyboard) that are not used in the actual game. In this example, the [up] and [down] key of the keypad are used.

[0066] As shown in Figs. 5 and 6, the speed S of the game (i.e. the speed of all objects that move) is used as the system feedback parameter to be adapted. In Pac-Man, the game speed S is a variable with levels between 1 (slowest) and 100 (fastest).

[0067] Jack is told in a user-friendly way that the game will start in the calibration mode. Before the start of the game, Jack is told that the system feedback level S (game speed) will start at a low level and will increase throughout the game. As soon as the game has become too fast, he can press the [down] key and as soon the game is considered too slow, Jack can press the [up] key to speed up.

[0068] The game starts at speed level 15, Jack finds this too slow and therefore presses the [up] key to speed up the game. At minute 7.30, the game has reached speed level 85, which Jack finds too fast ("I'd like a challenging game, but this is too much for me"). Therefore he presses the [down] key. The "slow down" user report plus the accompanying emotion signals over minute 7.20-7.30 are stored in the database 24. Now the game starts to decrease gradually in speed. At minute 10.30, the game has slowed down to level 55. Jack finds this not challenging enough ("this is kinda boring for me") and therefore presses the [up] key, which again lets the game's speed level increase gradually. Again, the "speed up" report plus the emotion signals over minute 10.20-10.30 are stored in the database 24. Besides that, a "this is ok" report is stored with the emotion signals over period 9.50-9.60. This calibrating continues for a while. At minute 19.10, Jack presses the [up] key. This user report and the three previous reports are classified (predicted) accurately by the game. Therefore, the game enters the adaptive mode. In this mode, the game's speed level is adapted to Jack's emotion signals:

- When the emotion signals are similar to that of a typical "too fast" report of Jack, the game's speed level will gradually decrease.
- When Jack's emotion signals match his pattern of "too slow", game speed will gradually increase.
- When Jack's emotion signals match the pattern of "this is ok", game speed will remain unchanged.

[0069] After five minutes of play in the adaptive mode, Jack notices he hasn’t changed the game speed for a while. "However", Jack concludes, "there is also no need for changing the speed level because I simply like it like this". After 30 minutes Jack decides to save and quit the game. He still has some work to do. At the end of the day, however, he continues the game, which starts directly in the adaptive mode.

[0070] Figs. 5 and 6 demonstrate why the emotionally adaptive system 1 is able to provide a more appropriate level of system feedback by being able to operate in the two modes. A lower dashed line 28 represents the lower threshold for the desired emotional state, and an upper dashed line 29 represents an upper threshold for the desired emotional state. A continuous line 30 represents the development of the actual game speed S over time. As can be seen, the boundaries of game speed corresponding to a desired emotional state develop over time as the user becomes used to a particular game speed and becomes more proficient. Fig. 6 shows how, in the long run, a more or less constant level is established. Because the system 1, at least in the calibration mode, constantly changes the level of at least one dimension of the system feedback, the development of the boundaries is tracked. The system is therefore able to aim for the middle of the range between the upper and lower threshold 28,29, making the adaptive mode last longer. Over a longer time period, fewer returns to the calibration mode are required, because the thresholds 28,29 are less subject to change.

[0071] Fig. 8 illustrates the interrelatedness of different dimensions of system feedback for the example of an ambient lighting system. One feedback parameter F in this case is the color, which can range from blue (level B) to yellow (level Y) via green (level G) and red (level R). In the illustrated example, the emotion signal data comprise heart rate values S1. A wider area 31 corresponds to an undesired emotional state. Smaller areas 32-36 correspond to desired emotional states. Thresholds are indicated in dashed lines. Thus, the thresholds for the desired emotional state vary according to the color. The system 1 can adapt the intensity to remain within the boundaries of the desired emotional states. To discover these boundaries, the system 1 will vary the color and intensity independently of each other in the calibration mode. The use of both self-reports and emotional signal data to train a classifier that predicts the user's reaction makes for a more adaptive system than would be the case if the system 1 were simply to try to target a particular value of the heart rate parameter S1.

[0072] It should be noted that the above-mentioned embodiments illustrate, rather than limit, the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

[0073] In one embodiment, the system according to the present invention is implemented in a single device. In another it comprises a service provider and a client. Alternatively, the system may comprise devices that are distributed and remotely located from each other.

[0074] The devices may be any of various consumer electronics devices such as a television set (TV set) with a cable, satellite or other link, a videocassette- or HDD-recorder, a home cinema system, a portable CD player, a remote control device such as an iPronto remote control, a cell phone, etc.

[0075] In an embodiment, the database 24 is populated with device-specific, user-generic data prior to first use. Thus, during the calibration phase, the data established for a different user or a hypothetical different user are gradually replaced by data based on self-reports and emotion data 16 from the actual current user of the emotionally adaptive system 1.

Claims

1. Method of controlling an influence on a user (14) in a rendering environment, the method comprising:
   - obtaining signal data (16) representing one or more physiological conditions of a user (14) in response to an influence caused by system feedback (13) of the rendering environment, the one or more physiological conditions of the user characterizing an emotional state of the user;
   - obtaining desired data corresponding to the one or more physiological conditions characterizing a user’s desired emotional state (19,20,32-36);
   - determining whether the desired data is reached by the signal data; and
   - if the desired data is not reached, adapting the system feedback (16) provided by the rendering environment correspondingly,
   - obtaining data that link mental states of a respective user to signal data values for the user over time,
   - obtaining the user's self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompa-
nying self-report.

2. Method according to claim 1, wherein the desired data include thresholds (28,29) corresponding to switch points at which the user (14) switches between emotional states.

3. Method according to claim 1, wherein, in a calibration mode, the user’s self-reports and the data representative of accompanying signal data (16) representing one or more physiological conditions of the user (14) over a last period before the accompanying self-report are obtained and a level of at least one dimension of the system feedback (16) is constantly changed for finding boundaries of an emotional state by going through a range of feedback levels.

4. Method according to claim 3, wherein a next level of at least one dimension of the system feedback (16) is selected from a scanning sequence database.

5. Method according to claim 1, wherein the user’s self-reports and the data representative of accompanying signal data (16) representing one or more physiological conditions of the user (14) over a last period before the accompanying self-report are stored in a database (24).

6. Method according to claim 1, wherein the user’s self-reports and the data representative of accompanying signal data (16) representing one or more physiological conditions of the user (14) over a last period before the accompanying self-report are obtained in a calibration mode, in which they are used to train at least one classifier for predicting the user’s emotional state from at least one signal (16) representing one or more physiological conditions of the user (14).

7. Method according to claim 6, wherein the classifier predicts (25) the user’s self-reports based on the signal data values, and the method comprises checking (26) the classifier’s predictions for determining whether the classifier has an accuracy that meets a minimum threshold and, if so, setting a system mode to an adaptive mode (27).

8. Method according to claim 1, wherein the user’s self-reports and the data representative of accompanying signal data (16) representing one or more physiological conditions of the user (14) over a last period before the accompanying self-report are obtained in a calibration mode, and wherein a switch is effected from the calibration mode to an adaptive mode while not prompting for self-reports.

9. Method according to claim 7 or 8, including remaining in the adaptive mode for as long as no new user’s reports are provided.

10. Method according to claim 7 or 8, wherein an indication from the user that the level of system feedback is no longer correct, triggers a switch to the calibration mode.

11. Apparatus for controlling an emotionally adaptive system, the apparatus including:

- an input/output unit (8) for obtaining signal data (16) representing one or more physiological conditions of a user (14) in response to an influence caused by system feedback (13) of the rendering environment, the one or more physiological conditions of the user characterizing an emotional state of the user;
- a processor (2) for implementing an algorithm; and
- memory (4) for a database (24), the algorithm enabling the apparatus to:
  - obtain desired data corresponding to the one or more physiological conditions characterizing a user’s desired emotional state (19,20;32-36); and
  - determine whether the desired data is reached by the signal data; and
  - if the desired data is not reached, adapt the system feedback (13) provided by the rendering environment correspondingly.

characterized in that the algorithm enables the apparatus, for obtaining data that link mental states of a respective user to signal data values for the user over time,

- to obtain the user’s self-reports and data representative of accompanying signal data representing one or more physiological conditions of the user over a last period before the accompanying self-report.

12. Apparatus according to claim 11, configured to carry out a method according to any one of claims 1-10.

13. Emotionally adaptive system, comprising products (10-12) for rendering feedback effects and an apparatus (1) according to claim 11 or 12.

14. Computer program including a set of instructions capable, when incorporated in a machine-readable medium, of causing a system having information processing capabilities to perform a method according to any one of claims 1-10.
Patentansprüche

1. Verfahren zum Steuern eines Einflusses auf einen Benutzer (14) in einer Rendering-Umgebung, wobei das Verfahren folgendes umfasst:
   - erhalten von Signaldaten (16), die eine oder mehrere physiologische Zustände eines Benutzers (14) repräsentieren, als Reaktion auf einen durch die Systemrückmeldung (13) der Rendering-Umgebung verursachten Einfluss, wobei die eine oder mehrere physiologische Zustände einen emotionalen Zustand des Benutzers charakterisieren;
   - erhalten von gewünschten Daten entsprechend der einen oder mehreren physiologischen Zuständen, die den gewünschten emotionalen Zustand eines Benutzers charakterisieren (19, 20; 32-36);
   - bestimmen, ob die gewünschten Daten durch die Signaldaten erreicht werden; und
   - falls die gewünschten Daten nicht erreicht werden, Anpassung der Systemrückmeldung (16), die von der Rendering-Umgebung entsprechend bereitgestellt wird,

dadurch gekennzeichnet, dass das Verfahren die erhaltenen Daten, die mentalen Zustände eines jeweiligen Benutzers mit Signaldatenwerten verknüpft, um Datenwerte für den Benutzer über die Zeit zu signalisieren,
   - erhalten von Benutzer-Selbstberichten und Daten, die für begleitende Signaldaten (16) repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen.

2. Verfahren nach Anspruch 1, wobei die gewünschten Daten Schwellenwerte (28, 29) umfassen, die Schaltpunkte entsprechen, bei denen der Benutzer (14) zwischen emotionalen Zuständen umschaltet.

3. Verfahren nach Anspruch 1, wobei in einem Kalibrierungsmodus die Selbstberichte des Benutzers und die Daten, die für begleitende Signaldaten (16) repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen.


5. Verfahren nach Anspruch 1, wobei die Selbstberichte des Benutzers und die Daten, die für begleitende Signaldaten (16) repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers (14) über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen, in einer Datenbank gespeichert werden (24).

6. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass in einem Kalibrierungsmodus die Selbstberichterstattung des Benutzers und die Daten, die für begleitende Signaldaten (16) repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers (14) über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen, repräsentiert werden, in dem sie verwendet werden, um mindestens einen Klassifikator für die Vorhersage des emotionalen Zustands des Benutzers aus mindestens einem Signal (16), das eine oder mehrere physiologische Zustände des Benutzers (14) repräsentiert, zu trainieren.


8. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Selbstberichterstattung des Benutzers und die Daten, die für begleitende Signaldaten (16) repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen, bei einer Kalibrierung erhalten werden und wobei ein Schalter von dem Kalibrierungsmodus zu einem adaptiven Modus betätigt wird, bei dem die Schritte zum Bestimmen, ob der gewünschte emotionale Zustand (19, 20; 32-36) erreicht wird, und wenn der Zustand (19, 20; 32-36) nicht erreicht wird, die Anpassung der Systemrückmeldung (13), die von der Rendering-Umgebung entsprechend geliefert wird, kontinuierlich durchgeführt, während sie nicht zu Selbstberichten aufgefordert werden.

9. Verfahren nach Anspruch 7 oder 8, einschließlich Verbleib im adaptiven Modus, solange keine neuen Benutzerberichte vorliegen.

10. Verfahren nach Anspruch 7 oder 8, wobei ein Hinweis von dem Benutzer, dass der Pegel der System-
rückmeldung nicht mehr korrekt ist, einen Schaltung zum Kalibrierungsmodus auslöst.

11. Vorrichtung zum Steuern eines emotional adaptiven Systems, wobei die Vorrichtung folgendes aufweist:

- eine Eingabe-/Ausgabe-Einheit (8) zum Erhalten von Signaldaten (16), die eine oder mehrere physiologische Zustände eines Benutzers (14) repräsentieren, als Reaktion auf einen durch die Systemrückmeldung (13) der Rendering-Umgebung verursachten Einfluss die eine oder mehrere physiologische Zustände des Benutzers, der einen emotionalen Zustand des Benutzers charakterisiert;
- einen Prozessor (2) zum Implementieren eines Algorithmus; und
- ein Speicher (4) für eine Datenbank (24), wobei der Algorithmus dem Gerät folgendes ermöglicht:

- erhalten gewünschter Daten entsprechend der einen oder mehreren physiologischen Zustände, die den gewünschten emotionalen Zustand eines Benutzers (19,20; 32-36) charakterisieren;
- bestimmen, ob die gewünschten Daten durch die Signaldaten erreicht werden; und
- falls die gewünschten Daten nicht erreicht werden, wird die Systemrückmeldung (13) entsprechend der Rendering-Umgebung angepasst,

- dadurch gekennzeichnet, dass der Algorithmus der Vorrichtung das Erhalten von Daten ermöglicht, die die mentalen Zustände eines jeweiligen Benutzers verknüpfen, um Datenwerte für den Benutzer über die Zeit zu signalisieren, um die Selbstberichte und Daten des Benutzers zu erhalten, die für begleitende Signaldaten repräsentativ sind, die eine oder mehrere physiologische Zustände des Benutzers über einen letzten Zeitraum vor dem begleitenden Selbstbericht darstellen.

12. Vorrichtung nach Anspruch 11, die zur Durchführung eines Verfahrens nach einem der Ansprüche 1 bis 10 konfiguriert ist.


14. Computerprogramm, das einen Satz von Befehlen enthält, die in der Lage sind, wenn in einem maschinenverfügbaren Medium integriert, ein System mit Informationsverarbeitungsfähigkeiten zu veranlas sen, ein Verfahren nach einem der Ansprüche 1 bis 10 durchzuführen.

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Revendications

1. Procédé de commande d’une influence sur un utilisateur (14) dans un environnement de restitution, le procédé comprenant :

- l’obtention de données de signal (16) représentant une ou plusieurs conditions physiologiques d’un utilisateur (14) en réponse à une influence causée par une rétroaction de système (13) de l’environnement de restitution, les une ou plusieurs conditions physiologiques de l’utilisateur caractérisant un état émotionnel de l’utilisateur ;
- l’obtention de données souhaitées correspondant aux une ou plusieurs conditions physiologiques caractérisant un état émotionnel souhaité (19, 20 ; 32-36) de l’utilisateur ;
- le fait de déterminer si les données souhaitées sont atteintes par les données de signal ; et
- si les données souhaitées ne sont pas atteintes, l’adaptation de la rétroaction de système (16) fournir par l’environnement de restitution de manière correspondante,

caractérisé en ce que le procédé comprend, pour obtenir des données qui lient des états mentaux d’un utilisateur respectif à des valeurs de données de signal pour l’utilisateur avec le temps,

- l’obtention d’auto-rapports de l’utilisateur et de données représentatives de données de signal d’accompagnement représentant une ou plusieurs conditions physiologiques de l’utilisateur sur une dernière période avant l’auto-rapport d’accompagnement.

2. Procédé selon la revendication 1, dans lequel les données souhaitées incluent des seuils (28, 29) correspondant à des points de commutation auxquels l’utilisateur (14) alterne entre les états émotionnels.

3. Procédé selon la revendication 1, dans lequel, dans un mode étalonnage, les auto-rapports de l’utilisateur et les données représentatives de données de signal d’accompagnement représentant une ou plusieurs conditions physiologiques de l’utilisateur sur une dernière période avant l’auto-rapport d’accompagnement sont obtenus et un niveau d’au moins une dimension de la rétroaction de système (16) change constamment pour trouver des limites d’un état émotionnel en traversant une plage de niveaux de rétroaction.

4. Procédé selon la revendication 3, dans lequel un ni-
veau suivant d'au moins une dimension de la rétroaction de système (16) est sélectionné à partir d'une bande de données de séquences de balayage.

5. Procédé selon la revendication 1, dans lequel les auto-rapports de l'utilisateur et les données représentatives de données de signal d'accompagnement (16) représentant une ou plusieurs conditions physiologiques de l'utilisateur (14) sur une dernière période avant l'auto-rapport d'accompagnement sont stockés dans une base de données (24).

6. Procédé selon la revendication 1, dans lequel les auto-rapports de l'utilisateur et les données représentatives de données de signal d'accompagnement (16) représentant une ou plusieurs conditions physiologiques de l'utilisateur (14) sur une dernière période avant l'auto-rapport d'accompagnement sont obtenus dans un mode étalement, dans lequel ils sont utilisés pour former au moins un classificateur pour prédire l'état émotionnel de l'utilisateur à partir d'au moins un signal (16) représentant une ou plusieurs conditions physiologiques de l'utilisateur (14).

7. Procédé selon la revendication 6, dans lequel le classificateur prédit (25) les auto-rapports de l'utilisateur sur la base des valeurs de données de signal, et le procédé comprend la vérification (26) des prédictions du classificateur pour déterminer si le classificateur a une précision qui répond à un seuil minimum et, le cas échéant, régler un mode de système sur un mode adaptatif (27).

8. Procédé selon la revendication 1, dans lequel les auto-rapports de l'utilisateur et les données représentatives de données de signal d'accompagnement (16) représentant une ou plusieurs conditions physiologiques de l'utilisateur (14) sur une dernière période avant l'auto-rapport d'accompagnement sont obtenus dans un mode étalement, et dans lequel un commutation est effectuée du mode étalement au mode adaptatif, dans lequel les étapes consistant à déterminer si l'état émotionnel souhaité (19, 20 ; 32-36) est atteint et, si l'état (19, 20 ; 32-36) n'est pas atteint, à adapter la rétroaction de système fournie par l'environnement de restitution de manière correspondante, caractérisé en ce que l'algorithme active l'appareil, pour obtenir des données qui lient des états mentaux d'un utilisateur respectif à des valeurs de données de signal pour l'utilisateur avec le temps,

- d'obtenir des données souhaitées correspondant aux une ou plusieurs conditions physiologiques caractérisant un état émotionnel souhaité (19, 20 ; 32-36) de l'utilisateur ;
- de déterminer si les données souhaitées sont atteintes par les données de signal ; et
- si les données souhaitées ne sont pas atteintes, d'adapter la rétroaction de système (13) fournie par l'environnement de restitution de manière correspondante,

9. Procédé selon la revendication 7 ou 8, dans lequel incluant le fait de rester dans le mode adaptatif tant qu'aucun nouveau rapport de l'utilisateur n'a été fourni.

10. Procédé selon la revendication 7 ou 8, dans lequel une indication provenant de l'utilisateur selon laquelle le niveau de rétroaction de système n’est pas plus correct, déclenche une commutation vers le mode étalement.

11. Appareil pour commander un système émotionnellement adaptatif, l’appareil incluant :
- une unité d’entrée/sortie (8) pour obtenir des données de signal (16) représentant une ou plusieurs conditions physiologiques d’un utilisateur (14) en réponse à une influence causée par une rétroaction de système (13) de l’environnement de restitution, les une ou plusieurs conditions physiologiques de l’utilisateur caractérisant un état émotionnel de l’utilisateur ;
- un processeur (2) pour mettre en oeuvre un algorithme ; et
- une mémoire (4) pour une base de données (24), l’algorithme permettant à l’appareil :

- d’obtenir des données souhaitées correspondant aux une ou plusieurs conditions physiologiques caractérisant un état émotionnel souhaité (19, 20 ; 32-36) de l'utilisateur ;
- de déterminer si les données souhaitées sont atteintes par les données de signal ; et
- si les données souhaitées ne sont pas atteintes, d’adapter la rétroaction de système (13) fournie par l’environnement de restitution de manière correspondante,

12. Appareil selon la revendication 11, configuré pour réaliser un procédé selon l’une quelconque des revendications 1-10.

13. Système émotionnellement adaptatif, comprenant des produits (10-12) pour restituer des effets de rétroaction et un appareil (1) selon la revendication 11 ou 12.

14. Programme informatique incluant un ensemble d’instructions pouvant, quand il est incorporé dans un support lisible par machine, amener un système ayant des capacités de traitement d’informations à effectuer un procédé selon l’une quelconque des revendications 1-10.
Operate in calibration mode

Operate in adaptive mode

Receive user report

Obtain emotion signal data and enter into database

Apply classifier to latest emotion signal data

Check classifier performance

[Fail] [Pass]

FIG. 4
REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description


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