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**Lee et al.**

(54) **METHOD AND SYSTEM FOR MEASURING AND RANKING AN "ENGAGEMENT" RESPONSE TO AUDIOVISUAL OR INTERACTIVE MEDIA, PRODUCTS, OR ACTIVITIES USING PHYSIOLOGICAL SIGNALS**

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(52) **U.S. Cl.** ..... **600/301**

(57) **ABSTRACT**

A system and method for calculating an engagement value by quantifying an amount that a user is acting without thinking considering brainwaves and a heart rate can be used to compare media based on an individual or a group of individuals. Events of the media can be contrasted and compared by the engagement value as well. Statistical measurements may be taken to improve media.

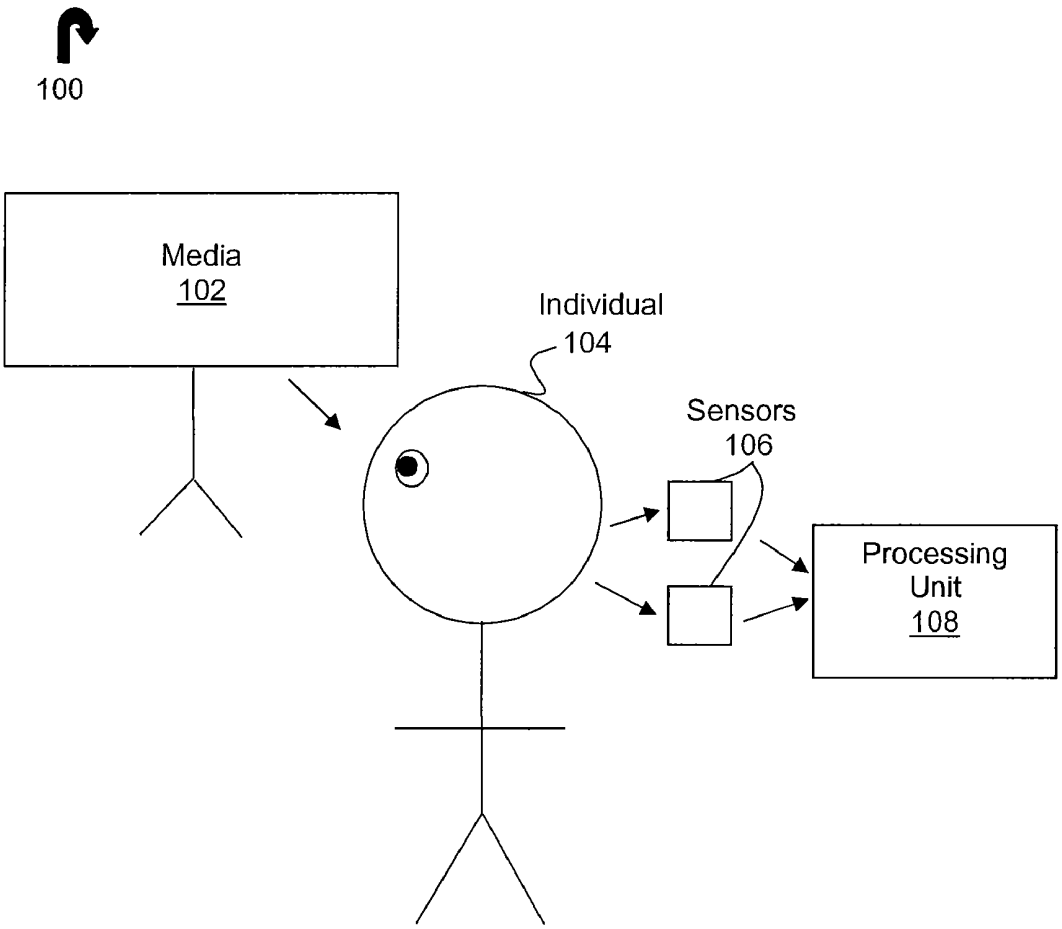


FIG. 1

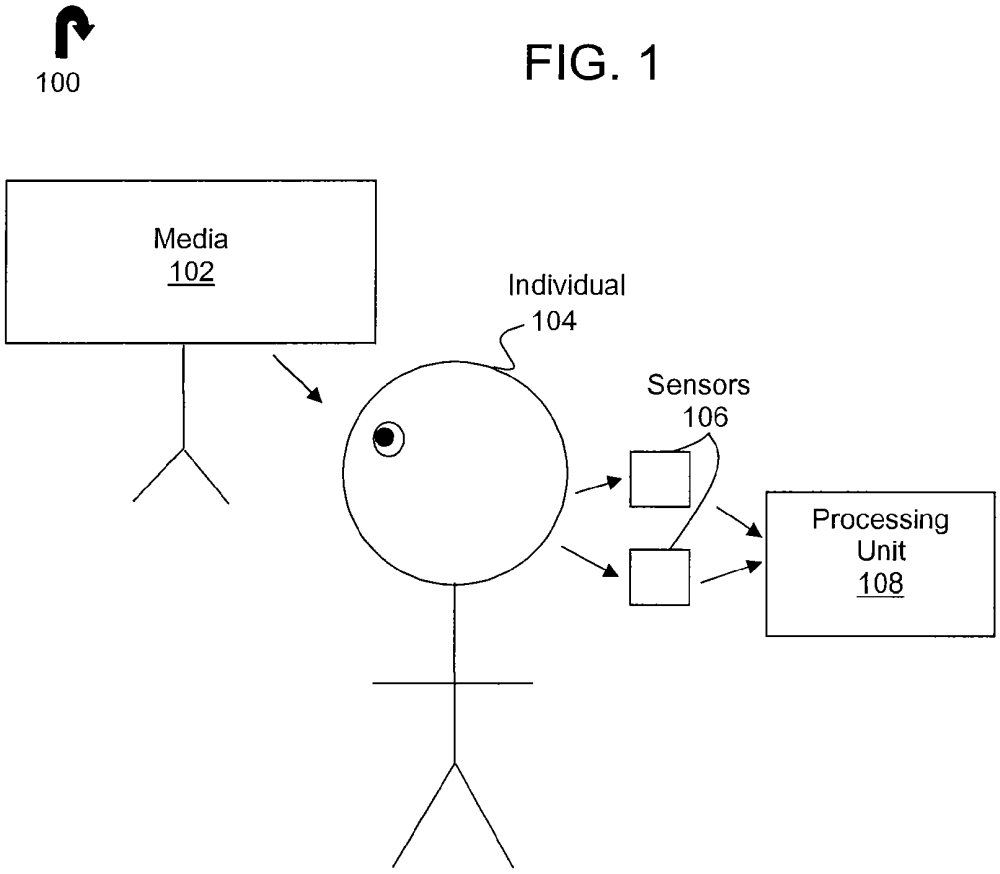

100
Media
102
Individual
104
Sensors
106
Processing
Unit
108

FIG. 2

200

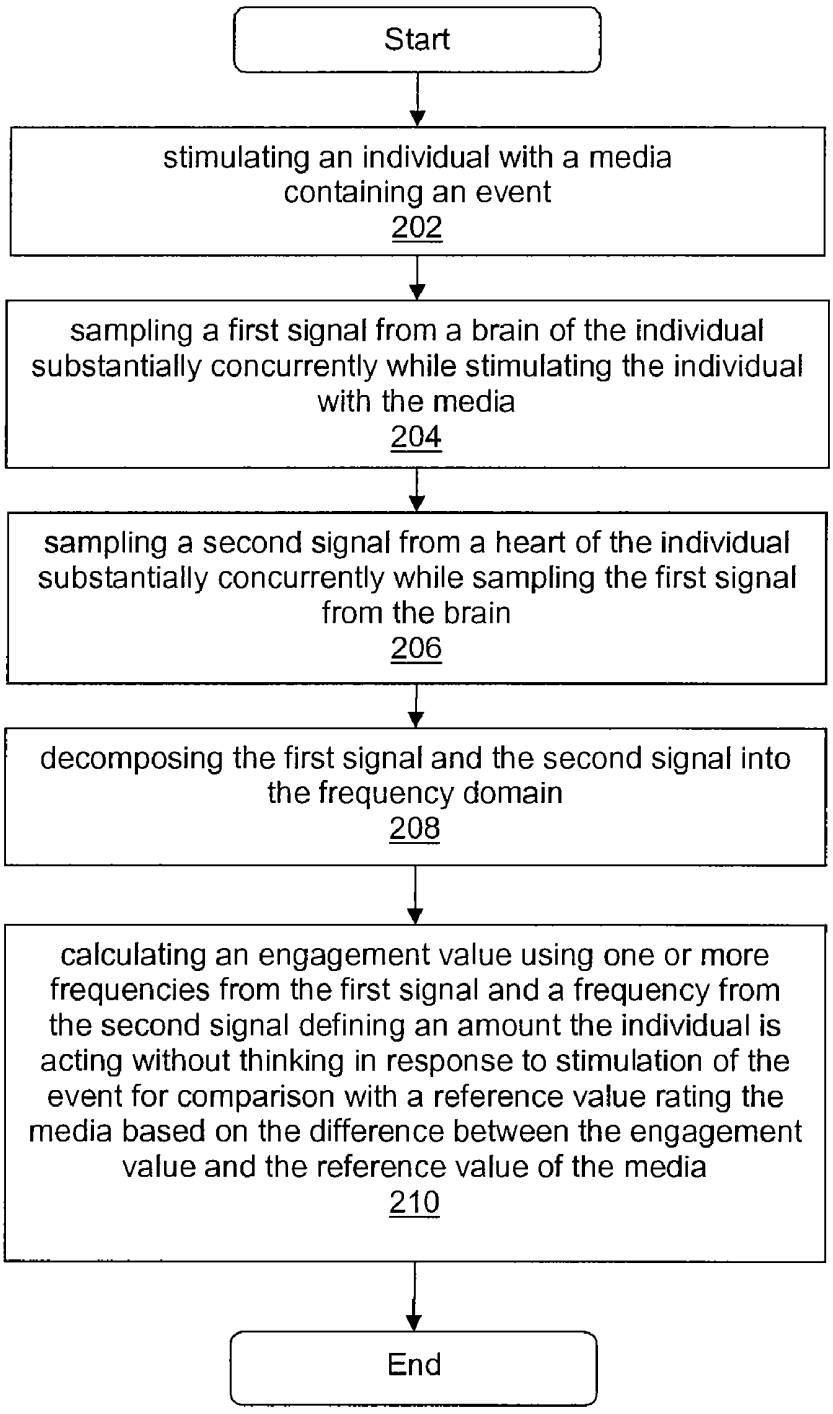

Start
stimulating an individual with a media containing an event
202
sampling a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media
204
sampling a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain
206
decomposing the first signal and the second signal into the frequency domain
208
calculating an engagement value using one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value rating the media based on the difference between the engagement value and the reference value of the media
210
End

FIG. 3

300

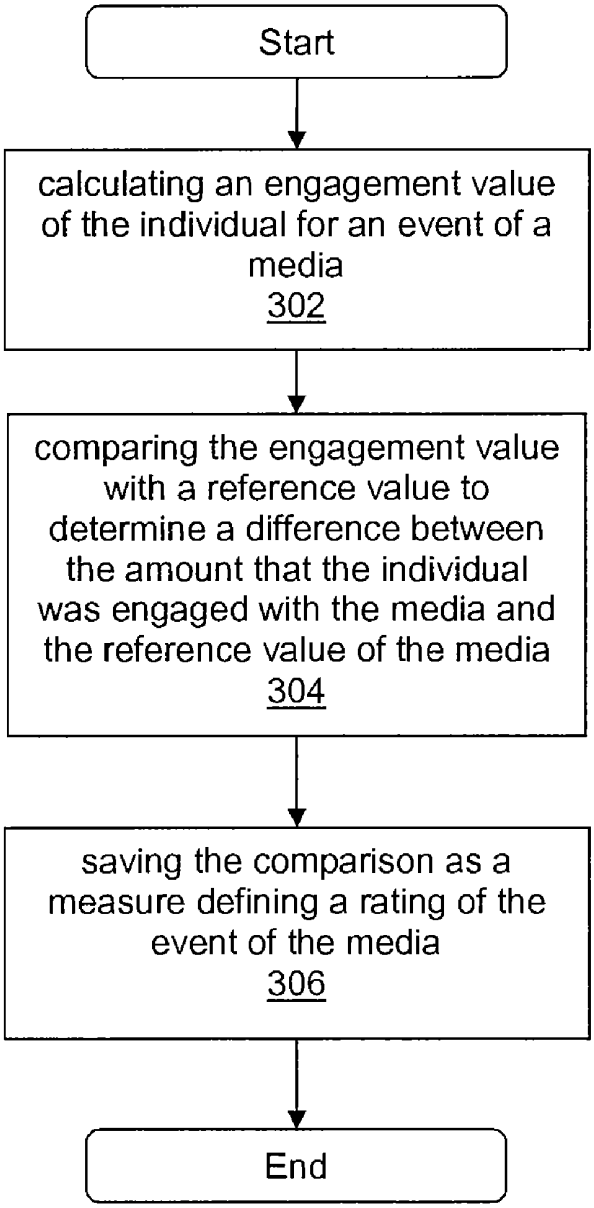

Start
calculating an engagement value of the individual for an event of a media
302
comparing the engagement value with a reference value to determine a difference between the amount that the individual was engaged with the media and the reference value of the media
304
saving the comparison as a measure defining a rating of the event of the media
306
End

FIG. 4

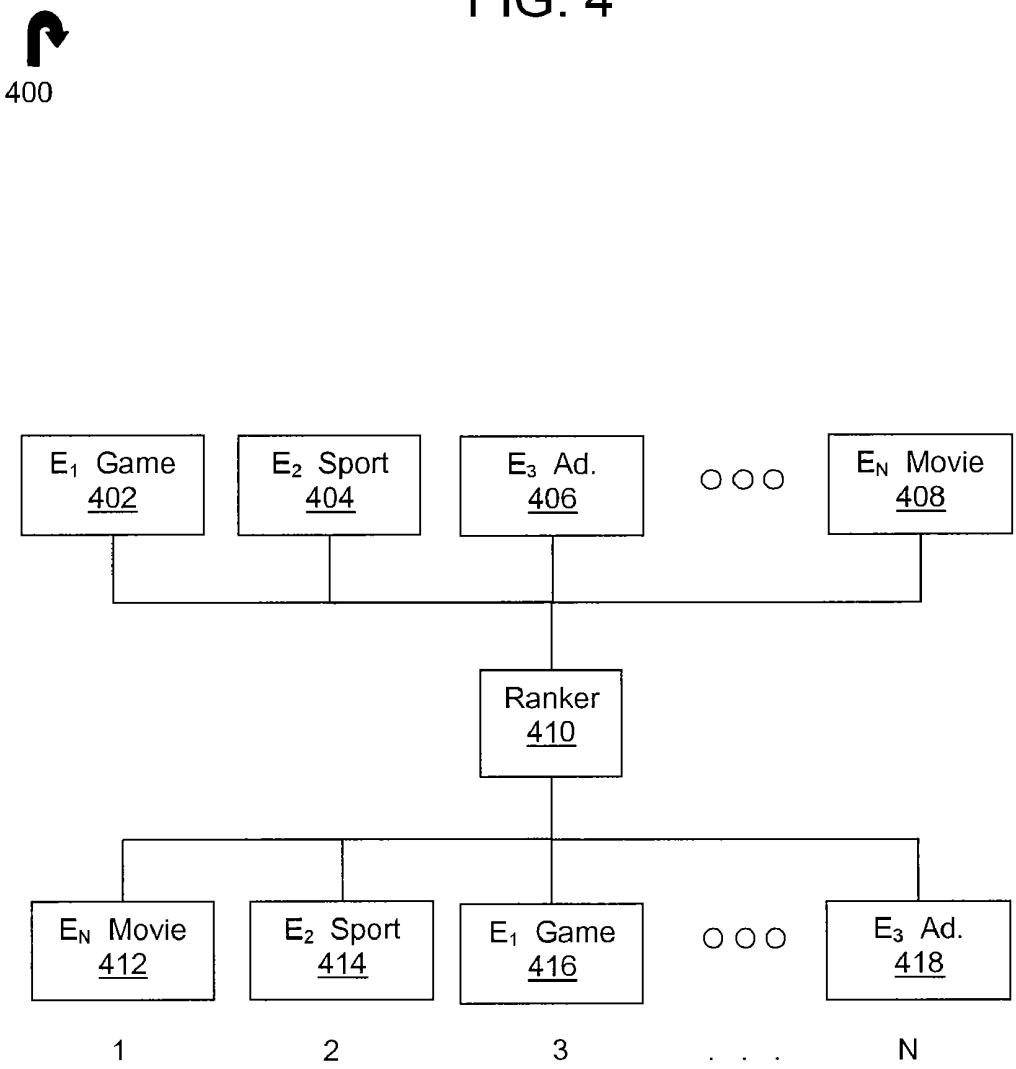

400
E1 Game 402
E2 Sport 404
E3 Ad. 406
EN Movie 408
Ranker 410
EN Movie 412
E2 Sport 414
E1 Game 416
E3 Ad. 418
1
2
3
. . .
N

FIG. 5

$$\Theta\downarrow + \alpha\uparrow + HR\uparrow \rightarrow \text{Engagement} \uparrow$$

$$\Theta\uparrow + \alpha\downarrow + HR\downarrow \rightarrow \text{Engagement} \downarrow$$

---

$$HR \uparrow \rightarrow \text{Engagement} \uparrow$$

$$HR \downarrow \rightarrow \text{Engagement} \downarrow$$

$$\Theta\downarrow \rightarrow \text{Engagement} \uparrow$$

$$\Theta\uparrow \rightarrow \text{Engagement} \downarrow$$

$$\alpha\uparrow \rightarrow \text{Engagement} \uparrow$$

$$\alpha\downarrow \rightarrow \text{Engagement} \downarrow$$

600

FIG. 6

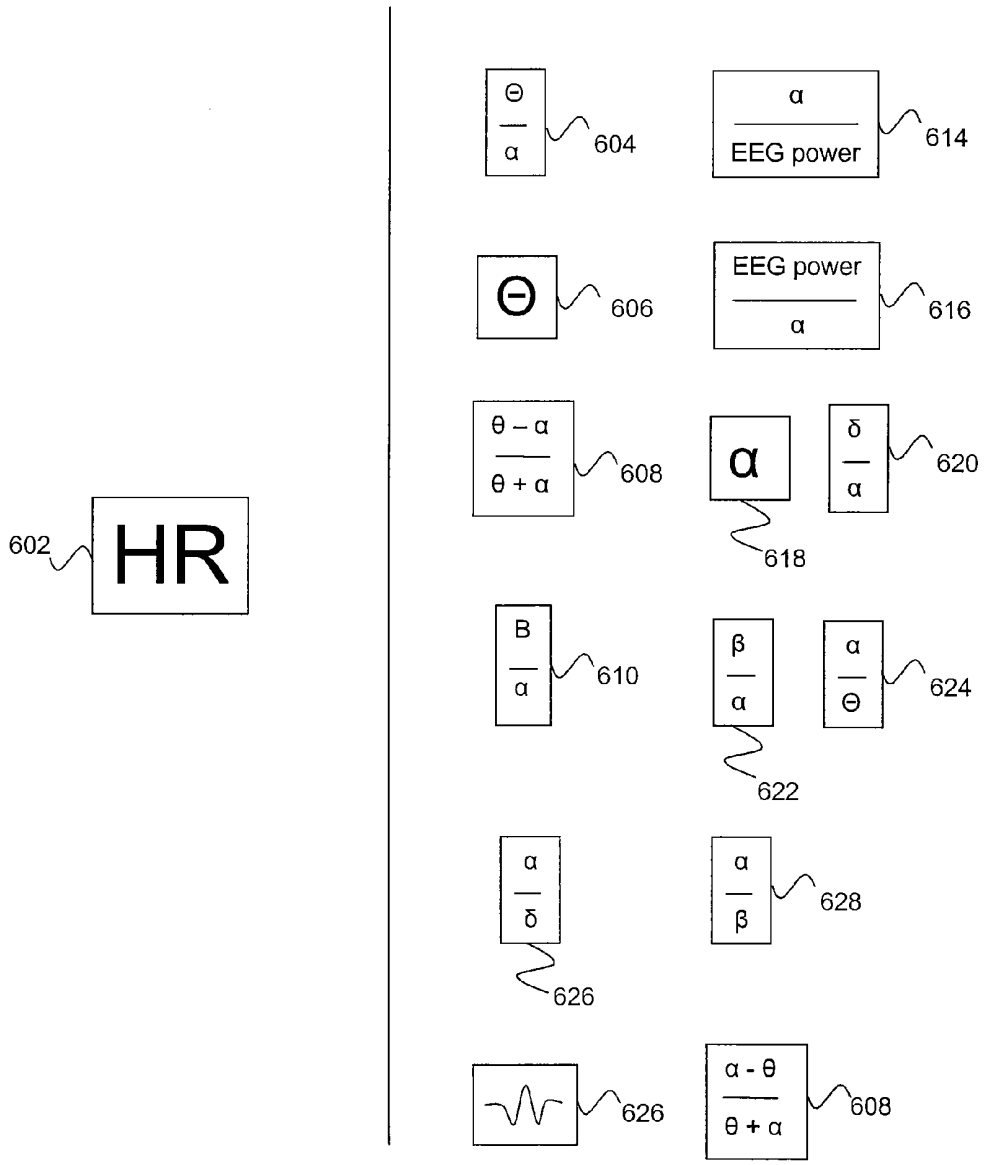

602
HR
Θ / α
604
Θ
606
θ − α / θ + α
608
B / α
610
α / δ
626
α / EEG power
614
EEG power / α
616
α
618
δ / α
620
β / α
622
α / Θ
624
α / β
628
α - θ / θ + α
608

FIG. 7

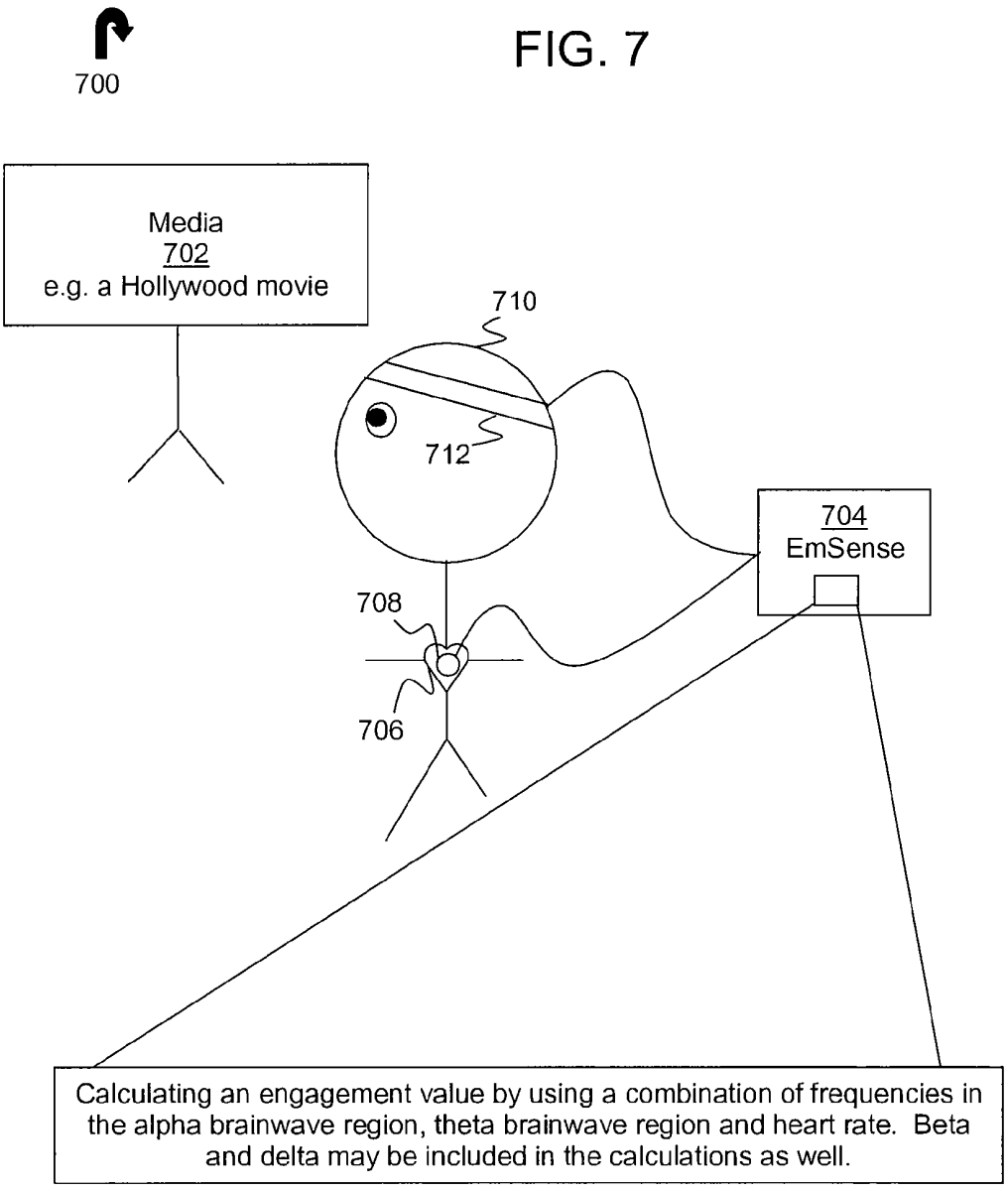

700
Media
702
e.g. a Hollywood movie
710
712
704
EmSense
708
706
Calculating an engagement value by using a combination of frequencies in the alpha brainwave region, theta brainwave region and heart rate. Beta and delta may be included in the calculations as well.

FIG. 8

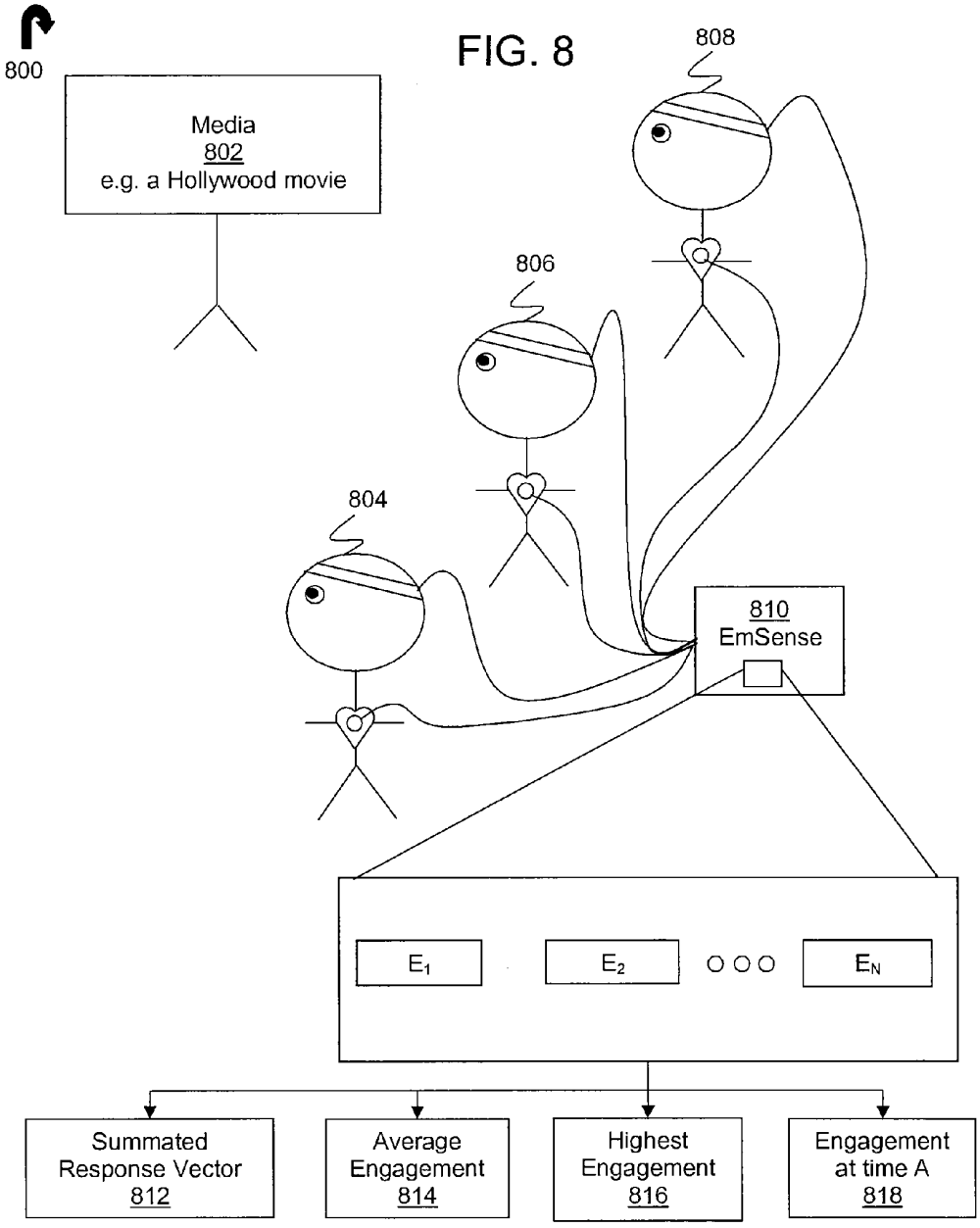

800
Media
802
e.g. a Hollywood movie
808
806
804
810
EmSense
E1
E2
EN
Summated Response Vector 812
Average Engagement 814
Highest Engagement 816
Engagement at time A 818

FIG. 9

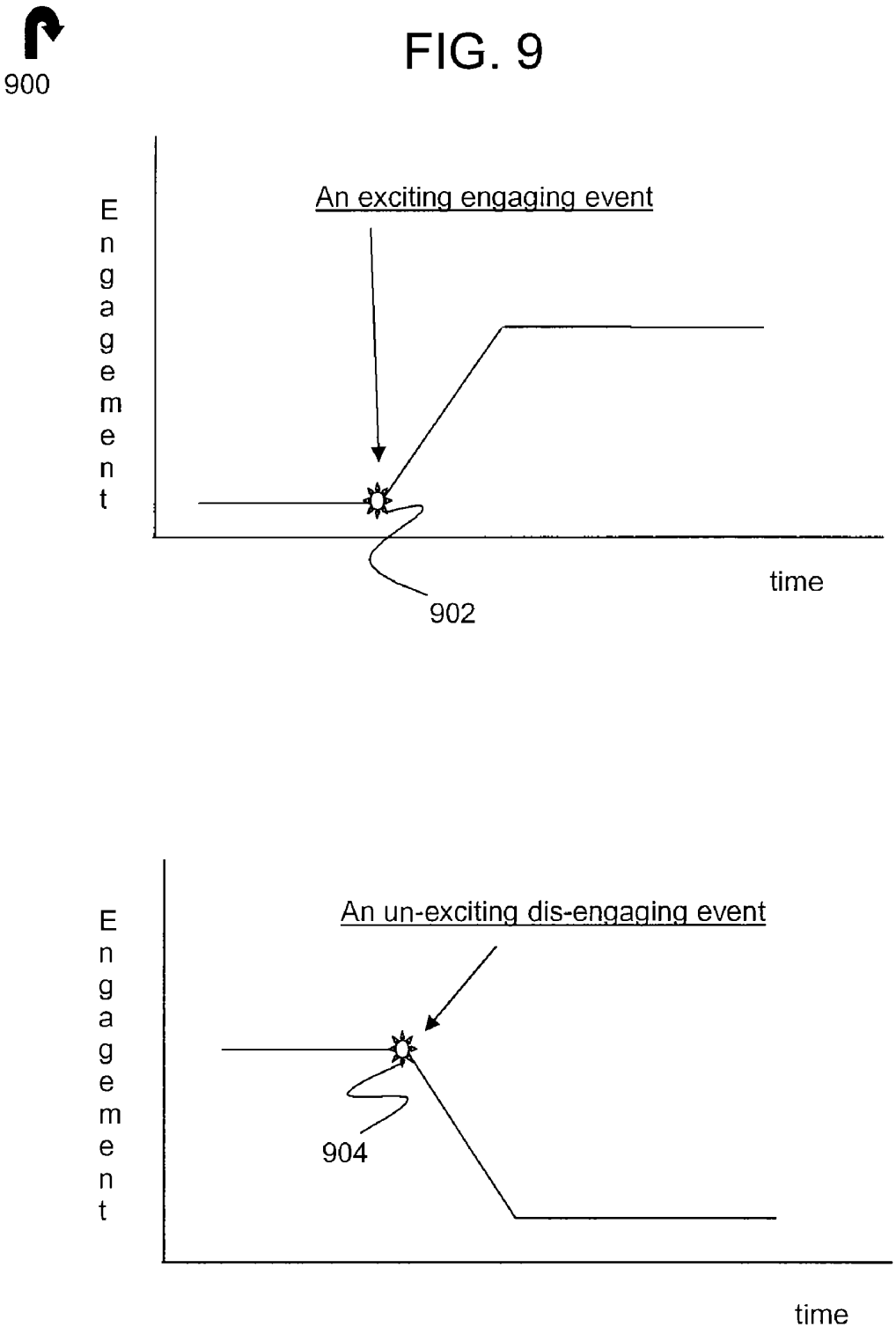

900
An exciting engaging event
Engagement
time
902
An un-exciting dis-engaging event
Engagement
904
time

FIG. 10

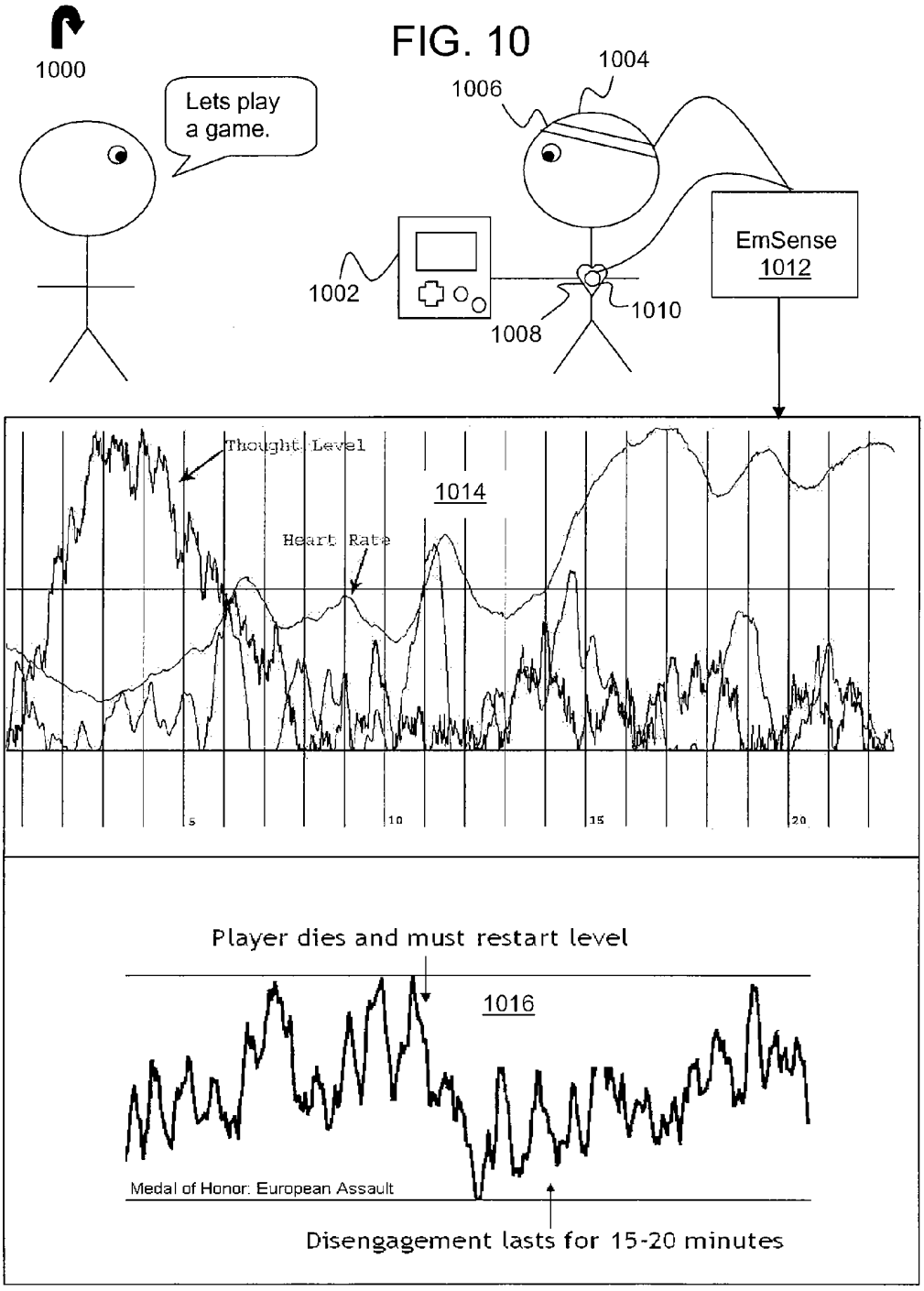
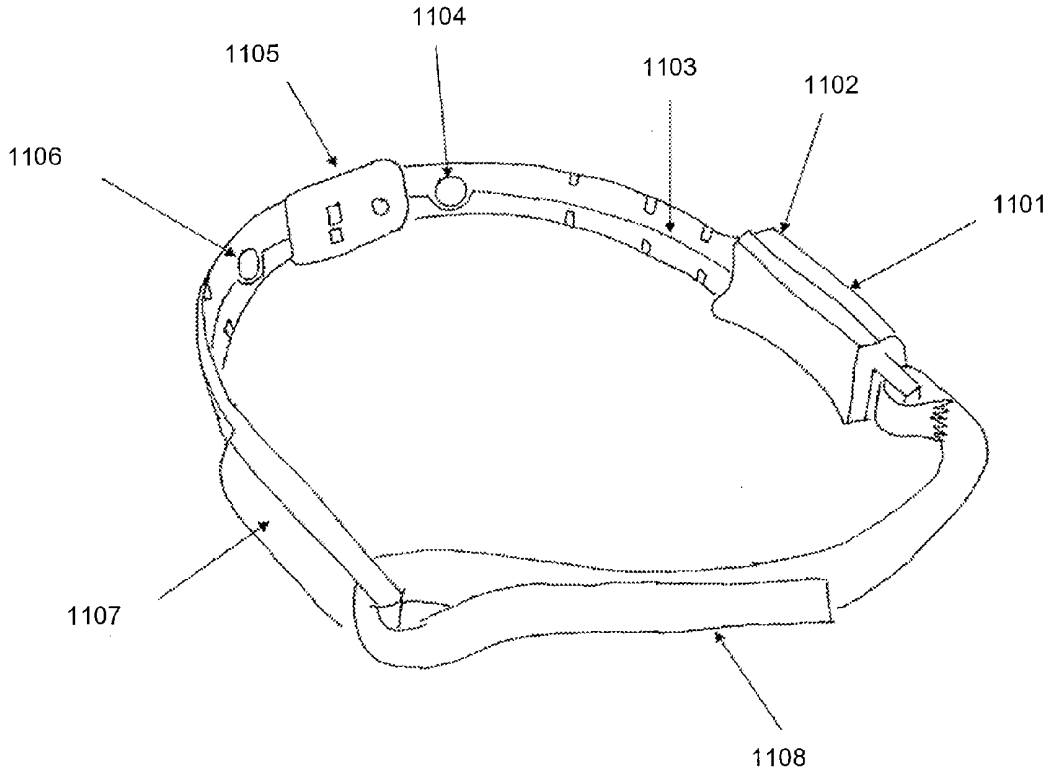

1000
Lets play a game.
1004
1006
1002
1008
1010
EmSense
1012
Thought Level
1014
Heart Rate
5
10
15
20
Player dies and must restart level
1016
Medal of Honor: European Assault
Disengagement lasts for 15-20 minutes

FIG. 11



# METHOD AND SYSTEM FOR MEASURING AND RANKING AN "ENGAGEMENT" RESPONSE TO AUDIOVISUAL OR INTERACTIVE MEDIA, PRODUCTS, OR ACTIVITIES USING PHYSIOLOGICAL SIGNALS

## RELATED APPLICATIONS

**[0001]** This application claims priority to U.S. Provisional Patent Application No. 60/905,44, filed Mar. 8, 2007, and entitled "Method and system for measuring and ranking 'engagement' response to audiovisual or interactive media, products or activities using physiological signals" by Hans C. Lee, et al., which is incorporated by reference.

## BACKGROUND OF THE INVENTION

**[0002]** Creative people design interactive media, activities and products ("media") that stimulate individuals and keep them engaged. Often times media are sold to consumers in highly competitive markets where the ability to stimulate engagement determines value. The creative people would like to know whether their customers are engaged in the media in order to maximize value by improving media to better stimulate individuals. If the value of the media is not maximized customers will purchase competing products which provide better stimulation. If competing products are sold, revenue will be lost as sales decline. A problem then is in providing accurate information about a response to stimulation by interactive media, activities, and products. Measuring the response requires creators of interactive media, activities and products to enter the minds of the target market.

**[0003]** In entering the human mind researchers in neurobiology, psychophysiology, and psychology found physiological signals emanating from the brain. Using the electroencephalogram (EEG) researchers recorded the physiological signals though electrodes attached to the head. The physiological signals had four main components below 30 hertz. Frequencies between 1-4 hertz were delta waves ($\delta$), frequencies between 4 and 8 hertz were theta ($\theta$) waves, frequencies between 8-13 hertz were alpha ($\alpha$) brainwaves, and frequencies between 13 and 20 were beta ($\beta$) brainwaves.

**[0004]** Additionally, tools used to collect data from the body include the photoplethysmograph (PPG), and the electrocardiogram (ECG or EKG, German electrocardiogram). The photoplethysmograph (PPG) is an optically obtained measurement which can be used to find the cardiac cycle. A PPG uses a pulse oximeter to observe a change in oxygen omission from the skin in relation to the cardiac cycle as blood is pumped to the extremities. The cardiac cycle can then be recorded based on this change in oxygen omission. Another measure of the heart rate is the ECG. The electrocardiogram (ECG), measures heartbeats via an electrode attached to the chest. Traditionally, an ECG produced an electrocardiograph, or a picture showing the heart beat over time. Alternatively, the signal generated by the heart is recorded.

**[0005]** The foregoing examples of the related art and limitations related therewith are intended to be illustrative and not exclusive. Other limitations of the related art will be come apparent to those of skill in the art upon a reading of the specification and a study of the drawings.

## SUMMARY

**[0006]** The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools, and methods that are meant to be exemplary and illustrative, not limiting in scope. In various embodiments, one or more of the above described problems have been reduced or eliminated, while other embodiments are directed to other improvements.

**[0007]** A novel technique measures an "engagement" response of an individual to a media. The technique uses physiological signals emanating from the brain and the body to gauge the engagement response. An engagement value is an objective measure of the engagement response that quantifies an amount that a user is acting without thinking. Advantageously, the engagement response can be used to efficiently improve media while it is being created. In a non limiting example, ranking determines whether the individual finds a television show more engaging provoking than a documentary. Further, groups of individuals can have an engagement response that can be measured and aggregated to determine the overall population response to the media. This population view of the media can then be used to rank the media which is a novel use of physiological changes in response to media.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** Embodiments of the inventions are illustrated in the figures. However, the embodiments and figures are illustrative rather than limiting; they provide examples of the inventions.

**[0009]** FIG. **1** is an illustration of an example of a system **100** for calculating an engagement value.

**[0010]** FIG. **2** depicts a flowchart **200** of an example of a method for calculating an engagement value based the amount that an individual is acting without thinking.

**[0011]** FIG. **3** depicts a flowchart of an example **300** of a method for ranking a first media against a second media based on engagement.

**[0012]** FIG. **4** depicts a diagram **400** of an example of ranking a plurality of media based on an engagement value.

**[0013]** FIG. **5** depicts a plurality of examples of formulas **500** related to ranking engagement.

**[0014]** FIG. **6** depicts a relationship **600** between a heart rate and one of a plurality of example formulas useful for calculating an engagement value.

**[0015]** FIG. **7** depicts a diagram **700** of an example of stimulating an individual with a media while calculating an engagement value relating the individual's engagement with the media.

**[0016]** FIG. **8** depicts a diagram **800** of an example of stimulating a plurality of individuals with a media and calculating relevant values based on their engagement with the media.

**[0017]** FIG. **9** depicts graphs **900** of examples of changes in engagement relative to events in time.

**[0018]** FIG. **10** depicts a diagram **1000** and data graphs of an example of stimulating an individual with a media, in this example a game, and recording the related levels of heart rate, thought, and engagement.

**[0019]** FIG. **11** depicts a headset **1100** containing electrodes useful for collecting signals from a head of an individual as well as a heart signal.

## DETAILED DESCRIPTION

**[0020]** In the following description, several specific details are presented to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or in combination with other components, etc. In other instances, well-known implementations or operations are not shown or described in detail to avoid obscuring aspects of various embodiments of the invention.

**[0021]** A novel system and method for measuring an "engagement" response for use in rating media uses physiological signals. An individual responds to a media while physiological sensors record this response. A processing component collects the physiological signals through the physiological sensors and substantially concurrently assigns an engagement value to the amount the individual acts without thinking. "Substantially concurrently" means that the response is at the same time or near in time to the stimulation. There may be a delay in the response. Therefore, the engagement value is calculated with the understanding that the response may be immediately following if not exactly at the same time with the stimulation.

**[0022]** In some embodiments, an exemplary way of calculating an engagement value is consider how much an individual is acting without thinking. Three useful signals for doing this include alpha waves and theta waves from a mind, and then a heart rate (HR). Other useful signals exist, and some of them will be discussed later on. Generally speaking, an increased heart rate is indicative of higher engagement, increased theta is indicative of higher levels of thought, thus lower engagement, and increased alpha is indicative of lower levels of thought, thus higher engagement. These exact relationships are explored in more depth in the discussion of FIG. **4** which depicts examples of formulas related to ranking engagement.

**[0023]** FIG. **1** is an illustration of an example of a system **100**. In the example of FIG. **1**, the system **100** includes media **102**, individual **104**, sensors **106**, and processing component **108**. As depicted, individual **104** is stimulated by media **102** while having the individual's engagement level monitored by processing component **108** using sensors **106**. Here the media can be one or more of a movie, a video a television program, a commercial, an advertisement, a video game, an interactive online media, a print, or any other media which could stimulate an individual. Sensors **106** could be one or more of an accelerometer, a blood oxygen sensor, a galvanometer, an electroencephalogram, an electromygraph, and any other physiological sensor.

**[0024]** FIG. **2** depicts a flowchart **200** of an example of a method for calculating an engagement value. The method is organized as a sequence of modules in the flowchart **200**. However, it should be understood that these and modules associated with other methods described herein may be reordered for parallel execution or into different sequences of modules. In the example of FIG. **2**, the flowchart starts at module **202** with stimulating an individual with a media containing an event.

**[0025]** In the example of FIG. **2**, the flowchart **200** continues to module **204** with sampling a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media. The signal from the heart will include the heart rate. The signal from the heart is being concurrently collected using an electrode attached for that purpose. In calculating the heart rate, or number of heart beats per minute, one can determine a heart beat by finding the peak of the heart signal to the bottom of the heart signal. The exemplary headset discussed in reference to FIG. **11** could be used to both record the heart rate and brain waves.

**[0026]** In the example of FIG. **2**, the flowchart **200** continues to module **206** with sampling a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain. The signal from the brain will include alpha and theta waves. Additionally, the signal from the brain will include other brain waves such as delta and theta waves. The frequency for the waves is approximately 1-4 Hz (delta) 4-8 Hz (theta), 8-13 Hz (alpha), 13-20 Hz (beta). The cut off point for a frequency range e.g. between alpha and beta, such as a cut off at 13 hz is approximate; one skilled in the art would apply the ranges with some interest in the various schools of thought in the science of psychophysiology. The examples of the algorithms provided herein can determine engagement by using any frequency or set of frequencies between 1 and 100 Hz in addition to a heart rate. It is possible to attach the electrodes to a head of an individual using a headset depicted in the example of FIG. **11**. A chest electrode may be a simple electrode having adhesive to secure it to the skin and a wire to connect it to a device for collecting the heart rate.

**[0027]** In the example of FIG. **2**, the flowchart **200** continues to module **208** decomposing the first signal and the second signal into the frequency domain. In this example, the fast Fourier transform (FFT), or wavelet analysis, both well known in the art of digital signal processing are used for the decomposition. FFT is an efficient method of computing the discrete Fourier transform (DFT); DFT could be used as well as other methods of computing Fourier analysis. In the alternative, wavelet analysis could be used to divide the signal into different frequency components so that they can be considered separately. Specifically, the morlet wavelet, the Mexican hat wavelet, a daubechies wavelet, a beta wavelet, or a coiflet wavelet would be useful for doing so. Other wavelets may be useful as well.

**[0028]** In some embodiments, the frequencies are separated out from the signal and stored into bins. In storing the frequencies from the signal, bins hold sampled signals from the frequency domain. A DFT bin can be defined by calculating an n point DFT. Specifically, n different sample values are created X(**0**) through X(n−1). With i being a value **0** to n−1, X(i) is a bin holding relevant sample values. The Alpha bin can hold anything between 8-13 Hz, but not necessarily including all frequencies in that range. The Theta bin can hold anything between 4-8 Hz, but does not have to include all frequencies. Similarly, delta and beta waves can be held in delta and beta bins. Additionally, the frequency profile can be adjusted to remove noise in the signal such as white noise or pink noise.

**[0029]** In the example of FIG. **2**, the flowchart **200** continues to module **210** calculating an engagement value using the one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value thereby rating the

media based on the difference between the engagement value and the reference value of the media.

**[0030]** In some embodiments it is possible to sense engagement using only alpha, or only theta in contrast with the heart rate. Total EEG power is also useful. A single formula could be used to calculate an engagement value, wherein x/EEG represents x in contrast to total EEG power. Further, an optimized multiplier of theta could be used, such as by taking the natural log of theta and multiplying by a scale factor. In a non-limiting example theta could be optimized as: optimized theta=s~ln(theta) where s is a scale factor and ln(x) represents a function finding the natural log of x. Theta or optimized theta could be used in conjunction therewith

**[0031]** In some embodiments alpha brainwaves are inversely correlated with cognitive activity. As alpha power increases there is a drop in thought; conversely as cortical processing increases, there is a drop in alpha power which is commonly referred to as alpha suppression. Using these bases, the engagement value is determined by using a formula which looks for an increasing heart rate, decreasing alpha power, and increasing theta power. An example of such a formula which is:

$$E = \frac{HR}{50} - \frac{\alpha - \theta}{\theta + \alpha}$$

This formula uses a combination of the heart rate, the alpha and the theta values. Specifically, a combination of alpha and theta values is subtracted from an adjusted heart rate which as been adjusted by dividing it by 50. The adjustment and the combination of alpha and theta values are non-limiting and the formula could be re-written as necessary for a particular application. Other formulas which could be used are discussed later in regard to FIG. **5** depicts a relationship between a heart rate and one of a plurality of example formulas useful for calculating an engagement value.

**[0032]** In some embodiments, one or more events of a media are used to define an engagement value for the media. An event is an identifiable portion of a media. It could be the punch line of a joke, or an important scene of a movie. An event of a media is measurable and can have an engagement value associated with it. A number of events will have a number of engagement values. The media can be ranked as a whole by considering the events it contains and engagement values associated with those events.

**[0033]** In some embodiments the engagement value is calculated at a specific point in time. An exemplary system produces a time variant graph of the engagement of the individual based on a plurality of engagement values calculated in reference to stimulation with a media.

**[0034]** In some embodiments, a derivative may be calculated to determine a change in engagement indicating a response to stimulus. In a non-limiting example an event of a media engages a person causing an engagement response which is identified by a positive derivative. A positive derivative indicates an increase in engagement and a negative derivative indicates a decrease in engagement. Creators of media could use this information to create media ware more engaging, or less engaging as the creators desire.

**[0035]** In some embodiments, a media may be ranked based on engagement values. FIG. **3** depicts a flowchart **300** of an example of a method for ranking a first media against a second media. Flowchart **300** starts at module **302** with calculating an engagement value of the individual for an event of a media. In acquiring the first engagement value, the first individual will be exposed to a media, and the data acquired may include a heart rate, alpha waves, theta waves, delta waves and beta waves. These values are gathered concurrently with respect to time. The data point will comprise the engagement value at this point in time. There may be a delay in the response, therefore the signal is sampled with the understanding that the response may be immediately following if not exactly temporal with the stimulation, thus it is substantially concurrent with the stimulation.

**[0036]** In some embodiments a reference value is used to compare a user engagement response to an event with a predetermined engagement value of the event. The reference value could be anything developed for the purpose of providing a comparison value from which to determine a difference between the user's engagement value and the event. Developers of media may create their own reference values. A reference value may be an ideal value i.e. a goal desired. A reference value could be the average of a number of different user engagement values calculated solely for the purpose of developing a reference value from which to compare other individuals.

**[0037]** In the example of FIG. **3**, the flowchart **300** proceeds to module **304**, with comparing the engagement value with a reference value to determine the difference between the amount that the individual was engaged with the media and the reference value of the media. The reference value can be acquired in the same manner as the first data point. Alternatively, it is supplied by a creator of the media.

**[0038]** In the example of FIG. **3**, the flowchart **300** proceeds to module **306** with saving the comparison as a measure defining a rating of the event of the media. The relative difference between the engagement value and the reference value will be used to determine that an individual is relatively more engaged in, or less engaged in the media than the reference value. The relative difference can be used to rank a plurality of different media such as is depicted in FIG. **4**.

**[0039]** In some embodiments, a plurality of media is ranked according to engagement values. In the example of FIG. **4**, the diagram **400** of an example of ranking a plurality of media takes in n different media and ranks them in order relative to the engagement value associated with an individual. This could be extended to a group of individuals as is discussed relative to FIG. **8** where an average engagement value, or highest engagement value or other statistically motivated engagement value could be used to compare one media with another. In the original order at the top of diagram **400**, the media are unorganized: the game **402**, then the sport **404**, then the Ad. **406**, and then the Movie **408**. Once the media have been ranked according to the related engagement values E**1**, E**2** . . . EN. The relative rankings can be viewed as ranked Movie **412**, then ranked Sport **414**, then ranked game **416**, then ranked Ad. **418**. The ranking may be used to determine which media is the most engaging of the plurality of media, which is the least engaging, and other statistical measures of relative engagement of an individual with a media.

**[0040]** FIG. **5** depicts a plurality of formulas **500** related to ranking engagement. As discussed relative to FIG. **1**, the relationship between theta, alpha, and heart rate determines the amount that an individual is acting without thinking, and thus the engagement of that individual. Decreasing theta waves are indicative of a decreasing level of engagement. Increasing alpha waves are indicative of a lower level of

engagement. This increase in alpha and or relative decrease in theta is indicative of a change in level of engagement. An increased heart rate is associated with a level of excitement as is experienced when an individual's heart "races" in response to an exciting event. The combination thereof is the basis for finding that an individual is engaged with the media that the individual is interacting with. It is not sufficient to state that the individual theta, alpha, and heart rate changes are sufficient to determine a change in engagement, however, the change in one of the values is associated with a change in the engagement value, and correlated change of all the values involved may indicate a change in engagement.

**[0041]** FIG. **6** depicts an example of a relationship **600** between a heart rate and one of a plurality of example formulas useful for calculating an engagement value. Relationship **600** includes heart rate (HR) **602**, and formulas **604** through formula **628**. Formula **626** denotes the predominating pulse width from a wavelet analysis. In calculating an engagement value, a formula may take into account HR and one or more of the formulas. The formula and the HR may each or both be multiplied or divided by constant values to adjust them for specific applications. Individual variables in one or more of the formulas may similarly be adjusted by constant values without similarly adjusting other variables in the formulas. The relationship between the HR and the formula is used to determine engagement. Formulas not depicted but complying with the spirit of these teachings are similarly included.

**[0042]** FIG. **7** depicts a diagram **700** of an example of stimulating an individual with a media while calculating an engagement value relating the individual's engagement with the media. Diagram **700** includes media **702**, processing device **704**, heart **706**, electrode **708**, individual **710**, and headset **712**. As depicted, individual **712** watches a Hollywood movie, media **702** while having his engagement level monitored by the processing device **704**. Signals are collected from the head and the heart **706** via electrode **708** and headset **712**. These signals are transmitted to processing device **704** for processing into an engagement value. Notably, delta, alpha, theta, and beta waves are all received by the headset **712**, and are transmitted to the processing device **704** whether or not they are each actually used.

**[0043]** In some embodiments an aggregate of a number of individual engagement values derived from physiological responses is created determining a group response to a media. The aggregation can be by an average response for the number of individuals or by a higher ordered approximation.

**[0044]** FIG. **8** depicts a diagram **800** of an example of stimulating a plurality of individuals with a media and calculating relevant values based on their engagement with the media. Diagram **800** includes media **802**, first individual **804**, second individual **806**, third individual **808**, processing device **810**, summated response vector **812**, average engagement **814**, highest engagement **816**, and engagement at time **818**. In the example of FIG. **8**, individuals **804**, **806**, and **810** are engaged in a media, in this example they are watching a movie. The processing device **810** receives signals in accordance with the discussion of FIG. **1**, and calculates engagements values. These engagement values are used to produce statistical information about the media based on the engagement values collected. E.g. summated response vector **812** may accept the engagement value of each of individuals **804**, **806**, and **810**, and determine a number of individuals that responded to the media with engagement. In this example, a group response to the media may be obtained. Such additional statistical information as average engagement **814**, highest engagement **816**, and engagement at time **818** may be used to rank media based on a group response to media.

**[0045]** In some embodiments, an event is classified as a specific type of event by using a mathematical transform to compare the event with other events. Such mathematical transforms may include but are not limited to, an average, a first order derivative, a second order derivative, a polynomial approximation, a standard deviation from the mean, a standard deviation of derivatives from the mean, and profiles of the physiological responses, which can be implemented with convolution or other methods that takes into account one or more of: peaking in the middle, spiking in the beginning, being flat, etc.

**[0046]** FIG. **9** depicts diagrams **900** of graphs of examples of changes in engagement relative to events in time. Diagrams **900** include exciting engaging event **902**, and unexciting disengaging event **904**. In the example of FIG. **9**, exciting engaging event **902** causes engagement to increase. The derivative of the engagement vector immediately following exciting engaging event **902** is clearly positive until the excitement has worn off resulting in a stable engagement. In the contrary, an excited engaged individual experiences unexciting disengaging event **904**, which over the time immediately following, causes the engagement of the individual to decrease to the point where the individual is significantly less engaged than prior to the event.

**[0047]** FIG. **10** depicts a diagram **1000** and data graphs of an example of stimulating an individual with a media, here a game, and recording the related levels of heart rate, thought, and engagement. Diagram **1000** includes game **1002**, individual **1004**, headset **1006**, heart **1008**, electrode **1010**, processing device **1012**, first graph **1014**, and second graph **1016**. First graph **1014** and second graph **1016** do not correspond to the same data from the same individual, but are from different experiments. In the example of FIG. **10**, the individual **1004** plays a game while his brain waves are collected by headset **1006** and his heart signal is collected by processing device **1012**. The resulting signal is analyzed in accordance with the discussion of FIG. **1**, and the engagement is tracked. In graph **1014**, the brainwaves and the heart rate are graphed. In the experiment an individual was observed and the graph was created. By comparing the actions of individual **1004** to graph **1014** over time, it was concluded that in periods of high intensity, when the individual identified that he had become engaged, his heart rate rose and his thought level, as identified by changes in alpha and theta, dropped. After finding that this engagement corresponded to the heart rate, and brain waves as discussed, graph **1016** was produced. Graph **1016** depicts the engagement of an individual with a game and a key point corresponding to disengagement is noted. This disengagement corresponds to that as described in the discussion of FIG. **9**, although graph **1016** was produced through actual experiment.

**[0048]** In some embodiments, an integrated headset can be placed on a viewer's head for measurement of his/her physiological data while the viewer is watching an event of the media. The data can be recorded in a program on a computer that allows viewers to interact with media while wearing the headset.

**[0049]** FIG. **11** depicts a headset **1100** containing electrodes useful for collecting signals from a head of an individual. Headset **1100** includes processing unit **1101**, three axis accelerometer **1102**, silicon stabilization strip **1103**, right

EEG electrode **1104**, heart rate sensor **1105**, left EEG electrode **1106**, battery module **1107**, and adjustable strap **1108**. FIG. **11** depicts an example of an integrated headset used with one embodiment of the present invention from different angles. Processing unit **1101** is a microprocessor that digitizes physiological data and can process the data into physiological responses that include but are not limited to thought, engagement, immersion, physical engagement, valence, vigor and others. A three axis accelerometer **1102** senses movement of the head. A silicon stabilization strip **1103** allows for more robust sensing through stabilization of the headset that minimizes movement. The right EEG electrode **1104** and left EEG electrode **1106** are prefrontal dry electrodes that do not need preparation to be used. Contact is needed between the electrodes and skin but without excessive pressure. The heart rate sensor **1105** is a robust blood volume pulse sensor positioned about the center of the forehead and a rechargeable or replaceable battery module **1107** is located over one of the ears. The adjustable strap **1108** in the rear is used to adjust the headset to a comfortable tension setting for many different head sizes.

**[0050]** In some embodiments, the integrated headset can be turned on with a push button and the viewer's physiological data is measured and recorded instantly. The data transmission can be handled wirelessly through a computer interface that the headset links to. No skin preparation or gels are needed on the viewer to obtain an accurate measurement, and the headset can be removed from the viewer easily and can be instantly used by another viewer. No degradation of the headset occurs during use and the headset can be reused thousands of times.

**[0051]** It will be appreciated to those skilled in the art that the preceding examples and embodiments are exemplary and not limiting to the scope of the present invention. It is intended that all permutations, enhancements, equivalents, and improvements thereto that are apparent to those skilled in the art upon a reading of the specification and a study of the drawings are included within the true spirit and scope of the present invention. It is therefore intended that the following appended claims include all such modifications, permutations, and equivalents as fall within the true spirit and scope of the present invention.

We claim:

**1**. A method for sensing an individual's immersion in an experience for rating a media comprising:

stimulating an individual with a media containing an event;

sampling a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media;

sampling a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain;

decomposing the first signal and the second signal into a frequency domain; and

calculating an engagement value using one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value thereby rating the media based on the difference between the engagement value and the reference value of the media.

**2**. The method of claim **1** wherein only one frequency from the first signal is selected from alpha and theta, and the only one frequency from the first signal along with the frequency from the second signal are used to calculate the engagement value.

**3**. The method of claim **1** wherein the engagement value is associated with the event in the media.

**4**. The method of claim **1** wherein the second signal is sampled via a photoplethysmograph attached to a head of the individual.

**5**. The method of claim **1** wherein multiple engagement values from multiple individuals associated with an even in the media are aggregated to form an engagement response to the event.

**6**. The method of claim **1** wherein multiple engagement values from multiple individuals associated with the event in the media are aggregated to form an engagement response to the event.

**7**. The method of claim **1** wherein multiple engagement values from multiple individuals are included in a summated response vector identifying the number of persons that responded with engagement to the media.

**8**. The method of claim **1** wherein decomposing is accomplished using a Fast Fourier transform or a wavelet analysis.

**9**. The method of claim **8** wherein wavelet analysis is accomplished using a wavelet selected from a Mexican hat wavelet a morlet wavelet, a daubechies wavelet, a beta wavelet, and a coiflet wavelet.

**10**. The method of claim **1** further comprising calculating a derivative of the engagement value to show a change in engagement over time.

**11**. The method of claim **1** wherein the formula used is [heart rate/50]−[(theta−alpha) /(theta+alpha)].

**12**. The method of claim **1** wherein the length of each heart beat is monitored.

**13**. The method of claim **1** wherein the engagement value is calculated by contrasting a heart rate from the first signal with the product of a formula selected from $\theta-\alpha$, $\theta$, $\theta/\alpha$, $\Delta/\alpha$,$\beta/\alpha$, and total EEG power/$\alpha$, wherein $\alpha$, $\beta$, $\Delta$, & $\theta$ are each found in the first signal.

**14**. The method of claim **1** wherein the engagement value is calculated by contrasting a length of a heart beat with the product of a formula selected from $\alpha$, $\alpha/\theta$, $\alpha/\theta$, $\alpha/\beta$, $\alpha/\Delta$, $\alpha$/total EEG power, and $(\alpha-\theta)/(\alpha+\theta)$, wherein $\alpha$, $\beta$,$\Delta$, & $\theta$ are each found in the first signal.

**15**. The method of claim **1** wherein the unit of data is created by stimulation using a media selected from television, video game, audiovisual advertisement, board game, card game, live action event, print advertisement, and web advertisement.

**16**. The method of claim **1** wherein the engagement value corresponds to a point in time, and the engagement value is aligned to the media by correlating the engagement value with an event occurring at the point in time by identifying an event of the media which occurred substantially concurrently.

**17**. A method for rating media based on the amount that an individual is engaged comprising:

calculating an engagement value of the individual for an event of a media;

comparing the engagement value with a reference value to determine a difference between the amount that the individual was engaged with the media and the reference value of the media; and

saving a result from comparing as a measure defining a rating of the event of the media.

**18**. The method of claim **17** wherein the reference value is supplied by a developer of the media.

**19**. The method of claim **17** wherein the reference value is an average value of numerous previously calculated engagement values of other individuals.

**20**. The method of claim **17** wherein the engagement value is calculated using a single frequency selected from alpha or theta, the single frequency is contrasted with a heart rate of the individual.

**21**. The method of claim **17** wherein the engagement value is calculated by contrasting a length of a heart beat with a product of a formula selected from $\alpha$, $\alpha/\theta$, $\alpha/\theta$, $\alpha/\beta$, $\alpha/\Delta$, $\alpha$/total EEG power, and $(\alpha-\theta)/(\alpha+\theta)$.

**22**. The method of claim **17** wherein the first media is selected from television, video game, audiovisual advertisement, board game, card game, live action event, print advertisement, and web advertisement.

**23**. A program for sensing an engagement response for use in rating media embodied in a computer readable medium that when executed causes a system to:

stimulate an individual with a media containing an event;

sample a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media;

sample a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain;

decompose the first signal and the second signal into the frequency domain; and

calculate an engagement value using one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value thereby rating the media based on the difference between the engagement value and the reference value of the media.

**24**. The program of claim **23** wherein only one frequency is selected from alpha and theta and only the one frequency is used to calculate the engagement value by contrasting the one frequency with the signal from the heart of the individual.

**25**. The program of claim **23** wherein the engagement value is calculated by contrasting a length of a heart beat with the product of a formula selected from $\alpha$, $\alpha/\theta$, $\alpha/\theta$, $\alpha/\beta$, $\alpha/\Delta$, $\alpha$/total EEG power, and $(\alpha-\theta)/(\alpha+\theta)$, wherein $\alpha$, $\beta$, $\Delta$, & $\theta$ are each found in the first signal.

**26**. The program of claim **23** wherein the signal is decomposed using a fast Fourier transform or a wavelet analysis.

**27**. The program of claim **23** wherein the unit of data is created by stimulation using a media selected from television, video game, audiovisual advertisement, board game, card game, live action event, print advertisement, and web advertisement.

**28**. The program of claim **23** wherein the signal is aligned relative to the media to create a first aligned engagement value corresponding to a first event in time which can be compared with a second aligned engagement value corresponding to a second event in time.

**29**. A system for sensing an engagement response fro use in rating media comprising:

one or more sensors operable to sample a first signal from an individual;

a processing component connected to the one or more sensors operable to:

sample a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media;

sample a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain;

decompose the first signal and the second signal into the frequency domain; and

calculate an engagement value using the one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value thereby rating the media based on the difference between the engagement value and the reference value of the media.

**30**. The system of claim **29** wherein the one or more sensors are included in an integrated sensor headset operable to measure a signal from the individual stimulated by the media.

**31**. A system for sensing an engagement response for use in rating media comprising:

means for sampling a first signal from a brain of the individual substantially concurrently while stimulating the individual with the media;

means for sampling a second signal from a heart of the individual substantially concurrently while sampling the first signal from the brain;

means for decomposing the first signal and the second signal into the frequency domain; and

means for calculating an engagement value using the one or more frequencies from the first signal and a frequency from the second signal defining an amount the individual is acting without thinking in response to stimulation of the event for comparison with a reference value thereby rating the media based on the difference between the engagement value and the reference value of the media.

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| 专利名称(译) | 用于使用生理信号测量和排序对视听或交互式媒体，产品或活动的“参与”响应的方法和系统 | | |
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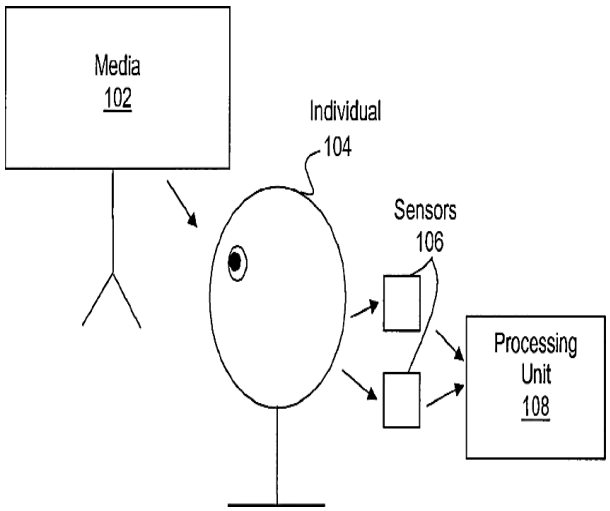
摘要(译)

通过量化用户正在行动的量而不考虑脑电波和心率来计算参与度值的系统和方法可用于比较基于个体或一组个体的媒体。媒体事件也可以通过参与价值进行对比和比较。可以采取统计测量来改进媒体。


Media
102
Individual
104
Sensors
106
Processing
Unit
108