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(54) APPARATUS AND METHOD FOR ADJUSTING DIFFICULTY LEVEL OF GAME

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(57) **ABSTRACT**

An apparatus for adjusting difficulty level of a game, includes: an artificial intelligence unit for storing artificial intelligence algorithms; a strategy toolkit for generating metadata for game resources and creating game strategies by applying the artificial intelligence algorithms using the metadata; and a simulation toolkit for calculating relative difficulty levels of the game strategies and combinations of the game strategies and applying to the game one of the game strategies and the combinations of the game strategies based on a user's skill level determined during the game.

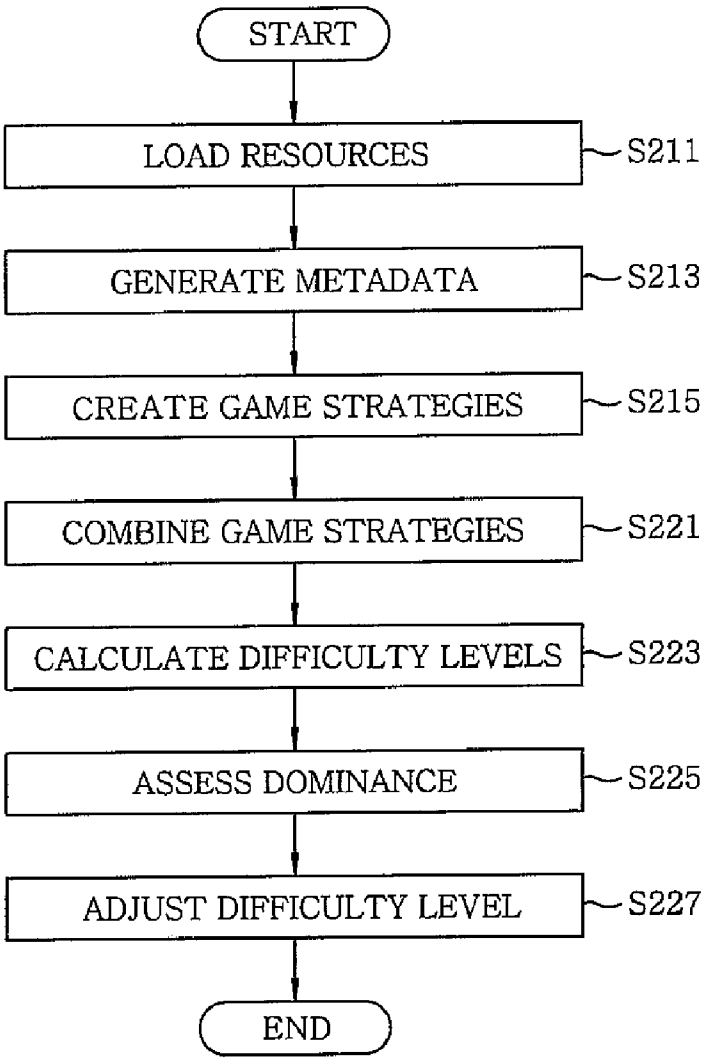


FIG. 1

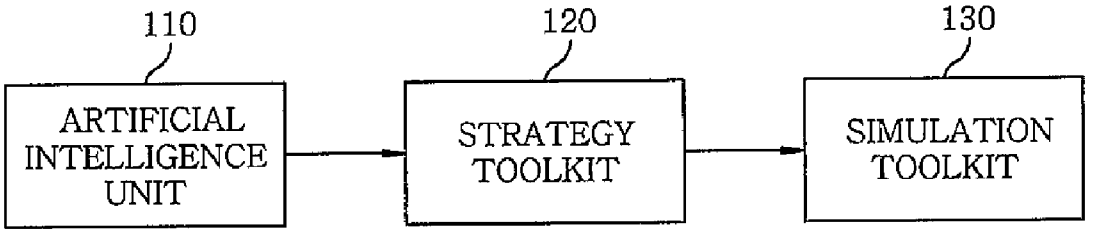

110
ARTIFICIAL INTELLIGENCE UNIT
120
STRATEGY TOOLKIT
130
SIMULATION TOOLKIT

FIG. 2

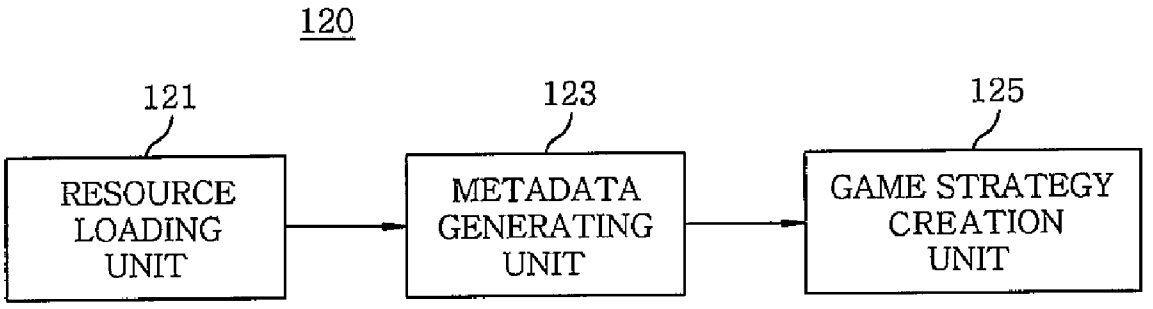

120
121
RESOURCE LOADING UNIT
123
METADATA GENERATING UNIT
125
GAME STRATEGY CREATION UNIT

FIG. 3

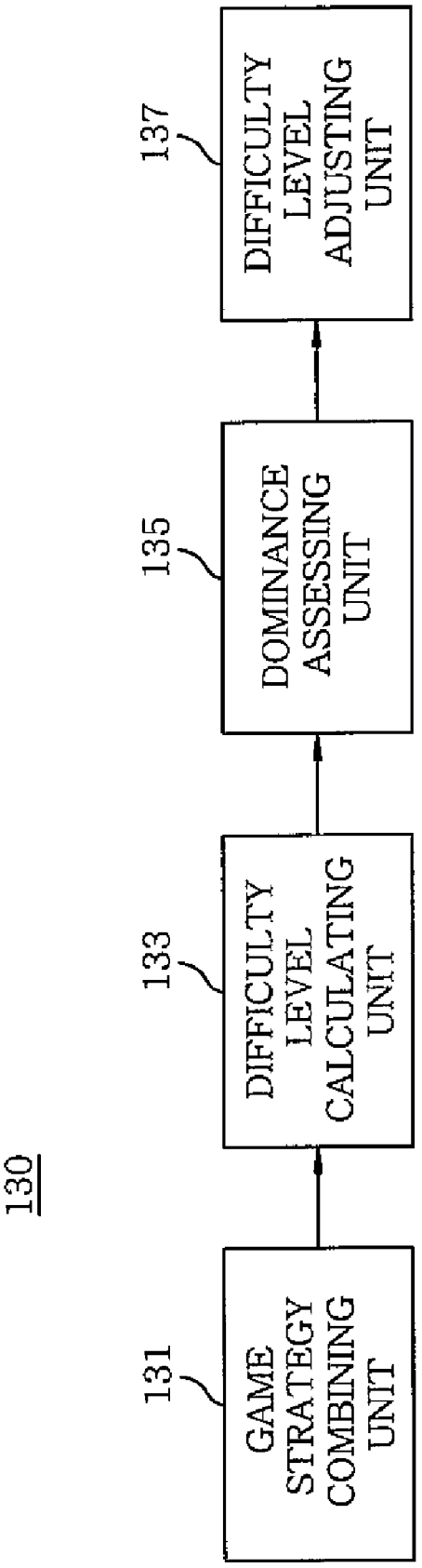

130
131
GAME STRATEGY COMBINING UNIT
133
DIFFICULTY LEVEL CALCULATING UNIT
135
DOMINANCE ASSESSING UNIT
137
DIFFICULTY LEVEL ADJUSTING UNIT

FIG. 4

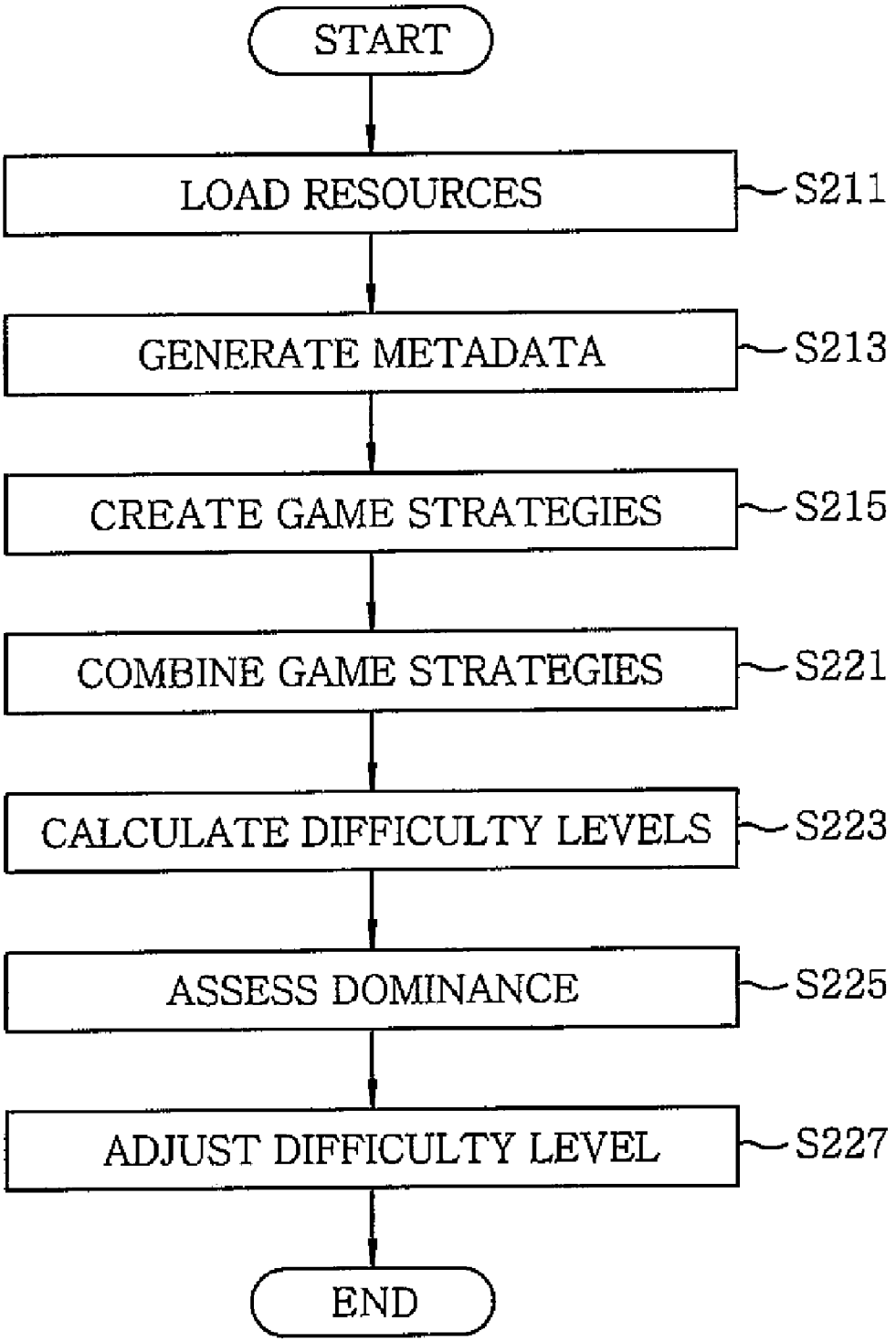

START
LOAD RESOURCES
S211
GENERATE METADATA
S213
CREATE GAME STRATEGIES
S215
COMBINE GAME STRATEGIES
S221
CALCULATE DIFFICULTY LEVELS
S223
ASSESS DOMINANCE
S225
ADJUST DIFFICULTY LEVEL
S227
END

FIG. 5

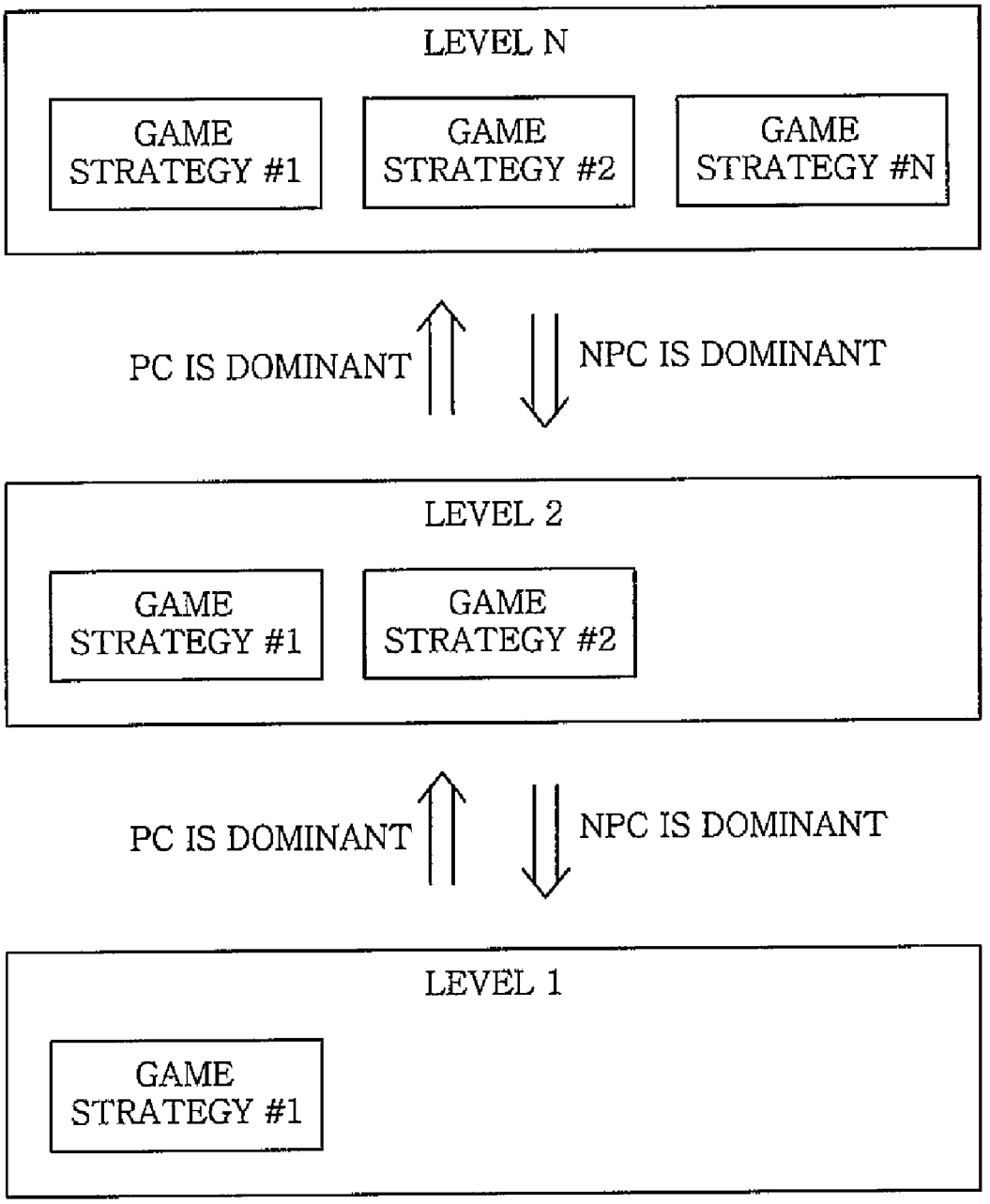
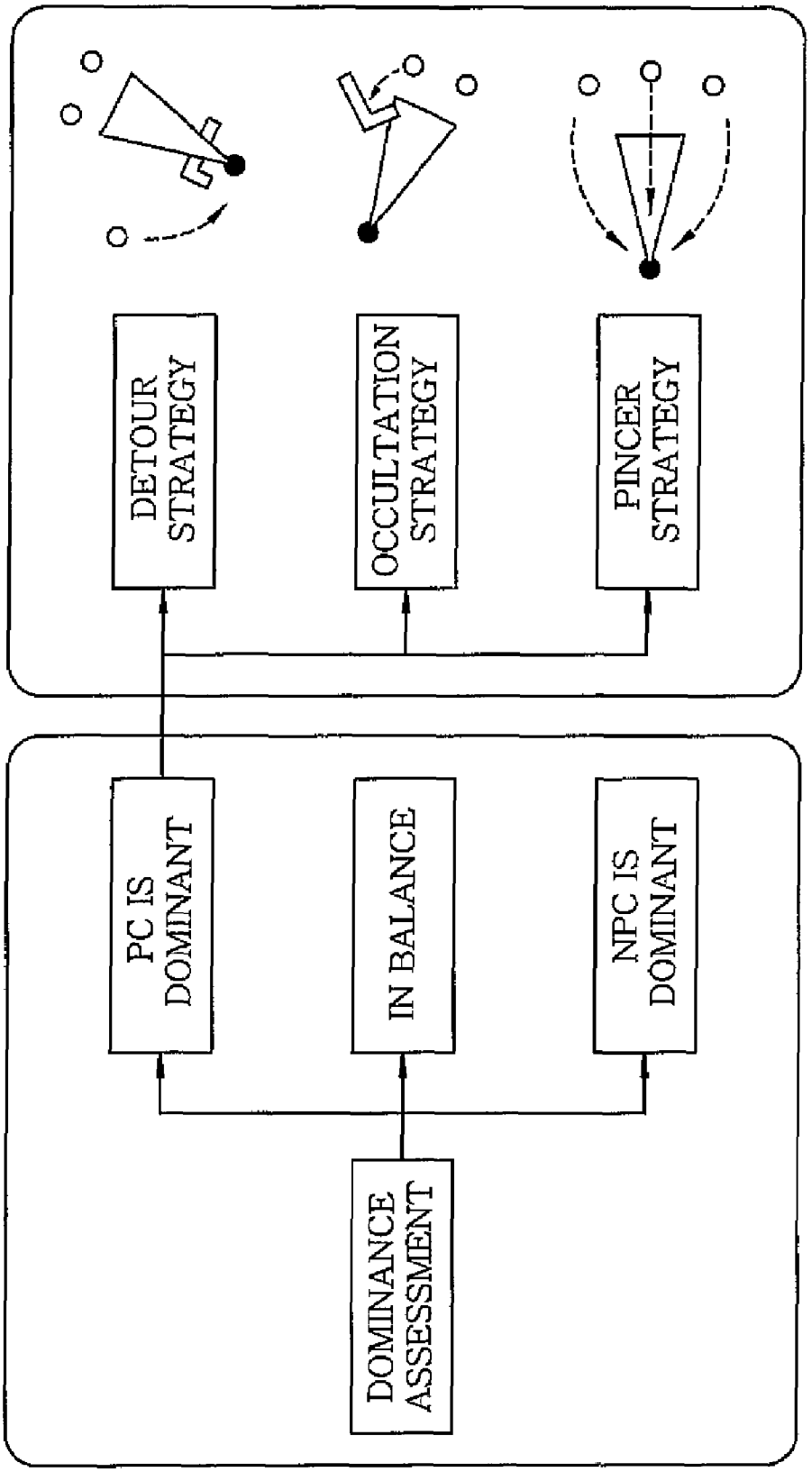

LEVEL N
GAME STRATEGY #1
GAME STRATEGY #2
GAME STRATEGY #N
PC IS DOMINANT
NPC IS DOMINANT
LEVEL 2
GAME STRATEGY #1
GAME STRATEGY #2
PC IS DOMINANT
NPC IS DOMINANT
LEVEL 1
GAME STRATEGY #1

FIG. 6


DETOUR STRATEGY
OCCULTATION STRATEGY
PINCER STRATEGY
PC IS DOMINANT
IN BALANCE
NPC IS DOMINANT
DOMINANCE ASSESSMENT

APPARATUS AND METHOD FOR ADJUSTING DIFFICULTY LEVEL OF GAME

CROSS-REFERENCE(S) TO RELATED APPLICATIONS

[0001] The present invention claims priority of Korean Patent Application No. 10-2009-0038239, filed on Apr. 30, 2009, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to an apparatus and method for adjusting difficulty level of a game, and, more particularly, to an apparatus and method for dynamically adjusting difficulty level of a game based on a user's skill level.

BACKGROUND OF THE INVENTION

[0003] Computer games have been developing along with the birth of the computer, from simple games of the early days to today's online games.

[0004] Most of the early days' games were two-person games that are played between two people. However, with integration of an artificial intelligence technology into the computer games, the computer games have rapidly developed. In recent years, the artificial intelligence technology has become essential part for success of the games.

[0005] Meanwhile, there were attempts to adjust difficulty level of a game using such a artificial intelligence technology. These attempts were implemented mostly by simple changes in numerical values, such as the number of enemies appearing on screen, the number of bullets the enemies can use, the physical strength of the enemies and the like, or by an increase in fixed patterns.

[0006] In the 2000s, a higher-level of artificial intelligence has integrated into a game. As a result, games which can change play patterns depending on user's behavior or can attack the user with real strategies and tactics have been introduced.

[0007] Several examples of a conventional method for adjusting difficulty level of a game will be described below.

[0008] According to a first example, the propensity of a user who plays a game and the user's adaptability to the game are determined using a genetic algorithm, which is one of the artificial intelligence techniques, and the difficulty level of the game is adjusted in real time based on the user's skill level. Here, factors for adjusting the difficulty level of the game are represented as genes. The difficulty levels are generated by determining the gene's fitness and the difficulty level is adjusted based on the user's skill level by adjusting simple factors including the speed of an enemy, the number of bullets that an enemy fires, the number of enemies, etc. This example may be effective to some extent in the adjustment of the difficulty level since the difficulty level is adjusted by adjusting the simple factors. However, there is a problem that the interest on the game cannot be sustained. Especially, this problem is more remarkably represented at a game of low difficulty level.

[0009] According to a second example, in a computer game or simulation, the user's skill level is determined by analyzing user input factors such as the user's response speed inputted through a user interface, and, based on this, the difficulty level is adjusted depending on the user's skill level. However, since the user's skill level is ascertained based on user input data obtained from simple factors such as the user's input speed, the accuracy in the ascertainment of the user's skill level is low. As a result, since the difficulty level is adjusted based on the user's skill level, the adjustment of the difficulty level is also doubtable.

[0010] Lastly, according to a third example, in an interactive program, such as a video game, the difficulty level based on the user's skill level is provided by continuously comparing a user input to a program's output to control a deviation between the user input and the program output through alteration of one or more program parameters based on the result of comparison. However, there is a problem in that the interest on the game cannot be sustained, as in the first example, because the difficulty level of the game is adjusted by changing game parameters.

SUMMARY OF THE INVENTION

[0011] In view of the above, the present invention provides an apparatus and method for dynamically adjusting the difficulty level of a game based on a user's skill level so as to prevent a user playing a computer game from losing interest because the game is either too easy or too difficult.

[0012] In accordance with a first aspect of the present invention, there is provided an apparatus for adjusting difficulty level of a game, including:

[0013] an artificial intelligence unit for storing artificial intelligence algorithms;

[0014] a strategy toolkit for generating metadata for game resources and creating game strategies by applying the artificial intelligence algorithms using the metadata; and

[0015] a simulation toolkit for calculating relative difficulty levels of the game strategies and combinations of the game strategies and applying to the game one of the game strategies and the combined game strategies based on a user's skill level determined during the game.

[0016] In accordance with a second aspect of the present invention, there is provided a method for adjusting difficulty level of a game, including:

[0017] reading out game resources to generate metadata for the game resources;

[0018] creating game strategies by applying artificial intelligence algorithms;

[0019] calculating relative difficulty levels of the game strategies and combinations of the game strategies; and

[0020] applying one of the game strategies and the combined game strategies based on a user's skill level determined during the game.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above features of the present invention will become apparent from the following description of embodiments, given in conjunction with the accompanying drawings, in which:

[0022] FIG. **1** illustrates a block diagram of an apparatus for adjusting difficulty level of a game in accordance with an embodiment of the present invention;

[0023] FIG. **2** shows a detailed block diagram of the strategy toolkit shown in FIG. **1**;

[0024] FIG. **3** offers a detailed block diagram of the simulation toolkit shown in FIG. **1**;

[0025] FIG. **4** is a flow chart illustrating a method for adjusting difficulty level of a game in accordance with the embodiment of the present invention;

[0026] FIG. **5** is a conceptual diagram illustrating a process of adjusting difficulty level of a game in accordance with the embodiment of the present invention; and

[0027] FIG. **6** presents an example of game strategies for adjusting difficulty level of a game when PC is dominant, in accordance with the embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0028] The advantages and features of the present invention, and methods of accomplishing these will be clearly understood from the following embodiments taken in conjunction with the accompanying drawings. However, the present invention is not limited to those embodiments but may be implemented in various forms. It should be noted that the present embodiments are provided to make a full disclosure of the invention and also to allow those skilled in the art to know the full range of the invention. Therefore, the present invention is to be defined only by the scope of the appended claims. Further, like reference numerals identify like or similar elements throughout the specification.

[0029] Hereinafter, embodiments of the present invention will be explained in more detail with reference to the accompanying drawings.

[0030] FIG. **1** illustrates a block diagram of an apparatus for adjusting difficulty level of a game in accordance with an embodiment of the present invention.

[0031] The difficulty level adjusting apparatus for a game shown in FIG. **1** includes an artificial intelligence unit **110** for storing artificial intelligence algorithms, a strategy toolkit **120** for generating metadata for game resources and creating game strategies by executing the artificial intelligence algorithms using the metadata, and a simulation toolkit **130** for calculating the relative difficulty levels of the respective game strategies and combinations of these game strategies and applying to the game one of the game strategies and the combined game strategies based on a user's skill level determined during the progress of the game.

[0032] The artificial intelligence unit **110** stores game artificial intelligence algorithms, which includes a decision tree, a genetic algorithm, a planning algorithm, a neural network and the like, for creating various game strategies.

[0033] The strategy toolkit **120** reads out game resources, which includes at least one of topographic features, buildings, objects, characters and so forth, to generate metadata for the game resources. The metadata includes occultation properties, viewing angle properties, path properties and so on, and is allocated to the game resources so that the artificial intelligence algorithms can recognize the game resources. Further, the strategy toolkit **120** creates game strategies through NPC positioning which derives positions of NPCs from executing the artificial intelligence algorithms using the metadata allocated to the game resources. The game strategies are provided to the simulation toolkit **130**.

[0034] The simulation toolkit **130** calculates the relative difficulty levels of the game strategies and combinations of these game strategies, and assesses relative dominance between PC (player character) and NPC during the game. Here, the relative dominance (or relative situation) is assessed depending on the results of comparisons between PC and NPC with respect to game status information, for example, score, physical strength, number of remaining bullets, number of wins, number of kills, number of remaining troops, etc. Further, the simulation toolkit **130** determines a difficulty level of the game depending on the relative dominance between PC and NPC to apply a game strategy of the determined difficulty level to the game. For example, the difficulty level of the game is adjusted in such a manner that, if PC is dominant, the difficulty level of the game is increased, or if NPC is dominant, the difficulty level of the game is decreased.

[0035] FIG. **2** shows a detailed block diagram of the strategy toolkit shown in FIG. **1**.

[0036] Referring to FIG. **2**, the strategy toolkit **120** includes a resource loading unit **121**, a metadata generating unit **123** and a game strategy creation unit **125**. The resource loading unit **121** reads out game resources, such as topographic features, buildings, objects, characters, and so forth. The metadata generating unit **123** generates metadata such as occultation properties, viewing angle properties and path properties to be allocated to the game resources. The game strategy creation unit **125** creates a variety of game strategies through NPC positioning, which derives positions of NPCs from performing the artificial intelligence algorithms stored in the artificial intelligence unit **110**. Here, the metadata generated by the metadata generating unit **123** are used for the algorithms as inputs. The created game strategies are provided to the simulation toolkit **130**.

[0037] FIG. **3** presents a detailed block diagram of the simulation toolkit shown in FIG. **1**.

[0038] Referring to FIG. **3**, the simulation toolkit **130** includes a game strategy combining unit **131**, a difficulty level calculating unit **133**, a dominance assessing unit **135** and a difficulty level adjusting unit **137**. The game strategy combining unit **131** combines the respective game strategies provided from the strategy toolkit **120** to create combined game strategies. The difficulty level calculating unit **133** calculates relative difficulty levels of the respective game strategies and the combined game strategies from the game strategy combining unit **131**. The dominance assessing unit **135** assesses the relative dominance (situation) depending on the results of comparisons between PC and NPC with respect to game status information, for example, score, physical strength, number of remaining bullets, number of wins, number of kills, number of remaining troops, and the like during the game. The difficulty level adjusting unit **137** applies a game strategy or combined game strategy of an appropriate difficulty level by increasing or decreasing the difficulty level depending on the relative dominance between PC and NPC assessed by the dominance assessing unit **135**.

[0039] Now, a method for adjusting the difficulty level of a game of the present invention will be described in detail with reference to FIGS. **4** to **6**.

[0040] FIG. **4** illustrates a flow chart for explaining a difficulty level adjusting method for a game in accordance with another embodiment of the present invention.

[0041] First, in step S**211**, the resource loading unit **121** of the strategy toolkit **120** reads out game resources, e.g., topographic features, buildings, objects, characters, and so forth, and provides the game resources to the metadata generating unit **123** of the strategy toolkit **120**.

[0042] Then, in step S**213**, the metadata generating unit **123** generates metadata for the resources read out from the resource loading unit **121**. The metadata includes occultation properties, viewing angle properties, path properties, passable roads, hideable and unbreakable objects, hideable and breakable objects (which will be broken when an impact of more than a predetermined value is applied thereto), objects that can be used for attack or defense, and so on.

[0043] Next, the game strategy creation unit **125** of the strategy toolkit **120** executes the artificial intelligence algorithms, for example, a decision tree, a genetic algorithm, a planning algorithm, a neural network and the like, stored in the artificial intelligence unit **110**, thereby performing NPC positioning. At this connection, the artificial intelligence algorithms use the metadata generated by the metadata generating unit **123** as inputs of themselves. The game strategy creation unit **125** creates various game strategies through the above NPC positioning in step S**215**, and provides the created game strategies to the game strategy combining unit **131** of the simulation toolkit **130**. The game strategies include a detour strategy, an occultation strategy, a pincer strategy, and so forth.

[0044] Thereafter, in step S**221**, the game strategy combining unit **131** of the simulation toolkit **130** combines the respective game strategies. The game strategies and the combined game strategies are provided to the difficulty level calculating unit **133** of the simulation toolkit **130**.

[0045] Subsequently, in step S**223**, the difficulty level calculating unit **133** calculates relative difficulty levels of the respective game strategies and the combined game strategies. At this time, a strategy simulation is performed in order to calculate the relative difficulty levels and to test the combinability of the game strategies. A combined game strategy having a relatively high combination effect is given a high difficulty level and a combined game strategy having a relatively low combination effect is given a low difficulty level according to the combination effects based on the results of the strategy simulation.

[0046] Next, in step S**225**, the dominance assessing unit **135** of the simulation toolkit **130** assesses relative dominance depending on the results of comparisons between PC and NPC with respect to game status information, for example, score, physical strength, number of remaining bullets, number of wins, number of kills, number of remaining troops, and the like during the game. For example, PC and NPC are compared with each other for each category of the game status information, and if it is determined that the comparison result is within a preset range, it is assessed that they are "in balance", and if it is determined that the comparison result is beyond a preset range, it is assessed that "PC is dominant" or "NPC is dominant".

[0047] Lastly, in step S**227**, the difficulty level adjusting unit **137** of the simulation toolkit **130** adjusts a difficulty level of the game by determining the difficulty level of the game depending on the dominance between PC and NPC assessed by the dominance assessing unit **135** to apply a strategy of the determined difficulty level among the game strategies and the combined game strategies to the game. For example, if PC is dominant, the difficulty level adjusting unit **137** provides a game strategy or combined game strategy with a higher difficulty level, while if NPC is dominant, it provides a game strategy or combined game strategy with a lower difficulty level.

[0048] FIG. **5** is a conceptual diagram illustrating a process of adjusting the difficulty level of the game in accordance with the embodiment of the present invention.

[0049] Referring to FIG. **5**, game strategies created by the game strategy creation unit **125** of the strategy toolkit **120** are denoted by game strategy #**1**, game strategy #**2**, . . . , game strategy # n. For instance, when a single game strategy only having game strategy #**1** is denoted by level **1**, which is the lowest difficulty level. And a combined game strategy having game strategy #**1** and game strategy #**2** is denoted by level **2**, which is a higher difficulty level than the level **1**. Further, a combined game strategy having game strategy #**1**, game strategy #**2**, and game strategy # n is denoted by level n which is the highest difficulty level. The difficulty level adjusting unit **137** of the simulation toolkit **130** increases the difficulty level of the game in the order of level **1**, level **2**, and level n whenever the dominance assessing unit **135** of the simulation toolkit **130** assesses that "PC is dominant", and decreases the difficulty level of the game in the order of level n, level **2**, and level **1** whenever the dominance assessing unit **135** assess that "NPC is dominant".

[0050] FIG. **6** illustrates an example of game strategies for adjusting the difficulty level of a game when PC is dominant, in accordance with the embodiment of the present invention. In the dominance assessment based on game status information, if the dominance assessing unit **135** of the simulation toolkit **130** determines that "PC is dominant", the difficulty level adjusting unit **137** of the simulation toolkit **130** increases the difficulty level of the game by applying a game strategy such as a detour strategy, an occultation strategy, a pincer strategy, and so forth or combination of those game strategies created in the game strategy creation unit **125** of the strategy toolkit **120**.

[0051] As described above, the apparatus and method for adjusting the difficulty level of a game in accordance with the present invention, which dynamically adjust the difficulty level of the game based on the user's skill level have the following effects.

[0052] First, it is possible to develop game strategies by applying various artificial intelligence algorithms regardless of genres or contents of the game.

[0053] Second, complex and diverse game difficulty levels are provided through combinations of game strategies.

[0054] Third, a player's interest on a game can be sustained by interestingly and diversely adjusting game difficulty levels like in a real situation, rather than by simply adjusting the difficulty level with changes in the speed and the number of enemies, the physical strength of enemies, etc.

[0055] Additionally, the present invention is applicable to existing single-play games, multi-play games, and online games, and is also applicable to game genres including PvE (player vs. environment) or interactive simulations.

[0056] Moreover, the present invention always offers exciting and challenging game play by developing game strategies created through various artificial intelligence algorithms, generating various difficulty levels by combining the game strategies, thereby dynamically applying a strategy appropriate for the user's skill level to the game.

[0057] While the invention has been shown and described with respect to the embodiments, it will be understood by those skilled in the art that various changes and modification may be made without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. An apparatus for adjusting difficulty level of a game, comprising:

an artificial intelligence unit for storing artificial intelligence algorithms;

a strategy toolkit for generating metadata for game resources and creating game strategies by executing the artificial intelligence algorithms using the metadata; and

a simulation toolkit for calculating relative difficulty levels of the game strategies and combinations of the game

strategies and applying one of the game strategies and the combined game strategies to the game based on a user's skill level determined during the game.

2. The apparatus of claim **1**, wherein the artificial intelligence algorithms include a decision tree, a genetic algorithm, a planning algorithm, and a neural network.

3. The apparatus of claim **1**, wherein the game strategies are created by performing NPC (non player character) positioning.

4. The apparatus of claim **3**, wherein the strategy toolkit includes:

a resource loading unit for reading out the game resources;

a metadata generating unit for generating and the metadata to be allocated to the game resources; and

a game strategy creation unit for creating the game strategies through the NPC positioning, which derives positions of the NPCs by executing the artificial intelligence algorithms using the metadata.

5. The apparatus of claim **4**, wherein the game resources include at least one of topographic features, buildings, objects and characters in the game.

6. The apparatus of claim **4**, wherein the game strategies include at least one of a detour strategy, an occultation strategy and a pincer strategy.

7. The apparatus of claim **1**, wherein the simulation toolkit performs a strategy simulation to calculate the relative difficulty levels of the game strategies and to test combinability of the game strategies, and allocates a high difficulty level to a combined game strategy having a relatively high combination effect and a low difficulty level to a combined game strategy having a relatively low combination effect according to the combination effects based on results of the strategy simulation.

8. The apparatus of claim **1**, wherein the simulation toolkit determines the user's skill level based on an assessment result of relative dominance between PC (player character) and NPC (non-player character) during the game.

9. The apparatus of claim **1**, wherein the simulation toolkit includes:

a game strategy combining unit for combining the game strategies provided from the strategy toolkit;

a difficulty level calculating unit for calculating the relative difficulty levels of the game strategies and the combined game strategies;

a dominance assessing unit for assessing relative dominance depending on results of comparisons between PC and NPC with respect to game status information during the game; and

a difficulty level adjusting unit for determining a difficulty level of the game depending on the relative dominance between the PC and the NPC assessed by the dominance assessing unit to apply a strategy of the determined difficulty level among the game strategies and the combined game strategies to the game.

10. The apparatus of claim **9**, wherein the game status information includes at least one of score, physical strength, number of remaining bullets, number of wins, number of kills and number of remaining troops.

11. The apparatus of claim **9**, wherein the difficulty level adjusting unit increases the difficulty level of the game if the PC is dominant and decreases the difficulty level of the game if the NPC is dominant.

12. A method for adjusting difficulty level of a game, comprising:

reading out game resources to generate metadata for the game resources;

creating game strategies by executing artificial intelligence algorithms;

calculating relative difficulty levels of the game strategies and combinations of the game strategies; and

applying one of the game strategies and the combined game strategies based on a user's skill level determined during the game.

13. The method of claim **12**, wherein said creating the game strategies creates the game strategies by performing NPC (non player character) positioning.

14. The method of claim **12**, wherein the artificial intelligence algorithms include a decision tree, a genetic algorithm, a planning algorithm and a neural network.

15. The method of claim **12**, wherein the game resources includes at least one of topographic features, buildings, objects and characters.

16. The method of claim **12**, wherein the game strategies include at least one of a detour strategy, an occultation strategy, and a pincer strategy.

17. The method of claim **12**, wherein said calculating the relative difficulty levels calculates the relative difficulty and tests combinability of the game strategies by performing a strategy simulation, and allocates a high difficulty level to a combined game strategy having a relatively high combination effect and a low difficulty level to a combined game strategy having a relatively low combination effect according to the combination effects based on results of the strategy simulation.

18. The method of claim **12**, wherein said applying one of the game strategies and the combined game strategies includes determining a difficulty level of the game based on an assessment result of relative dominance between PC (player character) and NPC (non-player character) during the game.

19. The method of claim **12**, wherein said applying one of the game strategies and the combined game strategies includes:

combining the game strategies;

calculating the relative difficulty levels of the game strategies and the combined game strategies;

assessing relative dominance depending on results of comparisons between PC and NPC with respect to game status information during the game; and

determining a difficulty level of the game depending on the relative dominance between the PC and the NPC to apply a strategy of the determined difficulty level among the game strategies and the combined game strategies to the game.

20. The method of claim **19**, wherein said assessing relative dominance includes comparing the game status information including at least one of score, physical strength, number of remaining bullets, number of wins, number of kills, and number of remaining troops, between PC and NPC.

* * * * *