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Virtual reality based on intelligent model

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ABSTRACT

Virtual reality is wildly used in computer games, 3D animation, film and advertising. Particle system is an effective method in Virtual reality. However, the particle system uses randomly generated particles and particles attribute to simulate reality, but the real reality particles are often not randomly distributed. The theoretical research of probability theory and random process and practical applications show that the similar normal distribution is the most widely in the actual natural phenomenon and social phenomenon, cloud model is a powerful tool in simulation similar normal distribution, controlling the particles system generate particles and particle attributes based on the cloud mode to simulate the reality is more realistic.

KEYWORDS

Virtual reality; Intelligent model; Particle system; Cloud model; Computer animation.

INTRODUCTION

Virtual reality (VR) is a computer-imulated environment that can simulate physical presence in places in the real world or imagined worlds. Virtual reality could recreate sensory experiences, including virtual taste, sight, smell, sound, touch, etc.

Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced systems now include tactile information, generally known as force feedback in medical, gaming and military applications. Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of telepresence andtelexistence or a virtual artifact either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus, and omnidirectional treadmills. The simulated environment can be similar to the real world in order to create a lifelike experience, such as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, because of technical limitations on processing power, image resolution, and communication bandwidth. However, the technology's proponents hope that such limitations will be overcome as processor, imaging, and data communication technologies become more powerful and cost-effective over time.

Virtual reality is often used to describe a wide variety of applications commonly associated with immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, head-mounted displays, data gloves, and miniaturization have helped popularize the notion.

The possibility exists to make films and television program which are watched with a head-mounted display and computer control of the image so that the viewer appears to be inside the scene with the action going all round. The computer presents the view which corresponds to the direction the viewer is facing, through a system of head-tracking. This would give the viewers the feeling that they are actually going to the scene in person instead of looking at pictures on a screen. The term "virtual space" has been suggested as more specific for this technology, which is described in detail in the article Virtual Space - the movies of the future.

In recent years, Virtual reality such as virtual reality, snow, smoke, fire etc. have been one of the most challenging subject, the simulation are widely used in computer games, television, advertising, visual simulation, tvirtual realitying system, fine art, music, manufacturing, urban design and other areas [1].

In 1983, Reeves proposed a particle system for the first time; the advantage is that you can always use a simple body to structure complex object, it provide a powerful tool of the modeling of natural phenomena. Particle system is an important part of computer animation technology; it is considered the most successful simulation graphics generation algorithm of irregular objects by far [2].

In the particle system, the new particle generation and properties were generally controlled by a random process, the landscape has been defined as thousands of randomly distributed particles which composed of it, however, In the research and practical applications of probability theory and random process theory, the normal distribution is the most important distribution in all probability distribution, which widely exist in natural phenomena, social phenomena, science and technology and production activities [3], in practice, many random phenomena encountered obey or approximately obey the normal distribution, for example, under normal conditions, daily sales amount of a shopping center, random measurement error of Geological Survey, the average water level in the reservoir and so on. In the natural phenomena the virtual reality drops number, size; speed and direction of movement, color, transparency, shape, and life cycle are the similar normal distribution.

Normal distribution is the limiting distribution of many important probability distributions, many non-normal random variables is a function of normal random variables, normal distribution density function and distribution function has a variety of good nature and relatively simple mathematical form, so it is widely used in theory and practice. But many random phenomena cannot be described by a strict normal distribution. If the decision factors to random phenomenon have a certain degree of interdependence, or when alone, are not uniform and small, they do not constitute a normal distribution; can only be described by approximate normal distribution[4][5][6].

Probability theory deal with such situations by joint distribution, but the joint probability distribution usually is very complex and difficult to practice. Cloud model are used to describe such random phenomenon, it extended normal distribution to similar normal distribution, with a new independent parameter - Super entropy, to measure the degree of deviation from normal distribution, this approach is more relaxed than simply normal distribution and simpler than the joint distribution, at the same time they are easy to represent and manipulate.

As the cloud model can produce the similar normal data which are widely distributed in nature, so use cloud model to control the virtual reality particle generation in particle system, and to control the attribute of the virtual reality to generate the change of them the generated virtual reality will be more real, at the same time, changing the cloud model parameters, can change virtual reality particle properties, thus to simulate heavy virtual reality, moderate virtual reality and light virtual reality.

PARTICLE SYSTEM

Particle systems are commonly used for rendering smoke, fog, clouds, etc. But term Particle system can describe modeling techniques as well as rendering techniques or even types of animation. Its definition can depend on the way of application. There are two main criteria for defining every particle system:

Collection of particles – set of one or more particles which can be often presented as graphical primitives (points, lines or polygons), but there's no limitation for object shapes such as school of fish, flock of bird or crowd, where one fish or bird is one particle. Each particle has a set of attributes which can directly or indirectly affect its behavior, position or way of rendering, e.g. position, speed, direction, color or lifetime.

Stochastically defined attributes–random elements which can control some attributes of the particle such as position or velocity. There are usually used some predefined stochastic limits to control random elements, e.g. bounds, variation or function of distribution.

During the particle lifespan, each particle has three phases – generation, dynamics and death.

Using particle system to render scalar field is a little bit problematic, but quite ineffective because scalar field is solid set. There's no need for random behavior or variability. There's also no unpredicted movement of particles. Movement of particles is realized by actualizing set of data in the matrix [7][8].

Main disadvantage of particle system is its complexity and hardware requirements. The best quality of visualization using particle system or systems is reached by non real-time rendering. This is used in many movies, where large and complex particle systems create realistic objects and visual effects. But when such movie is created one frame (picture) could be rendered even tens of hours [9].

Traditional particle system produce particles using random algorithm, the initial properties of particles are randomly determined.

Firstly, particles generated by the random algorithm are Inconsistent with the natural attributes of the virtual reality; natural virtual reality particle properties are very similar to the normal distribution.

Secondly, it is the same way as the fuzzy math, as long as the formula and process is established to generate random numbers, both the algorithm and parameters, once determined, the result of algorithm are the same whenever it run, cannot simulate the real property that they are more stable within the scope of a certain random. The Academician Li Deyi proposed cloud model which combine fuzziness and randomness organically based on fuzzy math and statistics, to study the universal law of uncertainty of human society.

CLOUD MODEL

Cloud model is a qualitative and quantitative conversion model; it combines ambiguity and randomness organically.

Set U is a mathematical domain U={x}, T is the language value associated with the U. μT (x) is a stable tendency random number which expressed the elements x subordination of T concept, subordination's distribution in the domain is known as the cloud [10] [11].

Figure 1 presents a cloud model; cloud mathematical expected curve is its subordination curves from the view of fuzzy set theory. However, "thickness" of the curve is uneven, waist is the most scattered, the top and bottom of the curve are convergent, cloud's "thick" reflects the subordination degree randomness, near to or away from the concept center have smaller subordination randomness, while concept center have the largest subordination randomness, which is consistent with people's subjective feelings.

The digital features of the normal cloud characterized by three values with the expectation Ex, entropy En, hyper entropy He) (see Figure 1), the expected value Ex: the center value of the concept domain, is the most representative qualitative value of the concept, it should be 100% belongs to the concept; entropy En: is a qualitative measure of the concept's ambiguity, reflecting the accepted range values of the concept domain; hyper entropy He: can be described as entropy En of entropy, reflecting the degree of dispersion of the cloud droplets. The normal cloud is the most important cloud model, because various branches of the social and natural sciences have proved the normal distribution's universality. The equation of normal cloud curve:

$$\mathrm{MEC}_{A}(\mu) = e^{-\frac{(\mu - Ex)^2}{2En^2}} \quad (1)$$

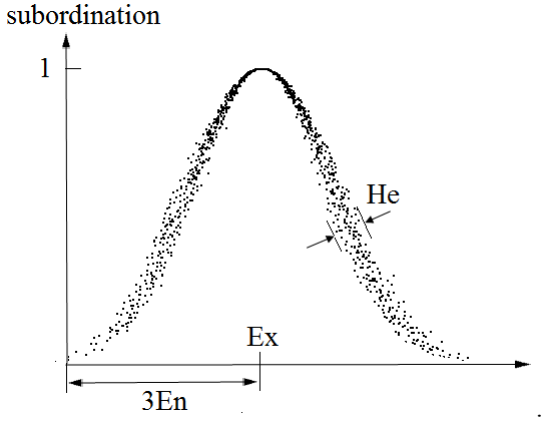

Figure 1 : The digital features of the normal cloud

Expectation curve is a normal curve, for a qualitative knowledge, the elements outside the Ex±3En in its corresponding cloud model all can be ignored, because it has been proved that approximately 99.74% elements of the model fall into the range of Ex±3En by the mathematical characteristics of normal distribution[12].

Thus, use the cloud model to represent the membership function is to determine the digital features of the cloud model, if the concept itself is clear and it is understood consistently by almost all people, you can use smaller En and He. If the concept itself is vague, our understanding is very inconsistent, you can use larger En and He. Trapezoidal cloud curve equations are determined by the expectations and the Entropys are following:

$$MEC_A(x) = e^{-\frac{(x-Ex1)^2}{2En1^2}} \quad (Ex1-3En1<=x<=Ex1)$$

$$MEC_A(x) = 1 \quad (Ex1<=x<=Ex2)$$

$$MEC_A(x) = e^{-\frac{(x-Ex2)^2}{2En2^2}} \quad (Ex2<=x<=Ex2+3En2)$$

Extending the normal cloud model we will get trapezoidal cloud model which is shown in figure 2. Trapezoidal cloud model can be expressed by six values, they are the expected number: Ex1 and Ex2, entropy: En1 and En2, hyper entropy: He1 and He2.

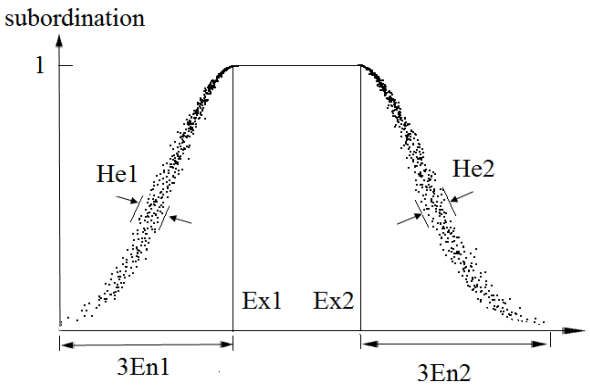

Figure 2 : The digital features of Trapezoidal cloud model

At present, cloud model studies have achieved greater results in theory and application, such as: the cloud model are used in intelligent control, successfully balanced posture conversion on three real-time inverted pendulum; for data mining, achieved the discovery of association rules knowledge, used to simulate the evolution and the fractal nature phenomenon, which explains the 24 solar terms. But the cloud model as a qualitative and quantitative conversion powerful tool in non-deterministic artificial intelligence research has a wider application to simulate and predict normal distribution data in natural phenomena, social phenomena, science and technology,

According to mathematical nature of the cloud model, here we generated initial particle system properties using cloud model generator, instead of the random algorithm, to simulate the natural virtual realityfall more realistically.

CLOUD MODEL GENERATOR

Forward cloud model generator is a mapping from qualitative to quantitative. It is based on the digital characteristics of cloud model to produce droplets, the droplets accumulated to a certain amount to convergence the cloud.

Forward cloud model generator get quantitative data and the scope of distribution from qualitative information which expressed by the language, it is a direct forward process, the input are the expectation Ex, entropy En and hyper entropy He which represent the qualitative concept, and the cloud droplet number N is the input also, the output is the number of cloud droplets in the location domain space of quantitative and every cloud droplets represent the concept certainty.

The data produced by the forward cloud generator belong to the same distribution with the raw data with the three digital characteristics which generated the cloud model, they represents the same similar normal distribution, and use these data to simulate natural phenomena, social phenomena, science and technology normal distribution and production activities, with the advantages of cloud model itself they can combine fuzzy and random organically, it has a better fit in the behavioral characteristics of human society. Can simulate reality better, create realistic simulation.

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Figure 3 Schematic diagram of a forward cloud generator.

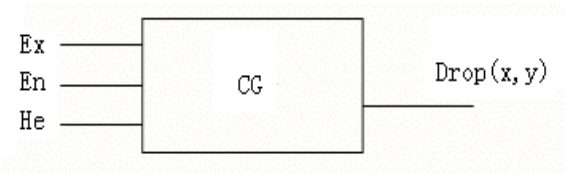

Figure 3: The generator of the forward cloud model

the forward cloud model generator algorithm is as follows:

Algorithm 1: forward cloud model generator algorithm / * Input: cloud model expectations Ex, entropy En and hyper entropy He Output: a collection of cloud droplets ((x1, y1) (x2, y2) ... ... (xi, yi) ... (xn, yn)) * /

{

(1) produce normal random entropy En' with expectation En, MSE He;

(2) Produce normal random number x with expectation Ex, MSE En';

(3) Calculate $y = e^{\frac{(x-Ex)^2}{2En^2}}$

(4) Let (x, y) be a cloud droplet;

(5) Repeat steps 1 through 4, until a required number of cloud droplets produced.

}

IMPLEMENTATION PROCESS

The dynamics of virtual reality shows that we can see the complexity of performance and movement of it. The observation shows that the smallest diameter of virtual realitydrops is 0.5mm, maximum diameter of virtual realitydrops is no more than 6mm, the dynamic features of the different diameter of virtual realitydrops is not same, by the knowledge of physics, the objects fall down from high altitude, will be resisted by air, This resistance are associated with the object size, shape and speed, the greater the speed, the greater the resistance. Meteorite, snow, virtual reality falling from the sky, as long as the high is enough, it will eventually make uniform motion. The process of the virtual raindrops whereabouts are simplified to uniform drop in this paper, based on actual observations, approximately as follows:

Diameter: 0.5mm≤d≤1.5mm, light virtual reality v= 3.8435m/s

Diameter: 1.5mm≤d≤4.0mm moderate virtual reality v= 4.6254 m/s

Diameter: 4.0 mm ≤ d ≤ 6.0mm heavy virtual reality v=9.0 m/s

Based on these observations, cloud model digital features can be determined by the diameter of different virtual reality levels of Ex= (mind + maxd) /2, entropy En=Ex-mind) / 3.

hyper entropy He is entropy of entropy En, if He is small, the random entropy En's change is small, that is each qualitative value of the concept belong to the qualitative concept is almost the same in the eyes of different people; on the contrary, if He is big, random entropy En will change dramatically, that characterized the concept of people belonging to this concept, that is each qualitative value of the concept belong to the qualitative concept is not the same, and they are very different in the eyes of different people. In this way, for a specific cloud droplet, people also do not know the degree to which the concept belongs to. Therefore, in order to reflect the qualitative concept that people have almost the same understanding, while there are some differences, the ratio between En and He usually fall in the range 15 to 40. Hyper entropy He can be determined based on experience or the stability of the virtual drops to simulate He = En/k (15≤k≤ 40). The other attributes can also be concluded through observation, using a similar method to determine one by one.

After the attribute of the virtual drops, snow particles be determined, to operate the particle system in accordance with the principle of particle systems, Particles will be drawn in the window to achieve real-time simulation of virtual reality. Figure 4 is flow chart of particle system to simulate virtual reality.

Particles are alive, their life value is T, in scene, Particles are constantly changing the location, and they continuously decrease the value of life. This value decreases with the particle's whereabouts until the particles reach the ground and then decreases to 0. In the process of virtual reality simulation, particles do not need to dilute, set the dilute value to 0 directly.

Use a particle system to simulate virtual reality, new particle formed and the old particles died constantly, the dead particles should be timely removed from the system to free up system resources.

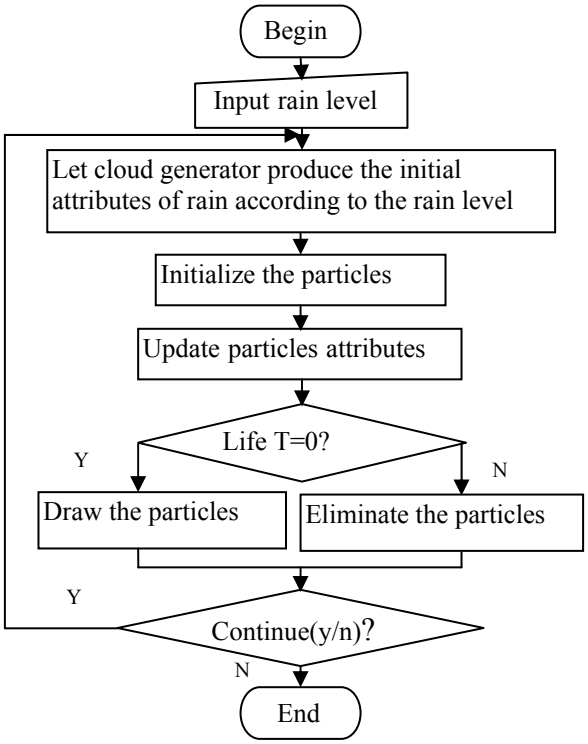

Figure 4: System flow chart

COMPUTER SIMULATION OF A BODY OF PLANTS BASED ON CLOUD MODEL

For the above parameters of cloud model, we can use it to simulate the natural phenomena such as a body of plant, take the basis plant model as the resource, get the height of plants, plant spacing, and deviation from the vertical direct angle, color, etc. set the mean values of above parameters as a cloud model expectations Ex, to definite the cloud model entropy and hyper entropy depending on the circumstances, if the plants and management are good such as farmland, it can give a smaller entropy and super entropy, so the plants grow even, if the farmland management was worse, you can give medium-sized entropy and hyper entropy, to reflect the growth of plants is not very even, if in the wild environment, we have to give greater entropy and hyper entropy, to reflect a very random and fuzzy plant growth phenomena.

Generated a body of plants using this model, even if the three figures of the cloud model are same, the algorithm run at different times will generate a different body of plants, represent the natural randomness phenomena, but the change are not so severe to affect our understanding of the phenomenon, so the method can simulate natural scenes vividly.

Simulation algorithm is given below.

Algorithm 1: Simulation Algorithm

/ * Input: plant model, the mean values of the plant height, plant spacing, the angle of deviation from vertical, the color of the model and the cloud model entropy En and hyper entropy He
Output: the simulation of the body of plant based on the cloud model * /

{

(1) Take the mean values of plant height, plant spacing, the angle of deviation from the vertical direction, the color as the clouds model expectations Exi;

(2) Generated normal random entropy Eni based on the expected value Eni, the mean square Hei;

(3) Generated normal random number Xi based on the expected value the Exi, mean square Eni;

(4) Take Xi as a plant model and draw the plant;

(5) Repeat steps 1 through 4, until all plants generated.

}

Using this algorithm with the same plant model, only change En and He of the method created the simulation scenarios are as follows:

For more uniform plants, we can take the original model parameters as the algorithm Ex, En and He take smaller values, and we generate more uniform plants in figure 5.

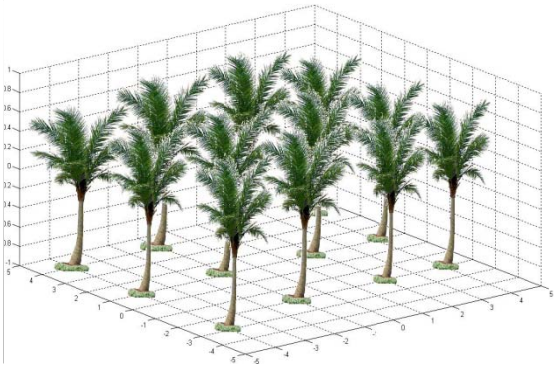

Figure 5: The more even plants generation

En and He are 0.2 and 0.01. En selection can consider the nature of the normal distribution, that is about 99.74% in all values with the same distribution of the x fall into the range [Ex-3En, Ex +3En], we can approximately take the Ex-3En as a probability distribution X minimum, Ex+3En as the maximum value of the probability distribution of X, En is one-sixth of the difference between Xmax and Xmin, so to further improve the algorithm's Adaptability.

The uniform plants generated in figure 6, the algorithm's En and He take 0.4 and 0.08. Of course, we can continue to let these two parameters become larger, and get the plants which distribute more unevenly.

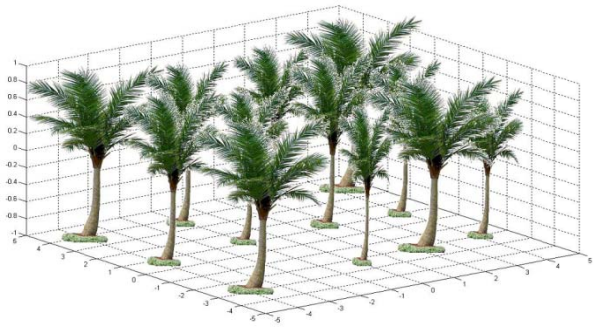

Figure 6: The more uneven plants generation

CONCLUSION

Irregular objects simulation based on particle system is a complex subject, the virtual reality simulation proposed in this paper considered the system simulation fidelity, although the fidelity of the method have achieved some results, However, the physical simulation model used is relatively simple and does not consider the virtual reality under complicated meteorological conditions, features. The work in the future could take these factors into account, to achieve more realistic virtual reality simulation

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