Research on Simulation System of Rubber Particle Mat Based on Web Technology

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Abstract. The current design of rubber granular floor mats is limited to a single fixed plane sample drawing, and it consumes a lot of time, manpower and material resources in obtaining customer design requirements. In response to this situation, the use of Web development technology to realize the free combination of particles in proportion, generate simulation application scenarios, provide interface operations, and finally complete the order process. By constructing a particle probability distribution model, establishing a particle position coordinate matrix, and developing a particle mat simulation system, based on the sample quality of the sampled data, it is compared with the real artificial mechanical product. Finally, by mixing and matching 9 different color values according to the industrial production ratio, randomly combining 10 groups and comparing with the real products of the same color ratio, quantifying the color difference, contrast, and particle position offset to obtain the production simulation floor mat sample and the actual product. The finished product is quite close. The system generates simulated particle mat maps and real sample maps with a high degree of simulation, and provides an interface that allows users to directly match the particle combination program that suits their needs, saving labor cycles and improving work efficiency.

Keywords: Rubber Particle Mat, Web Technology, Simulation System

1. Introduction
The characteristics of rubber floor mats are that they have a certain degree of softness and rigidity, which can reduce falls and have anti-slip functions, and can match different types of floor mats according to the matching ratio of different colors of particles and particles, which is suitable for indoors. Fitness places, office places, restaurants, houses and bedrooms are also suitable for outdoor places[1]. With the development of urban construction, the demand for rubber floor mats is increasing, and there are more and more manufacturers of floor mats. However, for designing the pattern of floor mat particles and adapting to different places, it is necessary to adjust the color The collocation and the proportional distribution of the particles are designed. Due to the different styles of different places
and application fields, a large number of designers are required to understand the needs of different customers, and tailor the design of the pattern of the granular floor mat. The problem with the general film is that the intermediate link needs to be repeatedly confirmed with the customer. Only by designing particle patterns can truly meet the customer’s needs[2]. This is also a crucial step in the production process, and it is tedious and time-consuming. In order to solve this problem and improve production efficiency, Singapore’s Rephouse company first developed a web-based online particle mat design program, and took the lead in converting the traditional offline manual work on customer needs to an independent matching design for Internet online customers[3].

The new model, with its powerful functions, support for designing and matching schemes in different scenarios, beautiful interface style, simple and easy operation, submission of user needs and information, etc., has always been in a leading position in the foreign particle floor mat industry. However, this application has several advantages. The problem is that there is a certain gap between the generated particle pattern and the actual particle pattern. In China the production of granular floor mats is still in the development stage, still staying in the traditional offline manual mode of customer demand, and the design-to-production period is long. Therefore, the research and development of web-based on-line design particle floor mats has its practical significance and broad application scenarios.

2. Key technology

2.1. Particle sampling sample analysis

2.1.1. Analysis from the appearance of the particles. The particles are irregular polygons [4], the particle size is measured by the equivalent particle size [5], the smallest particle size is 0.9mm, the largest particle size is 6mm, according to the existing industrial material colors, purple, beige, orange-red are available, Ocean green, turquoise, dark sky blue, light coral, beige, light blue, light green, saddle brown, sand brown, golden yellow, off-white, rose brown, dim gray 16 colors, the corresponding numbers of the colors are respectively They are caty01, caty02, caty03, caty04, caty05, caty06, caty07, caty08, caty09, caty10, caty11, caty12, caty13, caty14, caty15, caty16.

2.1.2. Particle distribution analysis. This paper uses the tabular method [6] to analyze the color distribution interval of the particles. Since the particle distribution of the real sample is found and the rule of setting the color parameter ratio, the particle distribution is probabilized, and the actual color particle number is $N_i$, i is the color, the total particle number is M, the actual ratio $P_i = \frac{N_i}{M}$, and the desired color ratio $\hat{P}_i$, The distance error is $d_i = |P_i - \hat{P}_i|$, the error distance of the sample is $D_k = \frac{\sum_{i=1}^{n} d_i}{n}$, k is the sample, and n is the number of colors. This time, 50, 30, and 20 samples of 2, 3, and 4 color collocations are analyzed respectively, and the average error distance of each color collocation scheme is $\bar{D} = \frac{\sum_{k=1}^{m} D_k}{m}$, and m is the number of samples. The analysis is shown in Table 1 below.

| Number of color types | Number of samples | Mean error distance |
|-----------------------|-------------------|---------------------|
| 2                     | 50                | 0.0385              |
| 3                     | 30                | 0.031               |
| 4                     | 20                | 0.0341              |
It can be obtained that the set color ratio is basically the same as the color ratio of the real sampled particles. It is found through research that the reason for the error distance is that during the processing of the granular floor mats, impurity is doped due to process technology or external factors.

2.2. **Build The Probability Of Color Particles**

Different particle colors have different proportions. A combination of particle mats requires a total of 100% of the proportions of different colors, such as red 10%, blue 25%, and black 65%. The total proportion of matching is exactly 100%. Since various colors do not appear in equal proportions, it is necessary to design and construct a probability distribution pattern of different color particles[7]. In this paper, an \( n \times m \) two-dimensional array is used, which is equivalent to \( n \times m \) independent events, one random event is performed in each unit, and particles of different colors are randomly selected, and \( c \) is the color value, \( N_c \) is the number of \( c \) color values, \( S \) is the total number of all color values, \( S = \sum N_c \ll (n \times m) \), \( S \in N_c \). The probability of randomly selecting the color value \( c \) is:

\[
p(c) = \frac{N_c}{S}.
\]

(1)

Analyzing from the perspective of memory, the proportion of different colors is used to occupy the number of cells in the memory, and a continuous cell space is created with the help of an array[8]. For example, 10% red occupies 10 cells in an array of length 100, 25% blue occupies 25 cells in the array, and 65% black occupies 65 cells in the array. The color value array distribution is shown in Figure 1.

![Figure 1. The original image](image1.png)

When extracting color values, this article uses equivalent random numbers to generate values from 0 to 99. In the above-mentioned array of length 100, the array elements are randomly accessed. The more cells a certain color value occupies, the more visited The probability of will be relatively larger[9]. On the contrary, the fewer the number of array cells occupied, the less the probability of being visited.

2.3. **Build The Particle Position Coordinate Matrix**

Observing the samples of real particle mats, we can find that the distribution of particles has randomness, discreteness, and overlapping effects, and they are scattered on the pattern according to the proportion of the color, and the color with a large proportion is used as the background color and other characteristics[10]. First of all, the randomness of particle distribution. In this paper, particles are randomly distributed on the interface according to the proportion of different colors, and a matrix is designed \( A_{mw} \), the scale is \( m \times n \). In the process of traversing the array, in the particle probability distribution model \( \alpha \) in the random selection, and the extracted color value \( C_k \) which is saved in the matrix \( A_{mw} \), then it can show the randomness of the \( A_{mw} \) appearance of different colors with a certain probability of appearance. The second point is the discreteness of particle distribution. Design a distance value \( \lambda \), control the distance value within a certain range, and randomly extract a certain value to prevent adjacent cells from appearing the same color value. The third point is the overlapping effect of particle distribution[11]. If there is a particle pattern for each cell, the particle distribution map that appears in this way will be very neat, and the particle pattern will also be limited to each cell. This is the same as the actual effect map. The effect of overlapping particles varies greatly, as shown in Figure 2.
Therefore, the elements in the matrix $A_{m,n}$ are set to $(C_{k}^i, p_x^i, p_y^i)$, the parameter value $p_x, p_y$ is the coordinate value $p$, and the coordinate interval is $\tilde{\sigma}, i < n, j < m$, and the calculation formula for the sum is:

$$
p'_x = p_{x,i-1} + \tilde{\sigma}
$$

$$
p'_y = p_{y,j-1} + \tilde{\sigma}
$$

Set random offset variable $\Delta p_x$ and $\Delta p_y$, the coordinate value:

$$
p = (p_x \pm \Delta p_x, p_y \pm \Delta p_y)
$$

The random offset $\Delta p$ is added to realize the offset amplitude of $p_x$ and $p_y$, so that the adjacent particle patterns have a random overlapping effect. The schematic diagram of the model is shown in Figure 3, and the simulation effect is shown in Figure 4.

![Figure 2. Original map of particle distribution](image1.png)

![Figure 3. Particle coordinate model](image2.png)

![Figure 4. Particle coordinate offset model diagram](image3.png)

2.4. Server-Side Model Processing Algorithm

The server program mainly realizes that according to the color ratio parameter, the probability distribution array is constructed as a data pool, and the particle distribution matrix is built. In this process, if the same color is close, the frequency of the same color is controlled according to the color distance coefficient, and then the coordinates are randomly shifted. Algorithm 1 is the step of constructing the color array, algorithm 2 is the step of generating the particle distribution matrix, and algorithm 3 is the step of the coordinate processing of the particle distribution matrix.

| Algorithm 1 | Realize the construction of the array color |
|-------------|-------------------------------------------|
| **Input**   | Color ratio array cary                     |
| **Output**  | Probability distribution array             |
| 1            | begin                                      |
| 2            | for c in cary do                           |
| 3            | /*Convert the ratio data of c into quantitative data*/ |
| 4            | n=c.data.ToQuantization()                 |
| 5            | C=c.colorVal /*Color value*/              |
| 6            | while i<n                                 |
| 7            | i++                                       |
| 8            | color[i]=C                                |
| 9            | end                                        |
| 10           | return color                              |
| 11           | end                                        |
Algorithm 2  
Realize the generation of particle distribution matrix

| Input | Color array color |
|-------|-------------------|
| Output| Particle distribution matrix |

1. begin
2. Construct a two-dimensional array A, scale m×n
3. row ←m,col←n /*Define the row and column values*/
4. priodColor←A[0][0] /*Store the last color value*/
5. d←0  /*Same color distance value*/
6. for x←0 to row do
7.   d←Generate random numbers from 0 to 3
8.   for y←0 to col do
9.     temp←Randomly draw color values
10.    if --d>0 and priodColor=temp
11.     temp←Randomly draw color values
12.    else
13.       A[x][y]←temp
14. end
15. end
16. return A
17. end

Algorithm 3  
Coordinated processing of particle distribution matrix

| Input | Particle Distribution Matrix A |
|-------|--------------------------------|
| Output| Coordinated particle distribution matrix |

1. begin
2. row ←m,col←n /*Define the row and column values*/
3. d←0  /*Coordinate spacing*/
4. for x←0 to row do
5.   for y←0 to col do
6.     Define the object ht of Hashtable<colorval,vector>
7.     deltPx←Get random number, -2 to 2
8.     deltPy←Get random number, -2 to 2
9.     px←(px+d*y+deltPx)
10.    py←(py+d*x+deltPy)
11.    vector←(px,py)
12.    ht[A[x][y]]←vector;
13.    A[x][y]←ht
14. end
15. end
16. return A
17. end

3. Web-based Rubber Particle Mat Simulation Application Experiment
In the system application, in order to allow users to use the application generator anytime and anywhere through the web browser, it is designed as a web application, and for easy operation, the color map of the real particles is implemented on the interface, so that customers will be more
Understand the shape and characteristics of the particles, and add the color addition and subtraction buttons to facilitate the user to control the color ratio. At the same time, the step-to-guide operation is added. The customer only needs to follow the steps to get the desired particle mat pattern sample. Next to the example, generate a simulation diagram of the application of the particle mat to the real scene. Just click Submit Order, and the information interface for the user to fill in and submit the order will pop up on the current interface to complete the final operation. The following are the system’s color selection interface, simulation interface generation, and order submission interface.

The effect of the sample map of the particle mat generated by the system is verified. The simulation example generated by several sets of data ratio parameters is compared with the particle template produced by the real artificial process. The comparison is shown in Table 2.

### Table 2. Experimental sample

| Test items | purple | beige | red | green | turquoise | blue | coral | blue | green |
|------------|--------|-------|-----|-------|-----------|------|-------|------|-------|
| Test1      | 0.8    | 0.21  | 0.23| 0.38  | 0.84      | 0.65 | 0.88  | 0.57 | 0.35  |
| Test2      | 0.43   | 0.65  | 0.27| 0.64  | 0.65      | 0.87 | 0.99  | 0.28 | 0.5   |
| Test3      | 0.97   | 0.44  | 0.28| 0.69  | 0.52      | 0.69 | 0.88  | 0.93 | 0.2   |
| Test4      | 0.44   | 0.49  | 0.28| 0.18  | 0.83      | 0.86 | 0.62  | 0.37 | 0.22  |
| Test5      | 0.31   | 0.86  | 0.23| 0.8   | 0.17      | 0.41 | 0.4   | 0.83 | 0.22  |
| Test6      | 0.23   | 0.8   | 0.76| 0.32  | 0.84      | 0.32 | 0.16  | 0.61 | 0.39  |
| Test7      | 0.46   | 0.68  | 0.82| 0.35  | 0.6       | 0.48 | 0.3   | 0.99 | 0.22  |
| Test8      | 0.74   | 0.68  | 0.97| 0.58  | 0.28      | 0.27 | 0.26  | 0.59 | 0.9   |
| Test9      | 0.24   | 0.17  | 0.43| 0.66  | 0.8       | 0.85 | 0.34  | 0.38 | 0.6   |
| Test10     | 0.74   | 0.81  | 0.46| 0.31  | 0.16      | 0.69 | 0.47  | 0.84 | 0.54  |

The samples generated based on the above 15 sets of test data items are compared with the samples produced by real artificial machines in terms of color difference[12,13], contrast, and particle offset, as shown in Figure 5. Comparing the sample particle floor mats generated by the test data with the real artificial particle floor mat samples, it is found that the data from each index are quite close.

**Figure 5.** Comparison of samples and physical indicators

### 4. Conclusion

This article mainly studies and analyzes the composition law of particle mats, and analyzes the key technologies and implementation algorithms of particle distribution. Based on the Web environment, it realizes more efficient and friendly presentation of data to users in the form of web pages, and in terms of operation, design. Based on the guidance method, the user is gradually guided to use the operation,
making the system suitable for most users to operate easily. The research results can help manufacturers of granular floor mats, directly obtain the user’s design requirements, save labor cycles, and improve work efficiency. Therefore, the research and development of a particle mat simulation system based on Web technology has its practical significance and broadness. Application scenarios.

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