Color Mapping Studies of the Meteorological Data

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Abstract. The meteorological data color mapping method is proposed according to the type, spatial frequency characteristics of the meteorological data as well as the human perceptual awareness and color theory. The specific color mapping step of high and low spatial frequency meteorological data have been given respectively. The results show that this method can provide a scientific and artistry color mapping for meteorological data.

Introduction

In meteorological information visualization system, the meteorological data is converted into the image which can stimulate people's thinking in images, one of the most common operations is the color map, which uses color indicates the meteorological data information.. a successful color mapping enables users to recognize the inherent complexity of the meteorological data regularly and accurately and recognize the intrinsic links between meteorological elements.

At present, in most of the meteorological information visualization system, color mapping created and choice are not under full attention. Some meteorological information visualization system can provide users with the default color map, one of the most common is the color spectrum map (also known as the rainbow color map), is by keeping color saturation and brightness is consistent, change the color gradient. And some meteorological information visualization system to create color mapping tools, independent control of color mapping by the user. Although these tools can create commonly at present commonly used color mapping, but for users, which is color map can help the accurate understanding the distribution of meteorological data structure, highlight the important features of meteorological data, may be lost.

Based on the meteorological data types, spatial frequency characteristics as the basis of theory of human perception, color into the color mapping scheme design, realized the meteorological data to compare the color mapping method of science. The experimental results show that the design scheme is feasible, raised in the visual system to identify judgment, quickness and accuracy of meteorological data.

The Design Theory of Meteorological Data Color Mapping

The data type

According to Lawrence d. Bergman and Bernice e. Rogowitz related research found that the measurement theory is described in the data type of the data for performance characteristics have important influence. In measuring theory basically have the following four data types [1].

(1)nominal data: According to the characteristics or attributes of different things, give different names, as a kind of tag, which can be characteristics or attributes of the same things into categories.

(2)ordinal data: Arranged in order for data according to the size, characteristics or attributes of thing, In rank or order arrangement, compare the tester’s position, but can’t reflect the specific gap between about status.

(3)interval data: For the change process is continuous things, reflected in the numerical value is also continuous, interval data is a group to digital representation based on this, the unit of measurement, continuous value can be addition and subtraction.

(4)ratio data: This data type can not only add and subtract, also can make, excellent numerical between equal proportion.

The analysis of a large number of meteorological data, meteorological data found mainly belongs to the interval data, such as pressure, temperature data (data unit C), and the ratio data types, such as temperature data (unit of Kelvin K), precipitation data. These two data types belong to the quantitative data, the information provided is more, function is relatively large, and the nominal data and sequence data belong to the qualitative data. Different data types have different characteristics. color mapping is therefore suitable for they also have different characteristics. In most cases, the image of meteorological data obtained from perceptual discrimination mainly depends on whether the accurate expression of the color mapping the distribution structure of meteorological data, therefore for equidistant data, should maintain the continuity of this data type, color mapping and then design for this goal should follow the equal distance of the meteorological data should be and color the perceived distance equal to maintain consistent, namely the meteorological data value and perceived magnitude relationship between. Proportional data should also be the case, but at the same time, also need to pay attention to emphasize visual outstanding zero points, because meteorological data value from the point of demarcation began to increase and decrease.

Spatial frequency characteristics of meteorological data.

Human's color perception mainly by saturation, brightness scale. Through the spatial visual characteristics of the human, high spatial frequency information processing is responsible for the human visual system is the main luminance channel [2]. Such as high spatial frequency variable in Figure 1, you can see color brightness scales are more likely to carry the data information; colors (saturation) of low spatial frequency variable scale tend to carry the data information, which means that in a color mapping, brightness and color tone (saturation). The balance depends on the spatial frequency in the meteorological data.

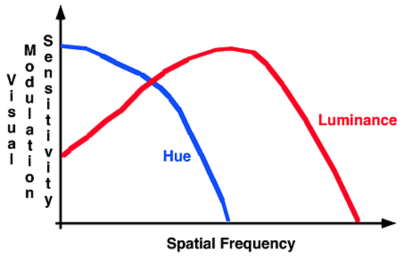


Figure 1 different sensitivity to spatial frequency for hue saturation and luminance

Mapping Principle

From the above analysis, the color mapping is generated by saturation or brightness on the whole. When mapping equal distance of the meteorological data should be consistent with color perception distance equal, the mapping style aims to enable mapping color can express continuous distribution and structure of data [3][4] .

If the meteorological data is consist of low spatial frequency, then mapping melody master is controlled by the change of saturation color. Due to the color matching principle, unity and variety of organic to maintain harmony, can be full of vitality of the situation, experience, so for this type of weather data using color mapping, the overall brightness is unified change, started by the central position of the color saturation mapping hue for equidistant data mainly adopts the color of opposites, for proportional data mainly adopts the complementary color of or opposition.

If the meteorological data mainly contains the high spatial frequency, then by luminance changes to master the color mapping hue. For equidistant data requirements, the brightness is increasing. The data are consistent with the proportion, color mapping design scheme above low spatial frequencies, color saturation is also the central location of, by color mapping began to increase to two monotone, but the brightness is not fixed, but increasing.

The Steps of Color Mapping for Meteorological Data

In the visual programming, mainly is the rectangle by drawing a plurality of having different colors, its split superimposed to form [5]. The following is the specific steps in two different spatial frequency data for color mapping.

Color mapping of low spatial frequency in meteorological data

Meteorological data field color map contains low spatial frequencies to achieve such as shown in figure 2.

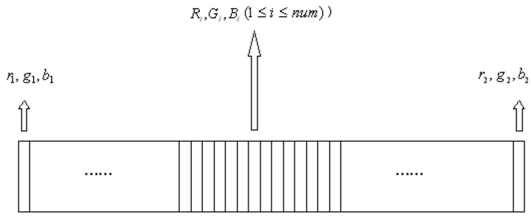


Fig. 2 Color mapping scheme of low spatial frequencies

Which R_i, G_i, B_i is the color value of rectangular i； num is the total number of components; r_1, g_1, b_1 is used as color mapping the starting color RGB value; r_2, g_2, b_2 is RGB value, assuming end scale color corresponding meteorological data set minimum value.

The relationship between these two colors can be represented by the type three: $r_1 + r_2 = 1.0$, $g_1 + g_2 = 1.0$, $b_1 + b_2 = 1.0$.

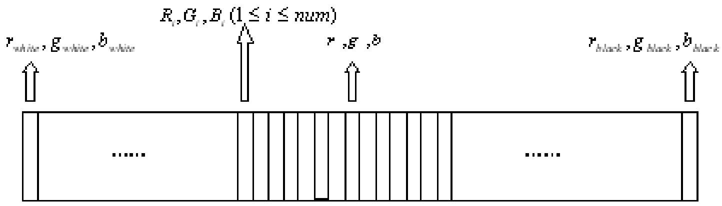
Because the brightness of this color mapping scheme is fixed, so the start and end of the two color choice of black and white. The rectangular block specific colors color mapping is obtained by calculation(1)

$$\begin{cases} R_i = r_1 + (r_2 - r_1) * (i-1)/(num-1) \\ G_i = g_1 + (g_2 - g_1) * (i-1)/(num-1) \qquad i = 1,2,3,\ldots num \\ B_i = b_1 + (b_2 - b_1) * (i-1)/(num-1) \end{cases} \tag{1}$$

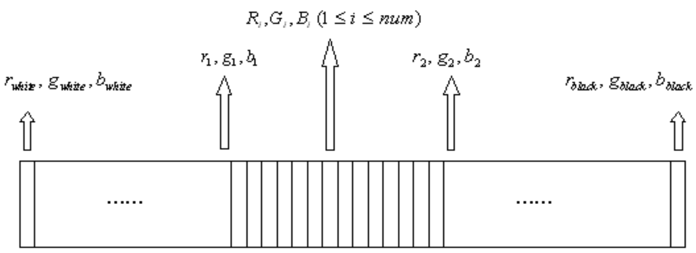
Color mapping of high spatial frequency in meteorological data

High spatial frequency of Meteorological data field 's color mapping is shown in figure 3. The (a) is to realize the mapping scheme using a single hue, the color mapping is composed of two parts, one part is made of white (brightness =1) gradual change to a color choice, the other part is composed of the color gradient to black (brightness =0).

Which R_i, G_i, B_i is the color value of rectangular I , num is the total number of components; num_1 is the number From the middle hue fades to white rectangular number occupied $num_1 = num/2$; $r_{white}, g_{white}, b_{white}$ is the RGB values of starting color (white), assuming the maximum brightness scale corresponding to the meteorological data set maximum; $r_{black}, g_{black}, b_{black}$ is the end color, assuming the minimum brightness corresponding meteorological data set minimum is selected; r, g, b is hue RGB value, also can no set, if not set is the gray color mapping. The rectangular block specific color is obtained by (2) (3).



(a) single hue



(b) The two hue

Fig. 3 Color mapping scheme of high spatial frequencies

$$\begin{cases} R_i = r_{white} + (r - r_{white}) * (i-1)/num \\ G_i = g_{white} + (g - g_{white}) * (i-1)/num_1 \qquad i = 1,2,\ldots num_1 \\ B_i = b_{white} + (b - b_{white}) * (i-1)/num \end{cases} \tag{2}$$

$$\begin{cases} R_i = r + (r_{black} - r) * (i - num_1 - 1)/(num - num_1 - 1) \\ G_i = g + (g_{black} - g) * (i - num_1 - 1)/(num - num_1 - 1) \qquad i = num_1 + 1, \ldots\ldots num \\ B_i = b + (b_{black} - b) * (i - num_1 - 1)/(num - num_1 - 1) \end{cases} \tag{3}$$

Graph (b) is the use of two hue mapping scheme, if the weather data belonging to the equidistant data types, which is the hue are smaller; if belong to the proportion of data, which is the complementary color or opposition. The color mapping is composed of three parts, the first part is made of white (brightness =1) gradient to the first hue, the second part is composed of the color gradient to second colors, the third part is composed of second color gradual change to black(brightness =0).Which R_i, G_i, B_i is the color value of rectangular i ; num is the total number of components; num_1 is the number From the middle hue fades to white rectangular number occupied $num_1 = num/2$, $r_{white}, g_{white}, b_{white}$ is the RGB values of starting color (white), assuming the maximum brightness scale corresponding to the meteorological data set maximum; $r_{black}, g_{black}, b_{black}$ is the end color , assuming the minimum brightness corresponding meteorological data set minimum is selected; r, g, b is a hue RGB value, also can not set, if not set is the gray color mapping. The rectangular block specific colors is obtained by (4)(5)(6).

$$\begin{cases} R_i = r_{white} + (r - r_{white}) * (i-1)/num \\ G_i = g_{white} + (g - g_{white}) * (i-1)/num_1 \qquad i = 1,2,\ldots num_1 \\ B_i = b_{white} + (b - b_{white}) * (i-1)/num \end{cases} \tag{4}$$

$$\begin{cases} R_i = r_1 + (r_2 - r_1) * (i - num_1 - 1)/(num - num_1 - num_2) \\ G_i = g_1 + (g_2 - g_1) * (i - num_1 - 1)/(num - num_1 - num_2) \quad i = num_1 + 1, \ldots\ldots num - num_2 \\ B_i = b_1 + (b_2 - b_1) * (i - num_1 - 1)/(num - num_1 - num_2) \end{cases} \tag{5}$$

$$\begin{cases} R_i = r_2 + (r_{black} - r_2) * (i - num + num_2 - 1)/num_2 \\ G_i = g_2 + (g_{black} - g_2) * (i - num + num_2 - 1)/num_2 \qquad i = num - num_2 + 1, \ldots\ldots num \\ B_i = b_2 + (b_{black} - b_2) * (i - num + num_2 - 1)/num_2 \end{cases} \tag{6}$$

Test Results

Color mapping design procedure proposed above can be encapsulated into a class, by directly calling the meteorological information visualization system. In the visual system, the meteorological data in a 3D box display, the three axes of the three-dimensional frame representing the latitude (X axis), longitude (Y axis), pressure (Z axis), the respective axes is latitude 0 degrees to 60 degrees, the east longitude 60 degrees to 140 degrees, from 1000 to 20000 PA. The temperature data this paper selected field is located in the 83448 PA on isobaric surface, temperature unit is Kelvin (K), which belongs to the scale of data. The data field in accordance with the above steps of color mapping implementation. Figure 4 and figure 5 is a map of these two kinds of color mapping scheme to achieve the temperature data obtained in the field.

As can be seen in figure, two different design scheme based on spatial frequency, because of the following reasons, color selection of all red and blue.

Through the comparison we can infer the color mapping scheme, the data of temperature field is more suitable to adopt the low spatial frequency, which is to obtain the features of temperature data field smooth variation and the characteristics of different perception of their own conclusions based on scale.

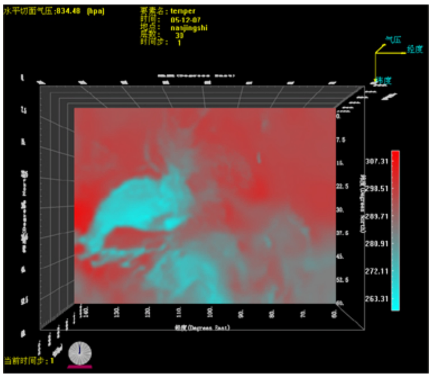


Fig. 4 Low spatial frequency color temperature data mapping

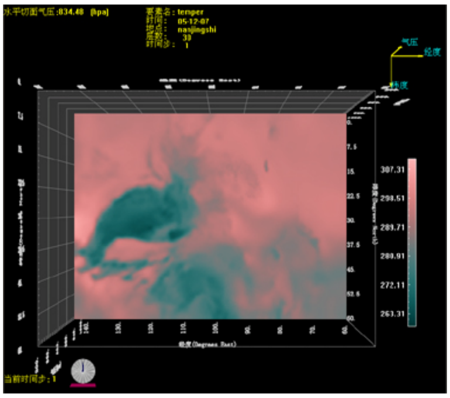


Fig. 5 high spatial frequency color temperature data mapping

Conclusion

Based on fully considering the types of meteorological data, spatial frequency characteristics of meteorological data and related color mixing principle, puts forward the design scheme is applied to the meteorological data of color map. Through the implementation of the wind data field, it can be seen that the proposed color mapping scheme is feasible, it and can Improve insufficient which the existing two kinds of design methods to create a valid color mapping that reflects the important characteristics of the data, satisfy the actual needs.

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