Image interpolation of gas concentration based on Google Earth

Yao Chen¹, Xiaoning Chen²*
¹School of Electrical Engineering and Automation, Anhui University, Hefei, China
²School of Electrical Engineering and Automation, Anhui University, Hefei, China

*Corresponding author e-mail: 1425741195@qq.com

Abstract: This study is based on the actual measured value of NO₂ gas concentration. The gas concentration of nitrogen dioxide is studied in a more intuitive way. Through some specific methods of data processing, get the ideal RGB diagram. This paper generates RGB diagram based on Google Earth function library. Three interpolation methods are applied to interpolate the image. By comparison: The three spline interpolation method is more effective in data interpolation. Satisfying gas concentration detection. The need for image processing effect. Therefore, The three spline interpolation method can be applied to the RGB diagram of gas concentration.

1、Introduction

Google earth (Google Earth, GE) is a Virtual Earth software developed by Google Corporation. Launched in 2005. As an important part of geographic information technology, Google Earth is an important way to implement the core quality of geographic disciplines, as well as a good tool for spatial analysis of geographic data and exploration of geographic issues[1]. Google Earth's visual analysis of geographic data is an important way for us to process images[2].

NO₂ gas is the main component of acid rain. Air pollution in China is becoming more and more serious, which brings about very serious environmental problems. In order to reduce air pollution, the first task is to detect the toxicity, so as to take effective remedial measures. The existing detection methods of NO2 gas include spectrophotometry, chemiluminescence, potentiostatic electrolysis and differential absorption spectroscopy.[3]

In the visible spectrum of the human world, many spectra are composed of three primary colors: red, green and blue. The three primary colors are also related to hue and saturation.[4] Therefore, it is very important for color analysis of spectra. Interpolation is the process of randomly selecting a research point, taking it as the research object, and calculating the optimal value around the point by corresponding functions.[5] There are many kinds of interpolation methods. We need to choose the most suitable method according to our own experimental content, so as to achieve the best
experimental results. The interpolation methods include Lagrange interpolation, Newton interpolation, Hermite interpolation, three spline interpolation and so on. The interpolation methods include Lagrange interpolation, Newton interpolation, Hermite interpolation, three spline interpolation and so on.

2. Experimental Principle

2.1 Lagrange polynomial

Lagrange interpolation defines a function \( y = f(x) \) on the \([a, b]\) intervals. The function values corresponding to each point in this interval are the basis functions that can construct interpolation polynomials.

\[
L_k(x) = \prod_{j=0}^{n} \frac{(x-x_j)}{(x_k-x_j)} = \frac{(X-X_0)(X-X_1)...(X-X_{k-1})(X-X_{k+1})...(X-X_n)}{(X_k-X_0)(X_k-X_1)...(X_k-X_{n})}
\]

Obviously, the basis functions of Lagrange interpolation polynomials satisfy.

\[
L_i(x_j) = \ell_{ij} = \frac{\prod_{i\neq j}^{n} (i, j, 0, 1, 2,..., n)}{j, i, n}
\]

Therefore, Lagrange’s interpolation polynomials are

\[
L(x) = \sum_{k=0}^{n} L_k(x)x_k
\]

Among them, \( L_k(x) \) is the basis function of interpolation polynomial, \( x_k \) is the interpolation point, and the remainder of Lagrange interpolation can be obtained by relevant theorems.

\[
w_n(x) = \frac{g^{(s=1)}(\lambda)}{(s+1)!} \prod_{i=0}^{n} (x-x_i) \quad (\lambda \in [a, b])
\]

The essence of Lagrange interpolation is polynomial interpolation. In short, it is to construct a smooth curve with the smallest number of polynomials. To some extent, Lagrange interpolation can solve quite a number of problems.

2.2 Newton interpolation

Newton interpolation has no inheritance from Lagrange interpolation. When interpolation nodes are added, it is necessary to calculate one item and get the corresponding difference polynomials. According to the uniqueness of interpolation polynomials, the two are different expressions of the same interpolation polynomials.[6] This experiment mainly uses Newton interpolation method, which is calculated by differential quotient. The Newton interpolation is deduced as follows: Given function \( f(x) \), an interpolation node is \((x_a, y_a), a=1, 2, ..., M\), \( f(x) \) has the following definition: \( f(x) \) has zero order difference quotient \( x_a \) at \( f(x_a) \). He first order difference of \( f(x) \) at point \( x_a \) and \( x_b \) is
\[ f(x_a, x_b) = \frac{f(x_a) - f(x_b)}{a - b} \]

\( f(x) \) has two orders of difference at point \( x_a, x_b \) and \( x_c \). Based on the above reasoning,

\[ f(x_a, x_b, x_c) = \frac{f(x_a, x_c) - f(x_b, x_c)}{c - b} \]

Based on the above reasoning, the \( a \) order difference of \( f(x) \) at the point is:

\[ f[x_{a}, x_{b}, \cdots, x_{a}] = \frac{f[x_{a}, x_{b}, \cdots, x_{a}] - f[x_{b}, x_{a}, \cdots, x_{a}]}{x_{b} - x_{a}} \]

The higher the number of nodes and the higher the number of nodes, the better the approximation of real data.[7] This is not exactly the case. When the number of interpolation reaches a certain level, many problems will be exposed, so it is very important to choose the appropriate number of interpolation.

2.3 Three spline interpolation method
Cubic spline interpolation uses piecewise low order multiplicity to approximate functions, and can satisfy the requirements of smoothness without giving the derivatives at each node.[6] In addition to the function values at each node, only the derivative information at two boundary nodes is needed. set up:

\[ a \leq x_0 < x_1 < \cdots < x_{n-1} \leq b \]

The corresponding function values can be obtained.

\[ y_0, y_1, \cdots, y_{n-1} \]

So the three degree polynomial can be obtained.

\[ Z(x) \in D^2[a, b] \]

This three polynomial must satisfy three requirements: There is a continuous derivable second-order function in the interval, and there is no polynomial with more than three times in each partition.

3. Data Processing
According to the measured concentration of nitric oxide, three concentration ranges are divided, and the corresponding color values of different concentrations are imported into Google Maps to form a gas concentration map. The graph is a part of measured gas concentration and corresponding longitude and latitude map.
The results of the three interpolation methods are as follows:

**Figure 1.** Lagrange polynomial

**Figure 2.** Newton interpolation

**Figure 3.** Three sample interpolation method

Finally, the RGB map, which is simulated by the three interpolation method, is imported into Google earth to get the final effect map.

**Figure 4.** Google earth
4. Conclusion
This paper is based on the Google Earth function library as a tool to generate pictures. According to the specific data in the actual project, Different interpolation methods are used to process the image effect. Through comparison, it is found that the effect of cubic sample interpolation method is more obvious. The results showed that: The cubic sample interpolation method has obvious advantages in image interpolation effect, and can fully meet the requirements of image effect in practical engineering teams.

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