Application of magnified BP algorithm in forecasting the physical changes of ancient wooden buildings

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Abstract

CA using neural network model of ancient buildings to predict changes in the physical properties of Applied X-ray detector collection of ancient buildings grey wood elements, so that the ancient wooden building components of each pixel grayscale and Neural Network CA model correspond to each cell, using the CA model "grey" concept learning through the improved BP Algorithm to calculate the grey value of each cell changes, so as to arrive ancient architectural wood elements over time the case of damage by example through the projections obtained wood over time damage to the picture.

Keywords: ancient building, BP neural network, cellular Automata (CA)

1 Introduction

In order to protect the ancient architecture, the destruction of the natural environmental factors is predicted on ancient building components. Since changes in the various factors that affect the objects often have irregular and unpredictable, difficult to describe traditional mathematical methods ancient building components change with time in the process. With the artificial neural network theory and technological developments, the theory has been widely applied, we use cellular automata (Cellular Automata) CA) and magnified BP algorithm [2] combines elements of ancient buildings damaged by natural environmental factors to predict. Application of X-ray scanning of ancient building components for 2D data, through the CA calculated for each neuron grey value changes that alter the ancient building components corresponding to a single bitmap pixel grey values to predict the damage of ancient building components extent.

2 CA model

In CA model, the state of the cell is only 0 or 1 and a discrete value, it can not reflect the state of continuous change process objects in the CA model binding, use ”grey” concept $G_d^t\{x,y\}$ to represent and reflect element mesh {x, y} state of continuous change process when the grey value $G_d^t\{x,y\}$ gradient from 0 to 1, it indicates that the cell directly in good condition from the beginning is completely transformed into damage state.

CA based binding model formula is:

$$P_d^t\{x,y\} = f\left(S^t\{x,y\},N\right)\times CONS_d^t\{x,y\}, \quad (1)$$

$P_d^t\{x,y\}$ is the state of development, S^t is the state, N is the close range, $CONS_d^t\{x,y\}$ is the total binding conditions, {x, y} is the cell specific location.

Total binding coefficient formula is:

$$CONS_d^t\{x,y\} = \prod_{i=1}^{n} cons_{id}^t\{x,y\}. \quad (2)$$

Gradation value increases $\Delta G_d^t\{x,y\}$ with transition probability and the coefficient value is proportional to the total binding:

$$\Delta G_d^t\{x,y\} = P_d^t\{x,y\}\times CONS_d^t\{x,y\}. \quad (3)$$

At a time, $t+1$ the grey value of $G_d^{t+1}\{x,y\}$ may be used to make predictions iteration:

$$G_d^{t+1}\{x,y\} = G_d^t\{x,y\} + \Delta G_d^t\{x,y\},\ G_d^t\{x,y\}\in(0,1). \quad (4)$$

Based on different grey, a cell {x, y} at a certain moment *t+1*, There are 3 possible states: in part or develop or remain undisturbed. Be expressed as:

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$$S_d^{t+1}\{x,y\} = \begin{cases} part-develop, & G_d^t\{x,y\}=1 \\ develop, & 0<G_d^t\{x,y\}<1, \\ S^t\{x,y\} & G_d^t\{x,y\}=0 \end{cases} \quad (5)$$

Through the introduction of local, regional and global constraint conditions and the "grey" concept, binding objects CA model for predicting the evolution of the ability to significantly enhance.

3 Ancient building components analysis

3.1 PHYSICAL PROPERTIES OF THE EVOLUTION OF ANCIENT COMPONENT ANALYSIS

In order to predict the erosion of ancient building components over time by natural factors, we use the model of the ancient building element numerical processing. Numerical ancient component model is a 2D grayscale graphics that make access to ancient architecture model for each pixel grayscale and Neural Network CA model each cell corresponds use pixels as cellular, CA model can easily be combined and image processing systems.

The ancient building element numerical information is captured. The neural network model is utilized to calculate the CA of the grey value of each cell. The temperature, humidity and other natural factors predictive value of historical data and neural networks to predict the combination of CA model, through changes in individual neurons grey, visually display the ancient architectural elements about the trend.

The physical properties of the evolution of ancient component analysis system structure shown in Figure 1.

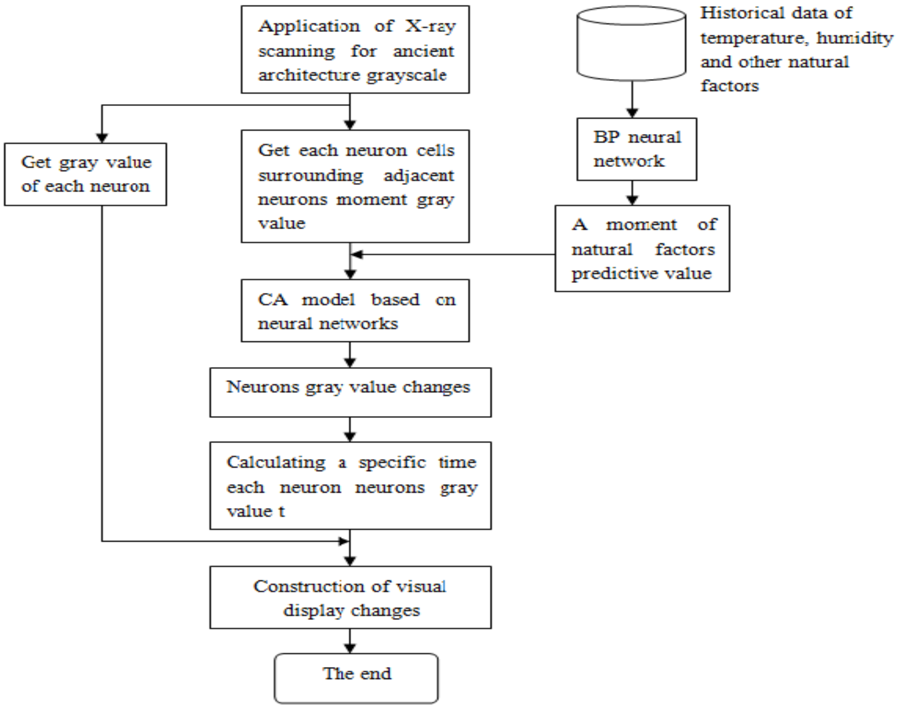


FIGURE 1 The physical properties of ancient building components analysis system architecture evolution

3.2 GRAY VALUE OF A SINGLE CELL

Ancient building element numerical model of treatment, the each pixel as a cell, a grey image (grey-scale) to said neural network cellular CA model of a single grey value.

Input from the image, each pixel with a particular grey value will correspond. The element of the grey value is set to D = f (x, y), after changing the gradation grey value, the grey value changes can be expressed as or. Among them, the set D and are in the image grey values within the specified range.

Function for the grey-scale transformation function, which describes the input grey value and the output gradation value conversion relationship between the neural network model is calculated for each cell CA grey value changes of the cell and through to change the grey levels of the corresponding cell and the grey value of the pixel.

3.3 CA ALGORITHM BASED ON MAGNIFIED BP NEURAL NETWORK MODEL[2]

Research on magnified BP [2] neural network is used. According to projections need to set 11 in the input layer neurons, each of the input neurons were 11 decisions ancient architectural elements correspond to the grey value changes.

The selection of numbers of neurons in the hidden layer affects the outcome of accuracy, training time and fault tolerance. Generally, the more hidden layer neurons, the more accurate the results are, but too many neurons in the hidden layer will increase the training time while hidden layer neurons will cause an increase in network fault tolerance decreases. studies show that for the n-layer neural network, the hidden layer neurons number is at least , where n is the number of neurons in the input layer after the above analysis, neural network hidden layer neurons number, in order to predict the best results, the hidden layer neurons is set to 6 in the output layer, by a neuron to the output grey numerical value by changing the output of each cell corresponding pixel grey value established neural network model shown in Figure 2.

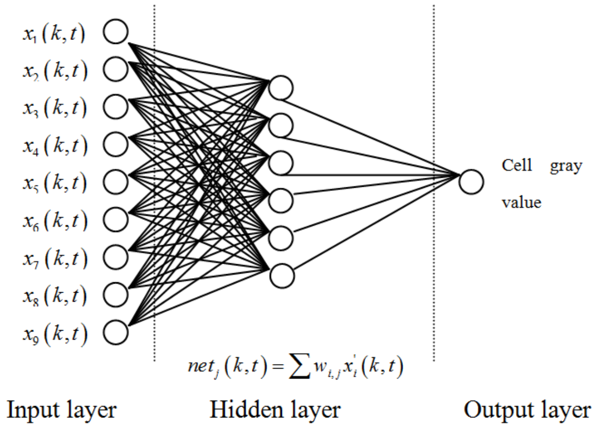


FIGURE 2 BP neural network model

Neural network hidden layer using Sigmoid transfer function, which makes the learning process is not high speed and sensitivity training and easy access to the saturation order to improve the speed and agility training and Sigmoid function effectively avoid the saturation region, the general requirements of the input data values between 0 and 1. This phenomenon in order to reduce the possibility of platforms, accelerate the learning speed, the input samples are normalized, handling as follows:

$$P_{\max}=\max\{P\},P'=P/P_{\max}, \tag{5}$$

wherein, P is input, $P_{\max}$ is processed through the normalized experimental data.

3.4 APPLIED ALGORITHM DERIVATION

Wood in the natural environment by a variety of natural factors, the influence of different factors, wood elements will produce different changes, shown in Figure 3.

Changes affecting the natural wood ancient architecture factors as temperature, humidity, microbes, the above three factors as the input layer three input data, however, the model of ancient buildings at the development of a cellular change is not accidental, for each element cell consists of a state transition to another state is a continuous process. Grey value of each cell to be affected by changes in natural wood ancient buildings factors as temperature, humidity, microbes, the above three factors as the input layer, three input data, however, ancient architecture model development at a cellular change is not accidental, each cell consists of a state to another state is a continuous process. Each cell of the grey values are it is subject to the grey values of the adjacent cell, therefore, needs to be around 6 neighbouring cell at time t_{n-1} of the 6 grey value as the input data input layer. The input is:

$$X(k,t)=\left[x_1(k,t),x_2(k,t),x_3(k,t),...,x_8(k,t),x_9(k,t)\right]^T, \tag{6}$$

where, $x_i(k,t)$ represents t time's i variable of the k cell in the simulation time.

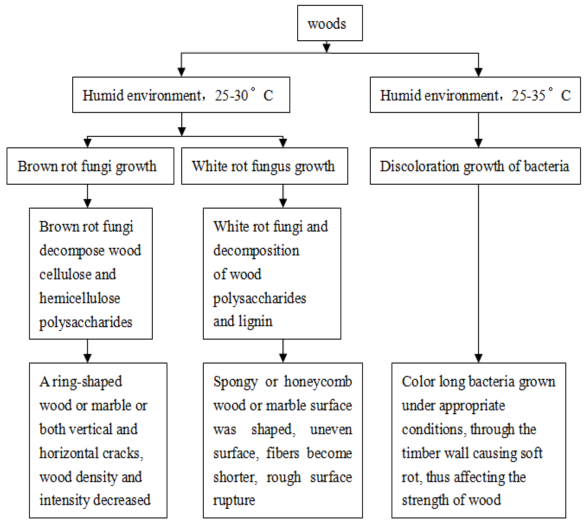


FIGURE 3 Wood is affected by changes in environmental factors

Input data normalization, the data passed to neural network input layer and then the data is output to the input layer hidden layer, each hidden layer neurons will accept various input layer neuron input. Neural network structure by the CA It can be seen, there are eight hidden layer neurons, neuron j-th received signal is expressed as

$$net_j(k,t)=\sum_i w_{i,j}x_i(k,t), \tag{7}$$

wherein, $net_j(k,t)$ represents the j neuron of the received signal, $w_{i,j}$ is the weight value.

Hidden layer obtained signal, the transmission signal to the output layer, to obtain the final output. Hidden layer response function is:

$$f\left[net_j(k,t)\right]=1/\left(1+e^{-net_j(k,t)}\right). \tag{8}$$

The output of the output layer (i.e., the grey value of each cell) is $\sum w_{j,l}\,1/\left(1+e^{-net_j(k,t)}\right)$, where $w_{j,l}$ is the weight value.

At this point, you can through the cell to change the grey value changes ancient architectural model of each pixel grayscale display changes.

In order to make the CA model simulation results closer to the actual situation, the introduction of random variables RA.

$$RA = 1 + \left(-\ln \gamma\right)^{\alpha}, \quad (9)$$

wherein γ represents the [0, 1], a random number, α is the size of the control parameters of the random variable.

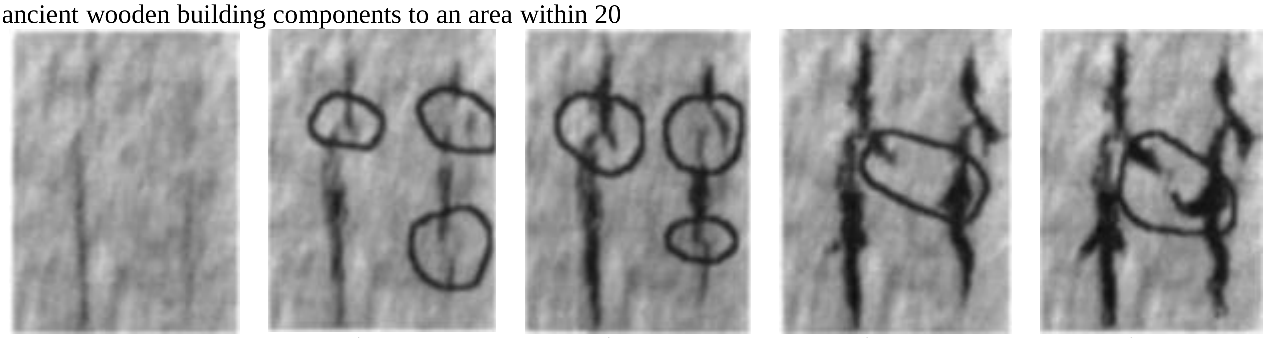
Adding random variable, the grey value equation becomes:

$$P\left(k,t,l\right) = RA \times \sum_{j} w_{j,1} \frac{1}{1+e^{-net_j(k,t)}} \,. \quad (10)$$

4 Application Examples

There is using CA model neural network structure of the ancient wooden building components to an area within 20 years to predict the evolution of the physical properties analysis.

Figure4(a) is an ancient architectural wood elements grey area image, Figure4(b) is the prediction image using CA model of neural network after 5 Years. It is seen that Figure4(a) in the shallow cracks in Figure4(b) to further expand, and the original grey value of the cracks at the light grey transformed into a dark grey colour, while in Figure4(b) new cracks is generated at the circle. Figure4(c) to predict the results of 10 years, and Figure4(b) contrast can be seen further expansion cracks, Old cracks at the original grey levels improved, in the circle the cracks are combined. Figure4(d) and Figure4(e) are image of results after 15 years and 20 years. Two figures contrast can be seen, while expanding cracks extending in new small cracks, cracks have to mesh trend. Circle from two graphs at clearly see that after five years of change, in drawing circle the rift is combined together.



a) Original image b) After 5 years c) After 10 years d) After 15 years e) After 20 years

FIGURE 4 Predict the evolution of the wood elements

Based on the above, for the collection of ancient buildings wood elements grayscale, CA model of neural network is used to predict the wood elements. through neural network training the “grey” concept of CA model is used to predict each a cellular changes in the grey values and to calculate the wood elements of ancient buildings and damaged over time the situation. Therefore, the neural network model of architectural wood elements CA extent of the damage prediction analysis over time had a significant effect.

5 Conclusion

In the study, measures are taken to make numerical treatment of the ancient building models and neural networks for each pixel in the CA model each cell one correspondence, and the use of the “grey” concept of CA model, based on neural network training to learn to predict the grey value of each cell changes, and then come to the ancient architectural models each pixel grey change, obtaining a prediction ancient buildings being eroded due to natural environmental factors effect. Studies have shown that this method of ancient buildings due to natural environment in a variety of factors and the degree of erosion prediction is valid.

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