

Research on the application of artificial intelligence in civil engineering monitoring

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Abstract. As the core basis of industrial reform in the new era, artificial intelligence can improve the development level of informatization, automation and intelligence in the field of civil engineering, and lay the foundation for the creation of a technical system with the value of The Times. In recent years, integrated research on the integration development trend between artificial intelligence and civil engineering, clear the basic research field of artificial intelligence, use visual tools to excavate the main problems and development bottlenecks of artificial intelligence in the field of civil engineering, and put forward effective research ideas and solutions, are the core issues discussed by researchers. In this paper, the process of mass concrete placement is taken as an example, several kinds of intelligent algorithms proposed in the field of artificial intelligence are compared and analyzed, and the related prediction model and measured data are constructed. The final results show that reasonable application of artificial intelligence method can provide effective basis for monitoring, forecasting and early warning in the field of civil engineering in the future.

Keywords: Artificial intelligence; Civil engineering; Deep learning; Neural network.

1. Introduction

As a theoretical method of using computer simulation to extend and expand people, artificial intelligence is regarded as one of the three cutting-edge technologies in the 21st century, including cybernetics, information theory, bionics, logic, computer science and other disciplines. This concept was first proposed by the Dartmouth Conference in the United States, and the practice has gone through three stages: the first is the initial stage from 1956 to 1980, the second is the upward stage of expert system from 1980 to 1990, and the last is the deep learning stage developed from 2020 till now. From the perspective of overall development, key AI technologies mastered by various countries are mainly reflected in statistical machine learning, neural network, deep learning, natural language processing, expert system, physical robot, robot process automation and other aspects, as shown in Table 1 below:[1-3]

Table 1 Analysis of key technologies of artificial intelligence

technology	Brief description	Application example
Statistical machine learning	Automate the training process and fit the model to the data.	Use big data for highly sophisticated market analysis.
neural network	Use artificial neurons to weight inputs and associate them with outputs.	Identify credit fraud, weather forecast
Deep learning	Neural network with multi-layer variables or characteristics	Image and speech recognition, extracting meaning from text.
natural language processing	Analyze and understand human speech and text.	Speech recognition, chat robot, intelligent seat
Expert system based on planning	A set of logical planning originated from human experts	Insurance underwriting, credit approval
Physical robot	Automatically complete a physical action.	Factory and warehouse tasks
Robot process automation	Automatically perform structured digital tasks and interface with the system.	Replace the credit card and verify the online voucher.

The construction industry is an important pillar of China's economic construction and development. With the continuous increase in the number of civil engineering construction projects, China's infrastructure is becoming more and more perfect, and the overall level of urbanization is getting higher and higher. Although the construction has effectively solved the problems of population housing, it is faced with the problems of low informatization level of the industry, extensive overall production level, low labor productivity and excessive consumption of resources. In order to guide the high quality development of civil engineering industry, the application of artificial intelligence technology to the whole life cycle of engineering construction, project management, maintenance and maintenance not only accelerates the pace of technical innovation of civil engineering, but also guides the whole industry to develop steadily towards the direction of intelligence and information. Nowadays, artificial intelligence technology provides a new method for architectural design, production, construction, maintenance and other stages, and to a certain extent, realizes the intelligent goal of engineering construction.[4-6] However, artificial intelligence technology has not been fully popularized in the field of civil engineering. With the rapid development of big data, cloud computing, Internet of Things and other technology industries, civil engineering construction projects in the new era will face more opportunities and challenges. Artificial intelligence is mainly divided into four research contents: natural language processing, visual computer, speech recognition and cross field. Therefore, the discussion on the technical algorithm of civil engineering monitoring can provide effective basis for the subsequent research of artificial intelligence in the field of civil engineering.

Nowadays, scholars from various countries have put forward a number of topics and research results in the study of artificial intelligence technology in civil engineering monitoring. For example, some scholars built urban intelligent models based on actual planning projects, and used artificial intelligence to assist urban planning to complete accurate layout. Some scholars use artificial intelligence technology to develop the expert system of multi-storey steel structure residential design with logic and rules as the core, and use the structure selection program compiled by artificial neural network to provide effective guidance for engineering design. Some scholars combined principal component analysis and neural network, regarded a set of optimal topology structure as initial data, projected it into low-dimensional space after principal component analysis, used neural network to achieve topology structure training, and finally obtained the prediction function of topology structure. Some scholars also generate topology optimization models based on deep learning. On the basis of no clear boundary conditions, the research model has higher prediction accuracy than the traditional model.

In the rapid development of big data and artificial intelligence technology, the field of civil engineering has a new health monitoring technology structure, and scholars from various countries have conducted in-depth research on this content. Especially after the proposed neural network, various application algorithms have been improved, so this paper mainly studies BP neural network, genetic algorithm, clustering network, support vector, convolutional deep learning, Bayesian inference and other methods. After grasping the information data obtained from actual engineering monitoring, MATLAB software is used to calculate the final results of various prediction models. By comparing and analyzing the actual measurement data and forecast data, the application value of artificial intelligence technology algorithm is clarified, so as to provide effective basis for the innovation of civil engineering monitoring work in the new era.[8-11]

2. Method

2.1 Monitoring Data

In this paper, the avionic hub project in a certain area is studied as an example. It belongs to mass concrete. Due to the excessive temperature stress generated during the forming process, the mechanical characteristics of the whole structure will be damaged, so the temperature change of concrete should be comprehensively monitored during the pouring. In this study, nine monitoring

points and air temperature were selected. The interval of the first temperature measurement was 7 hours, and the interval of each subsequent measurement was 12 hours.

2.2 Application Method

In this paper, after defining the monitoring area and main tasks of civil engineering, BP neural network, genetic algorithm, clustering network, support vector machine, deep learning, Bayesian inference and other methods should be selected to build the prediction model, and then judge and analyze the application effects of these methods.

First, BP neural network. Based on modern neurological research results, researchers have proposed the concept of artificial neural network in practice. The practice process is shown in Figure 1 below. Artificial neural network is composed of a large number of simple nonlinear processing units, after the input and processing of training data, to establish the BP neural network model, set the relevant parameters for training analysis, and finally judge whether the result error or learning times meet the requirements, this is one of the most widely used artificial intelligence technology research networks at the present stage. In order to apply it reasonably in the field of civil engineering monitoring, newlf function should be used in MATLAB software to create a network, to clarify the weight value and threshold value, and then train the network with train function, and finally use sim function to predict various data.[12-15]

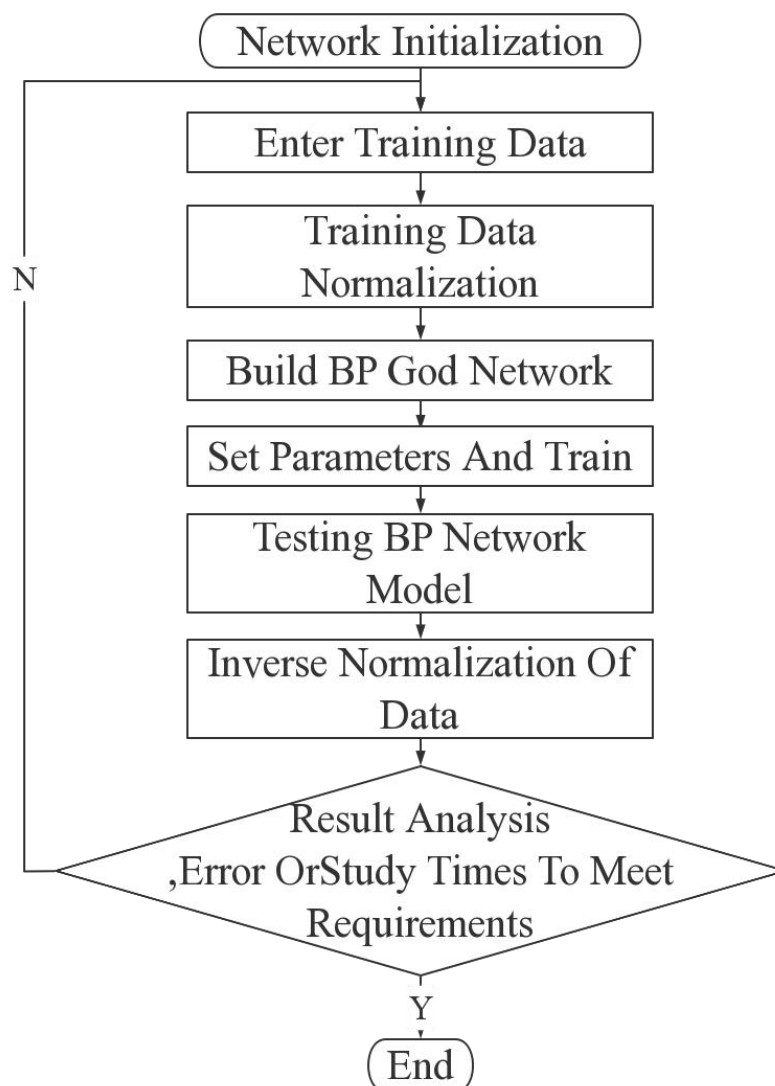


Figure 1. Flow chart of BP neural network

Second, genetic algorithm. Based on the principle of biological evolution, this algorithm constructs coded tandem population based on optimization parameters, and then selects individuals according to the selected fitness function through genetic selection, cross-processing and mutation. After retaining individuals with good fitness value, it directly eliminates individuals with poor hardness.

Third, particle swarm optimization. Similar to genetic algorithm, this algorithm is an optimization algorithm with iteration as the core. Although there is no crossover and variation function in genetic algorithm, the practical operation is simpler and does not require a lot of parameter adjustment. In civil engineering monitoring work, it is necessary to establish fitness function to calculate and analyze the fitness of particles, and then find individual extreme value and group mechanism according to the fitness value of particles.

Fourthly, SOM clustering network. This algorithm uses the input layer and the competition layer to build a single-layer neural network, in which the input layer belongs to one-dimensional neurons, and the competition layer belongs to two-dimensional neurons. The neurons of both have weight connections, and there can also be local connections between the nodes of the competition layer. To realize this kind of neural network algorithm in MATLAB software, newsom function should be used first to create the network, and then on the basis of clear weight value and threshold value, train function is used to train the network, and finally sim function is used to predict the data.

Fifth, convolutional neural networks. In this algorithm, multiple serial convolution layers and pooling layers are arranged at intervals to gradually learn data features and input the acquired data into the hidden layer through the sum function. Hiding is composed of alternating and repeated convolution layers and pooling layers. Combined with the flow diagram shown in Figure 2 below, it can be seen that it is an image crawler technology with convolutional neural network as the core, which can collect a large number of target classification image data from mainstream search engines and image sharing websites, complete network update on the basis of effective screening, accurately judge whether the final amount of data is reasonable, and avoid excessive noise of data information.

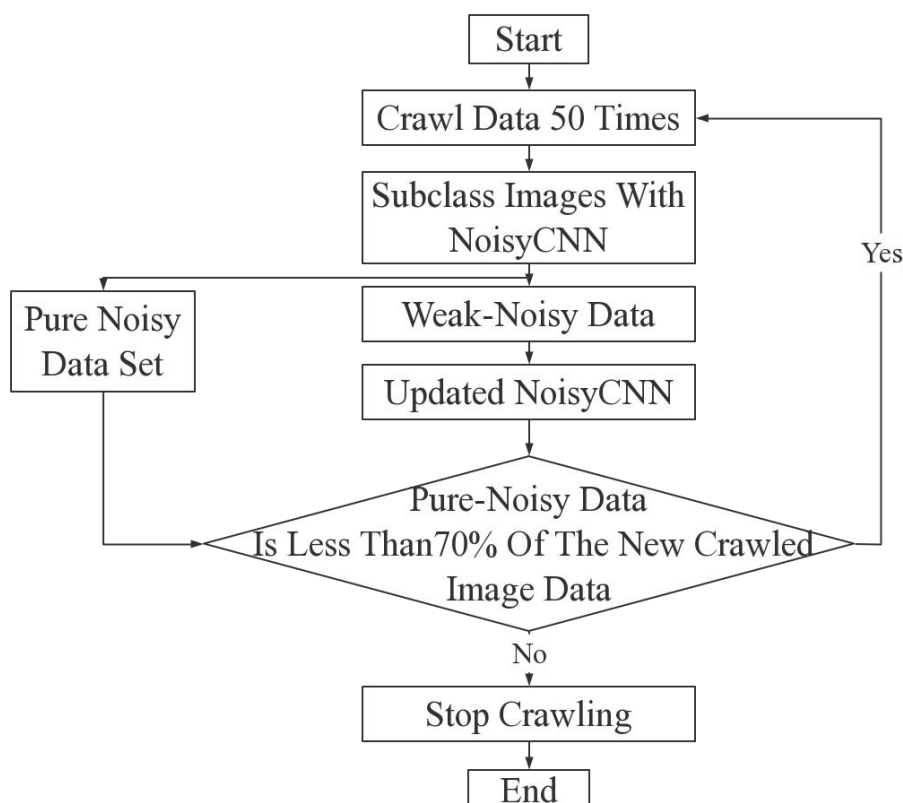


FIG. 2 Flow chart of image crawler technology based on convolutional neural network

According to the analysis in the figure above, all feature matrices can be regarded as a plane, and different planes correspond to different volume sets. In the civil engineering monitoring work studied in this paper, the deeplearning toolbox in MATLAB should be used to realize simulation prediction.

Sixth, support vector machine network. This algorithm is a brand new machine learning method, which can comprehensively improve the generalization ability of the model in accordance with the basic principle of minimizing the result risk in statistical learning theory, and does not have the limitation of data bits. Combined with the process analysis shown in Figure 3 below, it can be seen that this network algorithm can reduce dimensions by using least square method and Schmidt transform on the basis of considering multiple influencing factors of civil engineering monitoring, so as to mine more valuable data information.

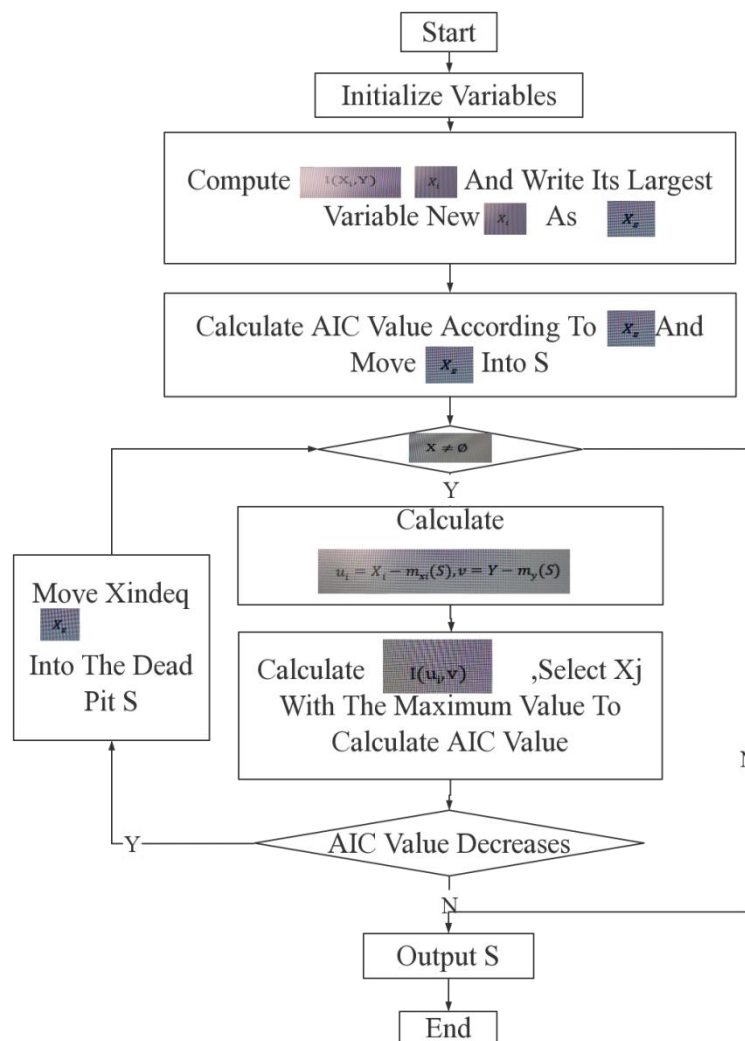


FIG. 3 Support vector machine network structure diagram

In the application of civil engineering monitoring work studied in this paper, the libsvm toolbox in MATLAB software should be used to construct the network model, and pay attention to the established support vector machine network model function svmpredict for simulation prediction.

Seventh, Bayesian modeling. Bayes' theorem is to describe the main probability of the whole event according to the empirical knowledge and basic information related to an event. This content should be combined with the basic idea of probability theory to consider the parameter error. The overall network structure is very similar to that of BP neural network, which also includes input layer, hidden layer and output layer. newpnn function in MATLAB should be used for design and operation.

3. Result analysis

According to the accumulated experience of civil engineering inspection work in recent years, the comprehensive application of artificial intelligence technology in the future mainly goes through two stages: on the one hand, the unit intelligent stage. This stage refers to the field of civil engineering construction, design, measurement work has been preliminarily completed intelligent processing, although there is a close relationship with each other, but are independent work units. The intelligence level of different links should meet the following requirements: firstly, it can measure data accurately and connect with GIS system; Secondly, the manual does not participate in the direct measurement work, but carries on the system development management; Finally, it is necessary to use computer software design to complete the simulation checking calculation, and the construction robot can directly participate in the drawing design and site construction. Based on the analysis of the unit intelligent structure diagram shown in Figure 4 below, it can be seen that the whole unit will realize the application of wireless data sharing, human brain labor will be replaced by intelligent devices, and the production efficiency and work quality of field construction will be improved, but the traditional production mode will not change, and there are obvious time differences between all links.

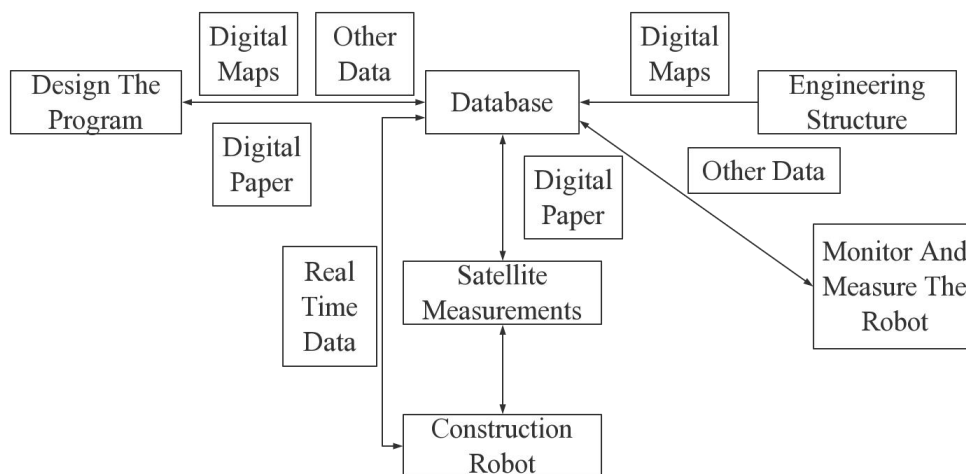


Figure 4. Structure diagram of unit intelligence

On the other hand, compound intelligence. This stage refers to the integration of design procedures, monitoring and measurement, construction management and other links to build and promote integrated intelligent engineering robots, and truly realize timely measurement and timely design. It is important to note that this stage requires a high level to achieve. In the primary stage, the intelligence level of each unit will be further improved, the interaction ability between robots and reality will reach a certain level, and the computer data processing ability will be gradually improved. On the basis of guaranteeing the quality of design and construction, the development goal of composite intelligence can be truly realized. Nowadays, scholars from all over the world pay more attention to the application and innovation of artificial intelligence technology algorithm while strengthening the research of civil engineering inspection work, which not only changes the development direction of the current construction field, but also releases the human brain to participate in more challenging and creative work.

4. Conclusion

To sum up, in the multiple artificial intelligence algorithms proposed in this paper, because the calculation results of each algorithm are different, repeated calculation and research should be

carried out in the experimental analysis. Only in this way can the perfection and accuracy of the final data obtained be guaranteed. At the same time, in the future technological theory innovation and development, Chinese scholars should continue to study and improve the artificial intelligence algorithm, based on the requirements of civil engineering monitoring work to obtain accurate and effective application content.

5. Topic

Scientific research project of Zhejiang Provincial Department of Communications "Disease Map of High Precision 3 D Display Based on Structural Optical Detection Technology"

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