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The application and design of neural computation in visual perception

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ABSTRACT

Visual perception is an important way for organisms to perceive the external world. Simulation of visual cognitive process can enhance the cognitive ability of machine vision. Therefore, how to simulate visual perception system and make computer have a high world understanding ability is a hotspot of current neurocomputing. Based on the information processing mechanism of visual perception system, this paper establishes a neural computing model based on visual perception mechanism. The simulation results of standard face database and natural landscape images show that the proposed method can recognize face samples better when other noise samples are added to the face image samples. In landscape contour fitting simulation, the results show that although this method has little advantage for large contour image recognition, but for small contour recognition, this method is obviously superior to other methods.

1. Introduction

With the development of computer science and technology, the computer level can simulate the visual system of higher animals to realize the understanding of the external world, but the understanding process of higher animals is a complex process, especially the understanding of images. Therefore, computer-aided image understanding has always been a hot and difficult topic in the field of vision perception based on neural computing. Both image understanding and computer vision are capable of researching and reflecting the level of human visual cognition. Therefore, it is of great theoretical significance and application prospects to study the process of image understanding from the perspective of human visual perception system.

With the further study of visual nerve mechanism, the results of biological visual nerve transmission mechanism provide a theoretical basis for the realization of graph comprehension by simulating visual nerve mechanism with computer system, and on this basis improve the image processing effect of computer [25–31]. For example, in 1985, Daugman [1] and others proposed using Gabor filters to describe this process to simulate the visual space of 2D neuroreceptor fields in the visual cortex, based on the research results that simple cell receptor fields in the primary visual cortex V1 have orientation sensitivity. With the further study of Gabor filter, more and more studies show that although Gabor filter has good performance in direction selection and band-pass filtering, Gabor cannot interfere with background and texture noise in complex scenes, so it is difficult to extract the main contour using Gabor. Therefore, many researchers began to study the Non-Classical Receptive Field (NCRF). In 2003, Chacron [2] and others published their results in nature. In their research, we found that stimulation in different spatial ranges mimicking prey and communication signals leads to frequency tuning and peak timing accuracy conversion of inductance pyramidal neurons, resulting in selectivity and optimal coding of the two types of stimulation. Like other sensory systems, pyramidal neurons respond only to stimuli located in restricted areas of space called classical receptive fields (CRF). In some systems, they also found that stimuli outside the CRF but in the non-classical receptive fields (nCRF) regulate the neural response to CRF stimuli. Even a single nCRF stimulus can not cause any response. The final results suggest that pyramidal neurons possess nCRF and can modulate the response to CRF stimulation to induce this neurobiological transition in frequency tuning. In Grigorescu [3], a biologically driven computational procedure called non-classical receptive field (non-CRF) suppression is proposed to improve the performance of contour detectors. By introducing a Gabor energy operator with non-CRF suppression, the proposed operator's performance of contour detection and texture edge suppression is evaluated by using natural images with relevant ground real-time edge images. Bar element operators always outperform Canny edge detectors. With the in-depth study of

Abbreviations: NCRF, Non-Classical Receptive Field; CRF, classical receptive fields; PCNN, pulse coupled neural network; SVM, support vector machine.

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Non-Classical Receptive Field, more and more researchers began to study the Non-Classical Receptive Field, and achieved a wealth of results [4–7]. These research results of the transmission mechanism of visual nerve provide a theoretical basis for the development of computer-based neural computing, and then realize the development of machine vision based on image recognition [32–37].

In the Maren [8] et al., a neural network method for spatiotemporal pattern recognition is introduced. Fu Liye transform preprocessing is used to complete spatial encoding of temporal information. In a delay network, some neurons receive their inputs from neurons that store information from the previous clock cycle rather than from an external source. Delay networks have shown great potential in speech recognition and other applications, and they compete fiercely with existing technologies. Cyclic networks are useful and interesting possibilities that have been applied to speech recognition and robot control tasks. The concept of quantum neural computing in the context of several new directions in neural network research has been published in the research results of Kak [9]. In particular, they considered new neuron and network models, resulting in rapid training, chaotic dynamics in neuron components, attention and consciousness models, cytoskeleton microtubule information processing and quantum models. Recently, neuroscience discoveries that cannot be placed in simplified models of bioinformatics processing have been studied. The explicit information is not a local additive variable in quantum computation; this property can be used to check the properties of bioinformatics structures. In Weinstein [10] and others' study, Chen described a set of neurocomputing-based activity models for predicting the mechanism of action of drugs. Given the six possible mechanism types, the network missed 12 (8.5%) of the 141 agents and 20 (14.2%) of the 141 agents missed by linear discriminant analysis (standard statistical techniques). Their findings mainly include the following three aspects: (i) Cell line response patterns are rich in information about the mechanisms involved. (II) a properly designed neural network can effectively utilize the information. (iii) A well-trained network can be used to prospectively classify more than 10,000 agents tested annually in screening programs. The combination of relevant networks and classical statistical tools will facilitate the pipeline transfer of new anticancer drugs from in vitro studies to various methods of clinical application. In recent years, with the development of computer hardware, neural computing has been developing rapidly. [11–16].

Neural computing based on visual perception is the most successful research in image processing. Vision is the perception of external things. For computer systems, this external thing is an "image." Today's computer information is mostly displayed in the form of pictures. Therefore, image processing is an important method of information transmission. Digital image processing, that is, image processing by computer, can help people understand the world more objectively and accurately. Human visual system can help human get more than 3/4 of the information from the outside world. Images and graphics are the carriers of all the visual information. Although the human eye has a high discriminative power and can recognize thousands of colors, in many cases, images are blurred or even invisible to the human eye, so in order to highlight the special features of the image. Signs must be processed. But nowadays, the demand for image is getting higher and higher. Traditional digital image processing methods are difficult to adapt to the current requirements. Therefore, neural computing technology imitating visual perception is widely used in image processing.

The main objective of neurocomputing science is to explore the mathematical basis of neurocomputing, to propose new computational principles that are different from current computational science, and to apply these principles to new information processing systems similar to human neural processing. With the progress of computational neuroscience, great progress has been made in neural computing research. For example, the hidden unit is used to investigate the learning algorithm of cyclic neural networks, and various techniques are put into a common framework. Pearlmutter and others in his research [17] focused on fixed-point learning algorithms, i.e. cyclic back-propagation and deterministic Boltzmann machines, and non-fixed-point algorithms, i.e. back-propagation through time, Elman's historical cutoff, and Jordan's output feedback architecture. The forward propagation technology and its variants using adjoint equation are also discussed. In many cases, unified representation leads to various types of generalizations. In this result, the author discusses the advantages and disadvantages of the time continuous neural network. Compared with the clock continuous neural network, we continue to use some "trading skills" to train, use and simulate the continuous time and recurrent neural network. Simulation results show that the proposed method solves the problem of computational complexity and learning speed. In Gruber [18], they found that more complex computational tasks involving the application of computational rules increased activity in the lower left frontal region, which is known to provide language and working functions, and that these findings help to embed computational specific cognitive operations into the neural framework that provides the set of required instrument components. The results can further inform the cognitive modeling of computations and increase the understanding of neuropsychological deficit patterns of patients. In order to achieve fast and high-precision processing of laser images in Cao [19], a laser image processing method based on multi-core DSP and pulse coupled neural network (PCNN) is proposed. PCNN algorithm is used as the image processing algorithm of the system. The laser image data is processed by combining FPGA with multi-core DSP. The image data is preprocessed by using FPGA, which reduces the calculation of DSP and improves the processing speed of DSP. The interconnection between the image and the host can be achieved by using Giga E module, which can meet the speed requirements of processing results and controlling information. The experimental results show that the system can realize image contour information and local fine information, and the processing time is less than 0.3 s, which can meet the requirements of laser image processing. Relevant neural computing research results have proved that [20–24], using neural computing method based on visual conduction mechanism can improve the image recognition ability of the system.

This paper establishes a neural computing model based on visual perception theory. By simulating the two important research methods of face recognition and natural landscape contour recognition in image recognition, SVM is used as classifier to classify and calculate. The results show that when facial simulation is performed, through the selection of faces and backgrounds in Caltech-101 database, this method can recognize human faces very well, and the recognition accuracy is high. In the natural landscape image contour extraction, this method is superior to other methods in small-scale contour extraction.

2. Proposed method

2.1. Visual perception

Visual nerve research results show that the visual system is able to perceive external information and make judgments, mainly the visual nervous system plays a signal acquisition function, so for the brain, the visual system is an image processing system, through this system to achieve information coding and recognition. The visual system is a complex and hierarchical nervous system. According to neurophysiological research results, the visual system