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Research article

Research on artificial intelligence of accounting information processing based on image processing

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Abstract: The rapid development and wide application of artificial intelligence is deeply affecting all aspects of human society. Combine artificial intelligence with the accounting industry, use computers to efficiently and automatically process accounting information, and let the accounting industry move towards the intelligent era. This can help people reduce the workload and speed up work efficiency. In recent years, with the rapid development of economy and technology, the use of financial instrument vouchers has exploded, but the processing requirements of financial instrument vouchers have become more and more efficient. Traditional accounting information processing methods, due to the staff's energy and ability, it is often difficult to quickly and accurately handle accounting information. This makes the processing of accounting information lack of timeliness, the degree of utilization of accounting information by enterprises is relatively low, and the demand for intelligent processing of accounting information is constantly pressing. In view of the above problems, this paper uses image processing technology to intelligently identify the content of accounting information to achieve automatic ticket input, improve work efficiency, reduce error rate and reduce labor costs. By simulating the actual 230 invoice images, the results show that the recognition accuracy rate is as high as 98.7%. The results show that the method is effective and has great application value, which is of great significance to the artificial intelligence of accounting information processing.

Keywords: image processing; accounting information processing; artificial intelligence

1. Introduction

Artificial intelligence is the result of the rapid development of information science, and artificial

intelligence profoundly affects people's production and lifestyle. With the rise and widespread application of artificial intelligence, the accounting industry has also been fully influenced by artificial intelligence. It has promoted the innovation of accounting information processing methods and actively promoted the development of the accounting industry, which has had a profound impact on the accounting industry. In the traditional accounting information processing process, accounting staff are often difficult to handle a large amount of accounting information in a timely manner due to their own efficiency and ability. This makes the processing of accounting information lack of timeliness, and it is difficult to meet the increasing timeliness and accuracy requirements of enterprises. The combination of artificial intelligence and accounting industry can make up for the shortcomings of traditional accounting information processing methods, thus improving the processing efficiency of accounting information [1]. Artificial intelligence is applied in accounting information processing, which can realize the accurate and efficient processing of accounting information. Accounting personnel only need to complete the accounting information processing through relevant algorithms. The processing process is completely through automated intelligent algorithms. The focus of accounting staff will shift from time-consuming and labor-intensive work such as accounting information entry, sorting, analysis, screening and inspection to key aspects such as auditing of accounting information [2]. It can be seen that the combination of artificial intelligence and accounting information processing can not only improve the efficiency and accuracy of accounting information processing, but also reduce the task burden of accounting staff.

In recent years, research on accounting information processing has emerged in an endless stream. Many experts and scholars at home and abroad have done a lot of research and achieved many results. C. Alippi et al. proposed an automatic invoice-document classification system. The system is based on the analysis of graphical information present in the document and is capable of performing closures (the number of classes is fixed) and the open world (increasing the number of classes during the lifetime) classification [3]. Zhang Yan et al. proposed a multi-category bill image classification method based on frame line detection for tabular documents. Accurately extract the frame features of the ticket image, and establish a template library according to the topology structure of the ticket frame line; match the frame feature of the template in the standard template library by the similarity model based on the frame line correlation, thereby determining the grouping of the ticket Category [4]. Feiyu Bu et al. proposed a table frame line removal algorithm based on color image. Using the color and gray information in the image, the interference of the frame line on character recognition can be better excluded [5]. Jin Haiyan et al. used the date number (Arabic number) of the printed body on the invoice of the used car. After binarizing the image, the two methods of vertical projection and contour feature were used to perform adaptive character segmentation and extraction. This method improves the segmentation rate of the character string located from the image and ensures the correct rate of character segmentation and extraction [6]. Sun studied the interaction mechanism of information disclosure tools and the value benefits brought by XBRL. This study finds that the application of XBRL in accounting information flow processing will enhance XBRL technology and improve the practicality of value chain accounting information [7]. Cui et al. proposed an invoice number identification algorithm based on digital structure features for the font structure and characteristics of ordinary invoice numbers, and compared the proposed method with the printed digital recognition method based on improved left and right contour features. The experimental results show that the proposed recognition algorithm has higher accuracy and faster recognition speed, and is more robust to noise [8]. Ouyang et al. proposed a multi-feature fusion decision-making seal recognition algorithm,

which uses the Maximum Symmetric Surround (MSS) algorithm to detect the region of interest in the image; removes irrelevant targets according to the morphological features of the seal, and iterative self-organizing data analysis (ISODATA) The algorithm clusters the remaining targets in the image; extracts the sample points on the outer contours of each category and performs random least squares ellipse fitting to realize the recognition and correction of the seal [9]. Fei et al. proposed a method for extracting text lines using invoice layout information and text features, and combined with previous text detection methods and attention-based bi-LSTM sequence learning structure for text recognition, improving recognition accuracy and development. A system that automatically processes and identifies invoices [10]. Shen et al. studied the related theory of financial accounting information system reconstruction process optimization and profit calculation module based on particle swarm optimization algorithm. The research shows that the reorganization of accounting business process after particle swarm optimization can greatly improve the usefulness of accounting information decision-making and improve the competitiveness of enterprises [11].

Although many achievements have been made in the processing of accounting information such as bill vouchers, there are still problems such as insufficient accuracy of recognition, fast speed, insufficient universality, and low intelligence. This paper uses image processing technology to study the image information of bills and vouchers involved in the accounting industry, so as to facilitate the artificial intelligence of accounting information processing and optimize the processing efficiency of accounting information.

The 21st century is an information age of big data. As the visual basis of human perception of the world, images are an important means for humans to obtain information, express information and transmit information [12–15]. Information technology has developed rapidly with the popularity of computers. As an important communication carrier in information technology, image has a vital position in the dissemination of information and has been widely integrated into people's daily life. With the rise of artificial intelligence, it has been widely used in our daily lives, for example, the shadow of artificial intelligence technology can be seen in medical, financial, media, construction, chemical and other industries. It has become a trend to use computers' efficient and fast computing power to help work in all industries to reduce workload and speed up work efficiency. However, computers can't directly acquire the information contained in images through human vision, so the process of image information processing into text information is of great significance for computers to understand images. Currently, image processing techniques have been applied to various scenes, such as for vehicle identification tracking [16,17], automatic identification of license plate numbers [18], face recognition [19], and the like. Its auxiliary application greatly improves work efficiency and reduces error rate, which greatly releases human resources and reduces labor costs. Image processing technology has tremendous advantages over labor. With image processing technology, computers can quickly and accurately process a large number of simple and repetitive image jobs. Traditional manual work will be affected by emotional and physical influences. The identification and preservation of information may also be wrong, and computers will not be affected by these problems. Since most of the information such as bill vouchers in the accounting industry uses paper or images. In order to perform image processing by means of a computer, it is necessary to first input paper data and convert the data information into computer-understandable information. The paper ticket voucher can be converted into image information efficiently and conveniently by means of photo scanning, and the image information is converted into text information recognizable by the computer through image processing technology, which has great application significance.

Artificial intelligence is the product of the development of information technology [20,21]. With the wide application of artificial intelligence, all walks of life are suffering a huge impact. For the accounting industry, the artificial intelligence technology combined with image processing allows the computer to automatically and automatically process some repetitive tasks. Accounting information processing is intelligent, which will bring huge advantages [22,23]. The combination of accounting and artificial intelligence to realize the artificial intelligence of the accounting industry is the tendency of the entire accounting industry to transform in the future. Accounting artificial intelligence will replace the simple and repeated accounting work, change the functions of accounting personnel, keep up with the trend of the times, and realize the intelligence of accounting information [24]. Accounting information processing artificial intelligence is the need of the times. The fast-growing economy generates huge-scale transaction information all the time. It is not enough to rely on traditional manpower. It is imperative to use the artificial intelligence technology of image processing to promote the intelligence of accounting information processing. Accounting artificial intelligence will greatly reduce the workload and time spent by accounting practitioners, and improve the efficiency of financial information processing and decision-making.

In this paper, image processing technology is used to first perform binarization preprocessing on the bill image. Then, the improved method based on directional white run is used for tilt correction; Wiener filtering is used for image denoising; and gray projection based method is used for character segmentation. Finally, the feature recognition model based on convolutional neural network is used to extract the feature data directly from the ticket voucher, and the content of the accounting information is intelligently identified to realize automatic ticket input, which improves work efficiency, reduces error rate and reduces labor cost. By simulating the actual 230 invoice images, the results show that the recognition rate is 98.7%. The results show that the method is effective and has great application value, which is of great significance to the artificial intelligence of accounting information processing.

2. Method

2.1. Image binarization preprocessing

There are many storage file formats for images, and different file formats describe images in different ways. Generally, a color pixel is represented by RGB notation. Each color has 0–255 levels, and a total of 28 is required to be 8-bit binary (one byte), so a color pixel occupies 3 bytes together [25]. For color character images, grayscale processing, that is, image decolorization, is required. Many image processing platforms provide encapsulation functions for image decolorization. The implementation principle is also very simple. The common algorithm for converting color pixels into grayscale pixels is to calculate the average of the series of three colors of RGB, and use the average value to represent the grayscale of gray pixels (0–255). Since the algorithm for converting color images into grayscale images is relatively simple, the processing form is the weighted average method. The formula is as follows:

$$Y = A * R(x, y) + B * G(x, y) + C * B(x, y) \tag{1}$$

In Eq (1), the sum of the three data items A, B, and C should be guaranteed to be 1. The process of converting a color image or a multi-gradation image into only two black and white grayscale images is called binarization of the image. A binary image is a gray value image with a bit depth of only 1 bit.

Each pixel has a value other than 0, which is called a binary image. The binarization operation of an image is an irreversible raster image operation with information loss. Whether in the field of visual inspection or in the field of intelligent identification is a very crucial step. Using different binarization methods, the binarization results of an image will vary. Therefore, the result of binarization directly affects the performance of the entire detection and recognition system. Whether the pixel is black or white (whether the pixel value is 1 or 0) is determined by comparing its gray value with the threshold. The formula is as follows:

$$f(i,j) = \begin{cases} 0, f(i,j) < e \\ 1, f(i,j) \geq e \end{cases} \tag{2}$$

As can be seen from Eq (2), e is the selected threshold. When $f(i,j) < e$, the pixel value of the image is 0(that is, white). When $f(i,j) \geq e$, the pixel value of the image is 1(that is, black), which is a character image. It can be seen that the selection of the threshold e plays a very important role in the binarization of the image.

2.2. Tilt correction

Since the acquired invoice image will inevitably have image tilt due to human operation or mechanical reasons during image acquisition. This will not only affect the subsequent character segmentation, but also directly affect the final recognition rate. To use the computer to correctly understand the image of the invoice, it is necessary to perform a skew detection to correct the tilted invoice to make it horizontal. This step is called tilt correction.

Wang Wei et al. proposed a tilt angle detection algorithm based on directional white run. The algorithm scans the image from a white run of different tilt angles, starting from a white pixel in the image, and searching along a certain direction until it hits the black pixel or the edge of the image. The result is a line segment where the white point passes [26].

The traditional direction-based white travel tilt correction method has a large calculation error for the tilt angle in the case of large text line spacing in the image. In this paper, an improved method based on the direction white travel is proposed. Specific steps are as follows:

1) After the image is preprocessed, the row and column of the image are scanned, and the first black pixel of the row and column in the image is found as the starting point of the sample. Take one sampling point at intervals of ten points in the horizontal and vertical directions, and sequentially obtain the sample points of the full image.

2) Analyze the sample point, first determine whether it is the center point of the line between the text and the line. If there is a black pixel in the area of the sample point 30 × 30, the sample point is removed. Otherwise, write down the location of the change.

3) For each sample point that satisfies the condition, as the image center, calculate the length of the white run length in units of one degree, and find the maximum length of the white run length of each sample point. Then, the white run of each angle is searched up and down from the maximum direction of the white run length of each sample point, and the search is stopped as long as a white run with black pixels is encountered. In this way, a white run of each angle between the lines is obtained, and the obtained angles are averaged, and then the angle value is recorded. The above steps are then repeated for each sample point that satisfies the condition, and the average of the angles obtained for each sample point is again averaged. That is, an accurate tilt angle is obtained.

4) After finding the exact tilt angle, the image can be rotated to achieve the purpose of tilt correction. If you rotate from the (0, 0) point of the image, a part of the image will be rotated outside the image area, causing the loss of information. Therefore, it is necessary to rotate with the center point of the image as the origin. The horizontal and vertical coordinate formula after any point (x, y) rotation is as follows:

$$x' = (x - x_c)\cos\theta + (y - y_c)\sin\theta - x_c \tag{3}$$

$$y' = (y - y_c)\cos\theta + (x - x_c)\sin\theta - y_c \tag{4}$$

The reason why this method can achieve better correction effect is mainly because multiple sampling points are selected, and the white run in each direction is calculated, and the white travel of each direction is adjusted and averaged as the final white run. To get the tilt angle.

2.3. Information area denoising

Invoices have strong noise due to printing or saving problems. In order to ensure subsequent character segmentation and character recognition, the invoice image must be denoised. There are many factors that generate noise in an image. The distribution characteristics of noise are affected by the cause of noise, just as the relationship between noise and signal is also dependent on the cause. According to the relationship between noise and signal, noise can be divided into additive noise and multiplicative noise. Additive noise includes thermal noise, shot noise, etc. It is superimposed with the signal, so it is independent of the signal, and additive noise exists regardless of the presence or absence of the signal. Multiplicative noise (also known as convolutional noise) depends on the presence of the signal, and if there is no signal, it will not. There are three main sources of additive noise: man-made noise, natural noise, and internal noise. In general, additive noise is regarded as the background noise of the system during communication. Multiplicative noise is caused by time-varying factors such as system fading or other nonlinear factors.

The noise of this study exists as part of the image itself and exists in the scanned binary image. For the information processing of this system, it is noise information that should not exist. That is, it is superfluous and causes processing errors, which in nature belong to the additive noise of the image.

Wiener filtering is one of adaptive filtering. The adaptive filtering is to automatically adjust the subsequent filter parameters by using the results of the originally obtained filtering parameters in a computable case to obtain statistical characteristics suitable for the input image and noise. [27]. Obviously, from its definition, adaptive filtering has better adaptability than linear and nonlinear filtering. It can better remove noise and preserve image high frequency and edge information. Wiener filtering is the most widely used method in adaptive filtering [28–30]. The theory is based on the recognition that the probability density function of image and noise is a random function. The goal of the algorithm is to find an estimate $\hat{f}(x,y)$ of the uncontaminated image such that the error between the estimated image and the original image $f(x,y)$ is satisfied:

$$E\left[\left|f(x,y) - \hat{f}(x,y)\right|^2\right] = min \tag{5}$$

Which is $E[|f(x,y) - w(x,y) * g(x,y)|^2] = min$, the Wiener filter function that satisfies this equation is:

$$W(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 + P_n(u,v)/P_t(u,v)} \tag{6}$$

Where $H(u,v)$ is the degenerate function, H^* is its conjugate function, $H(u,v)$ and $W(u,v)$ are the Fourier transforms of $h(x,y)$ and $w(x,y)$, respectively. And the signal power spectrum and noise power spectrum are:

$$P_f(u,v) = |F(u,v)^2|, P_n(u,v) = |N(u,v)^2| \tag{7}$$

Where $F(u,v)$ and $N(u,v)$ are the Fourier transforms of $f(x,y)$ and $n(x,y)$. Define the ratio of the signal power spectrum to the noise power spectrum as the signal-to-noise ratio. The formula is expressed as: $P_f(u,v)/P_n(u,v)$. In practical applications, choose a normal number to approximate the reciprocal of the signal-to-noise ratio: $c \approx \frac{1}{P_f(u,v)/P_n(u,v)}$. Thus, the Eq (6) becomes:

$$W(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 + c} \tag{8}$$

Wiener filter estimate:

$$F(u,v) = \frac{H^*(u,v)G(u,v)}{|H(u,v)|^2 + c} \tag{9}$$

Where $G(u,v)$ is the Fourier transform of $w(x,y)$.

2.4. Character segmentation based on gray projection

After the previous denoising operation, a relatively clean digital string area is obtained. Next, the printed numbers in the numeric string area need to be separated one by one for subsequent digital recognition processing. Therefore, the ability to accurately complete the cutting of a single character will directly affect the accuracy of subsequent digital recognition. This paper uses a character-cutting algorithm based on gray projection to cut individual characters accurately and quickly [31].

Calculate the first-order difference value of the number of pixels of the 0 gray value. Since the interval of the binary image is white, there is no 0 gray value pixel, thereby separating the different sequences in the vertical direction. Then, the vertically-divided binary image is projected in the horizontal direction and the difference value is calculated to separate the sequence into independent characters. This method requires a higher image angle. Some angles are not suitable and there will be overlapping areas after projection. Moreover, further clustering is required for characters with separate elements such as English lowercase letters. For invoices, many character rows and columns are staggered and will be affected when projected in the horizontal and vertical directions. If sub-area projection, how the size of the area is determined is affected by the type and format of the invoice.

2.5. Character recognition model based on convolutional neural network

The convolutional neural network belongs to the artificial neural network. Its weight-sharing network structure significantly reduces the complexity of the model and reduces the number of weights. Convolutional neural networks can directly use pictures as input to the network, automatically extract features, and are highly invariant to image deformation (such as translation, scaling, tilting) [32].

Convolutional neural networks are deep feedforward neural networks that use more and better results in image recognition [33,34]. This paper also uses convolution to perform image feature calculations to identify and classify images. After the character image is normalized to 30 × 30, the image is convoluted using a 5 × 5 convolution kernel, and the convolution step size is (1, 1). Use the Batch Norm layer after the convolution layer. The pooling layer is used again, and the pooling uses a pool of 2 × 2 size with a step size of (2, 2). Pooling uses the most pooled approach. The network has a total of two layers of convolution.

The recognition model is small because the size of the input image itself is small. In this paper, only two layers of convolution are used to extract features. The convolution layer of the first layer uses 16 5 × 5 size convolution kernels for feature extraction to obtain a 26 × 26 × 16 feature map. After 2 × 2 pooling, a feature map of 13 × 13 × 16 size is obtained. The second convolution uses 32 4 × 4 convolution kernels in order to fit the convolved slices to a 2 × 2 pool. After a maximum pooling of 2 × 2, a vector of 5 × 5 × 32 size is finally obtained after Flatten. After three layers of full connection, the full connection of the second layer uses 1024 size, the third layer is 6392. Finally, the Soft Max classifier is used to obtain the serial number of the largest possible character, that is, the character can be recognized.

3. Experiment

3.1. Experiment environment

The experimental environment of this paper is as follows:
1) Hardware configuration: CPU: Intel Core i5-6500M @ 3.20 GHz
2) Memory: 4 G
3) Software configuration: System: 64 bit win10
4) Development environment: MATLAB 2013B

3.2. Data sources

This article collected 230 VAT invoices to test the accuracy of system digital identification. The experiment used a total of 12,646 characters, including 2766 characters in the invoice code area; the taxpayer identification number has 3920 characters; the billing date has 1920 characters; the unit price area has 1084 characters; the quantity area has 406 characters; the money area has 2550 characters. An example of the invoice is shown in Figure 1.

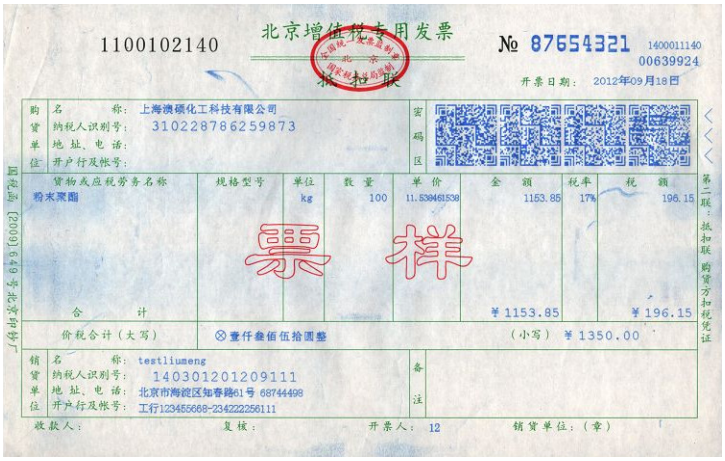

Figure 1. Example of VAT invoice.

4. Results and discussion

4.1. Character segmentation experiment

Character segmentation of text lines, the experiment uses a method based on gray projection, combined with the aspect ratio of the characters in the segmentation area. In this experiment, the text lines of 230 invoice images were used for character segmentation. Since the segmentation effects of the various parts of the invoice were different, the segmentation results of the various parts of the invoice were analyzed. In the segmentation of text characters, the processing and segmentation of the graphics are separated. After the horizontal coordinates are calculated during image processing, the characters are segmented based on the original image, and the image processing does not affect the image quality after the character segmentation. Due to the large number of invoices, this paper only analyzes the invoice code, taxpayer identification number, billing date, amount, unit price, quantity and other information to verify the effectiveness of the segmentation algorithm. For the quantity area, sometimes there is more than one type of goods purchased, and for each type of goods, the required positioning information area is increased by three. Statistics of 230 experimental invoices, the required location block is 1464.

Table 1. Invoice image character segmentation experiment results.

	Total number of segmentation areas	Correct cut score	Error cut score	Correct rate
Invoice code	230	228	2	99.1%
Taxpayer Identification Number	230	227	3	98.7%
Billing date	230	221	9	96.1%
Unit price area	258	256	2	99.2%
Quantity area	258	253	5	98.1%
Money area	258	256	2	99.2%
total	1464	1441	23	98.4%

The effect of character positioning and segmentation is shown in Table 1. For each part of the invoice, the correct rate of character segmentation in the invoice code, unit price area, and amount area is the highest. Because the invoice code, unit price area and amount area are used as invoice localization information, they are basically all numbers or letters. Their aspect ratio is not much different, and each character is a complete whole without the influence of complex structures. From the results shown in Table 1, the correct rates for the invoice code, unit price area, and amount area are 99.1, 99.2, and 99.2%, respectively, and the correct rate is already quite high. The correct rate of segmentation for the taxpayer identification number and quantity area also reached 98.7 and 98.1% respectively. However, since the billing date is the variable domain information, there are some overlaps in the characters (the date coincides with the rectangular frame portion of the invoice layout), and the complexity is high. So the correct rate of complete segmentation is slightly lower, only 96.1%. From the point of view of the overall correctness of the segmentation, the overall segmentation rate of the character segmentation model based on the gray projection method reaches 98.4%, and the effect is remarkable. Of course, there is room for further improvement.

4.2. Regional character recognition result

The character recognition model uses a recognition model based on convolutional neural network. After the invoice image is subjected to binarization preprocessing, image correction, image denoising and positioning and segmentation operations, the image block is input into the recognition model for character recognition.

In the 230 VAT invoices of the experiment, there are a total of 12,646 characters, including 2766 characters in the invoice code area, 3920 characters in the taxpayer identification number, 1920 characters in the billing date. Calculate the number of characters that are accurately recognized in each area, and calculate the character recognition rate of each area. The experimental results are shown in Table 2.

Table 2. Digital recognition rate of each information area.

	Total number of characters to be recognized	Correct identification number	Error identification number	Recognition rate
Invoice code	2766	2741	25	99.1%
Taxpayer Identification Number	3920	3876	44	98.8%
Billing date	1920	1874	46	97.6%
unit price	1084	1067	17	98.4%
Quantity	406	400	6	98.5%
money	2550	2522	28	98.9%
total	12,646	12,480	166	98.7%

As seen from Table 2 above, because the character image contained in the determined area is more standardized, the character recognition rate in this area is higher than the overall character recognition rate obtained by experimental statistics; the recognition rate of characters in the variable

domain information area is low, even one percentage point lower than the statistical recognition rate of all characters. In general, since the character information of the variable domain is printed by the machine, the characters generated may be unclear, missed, pressed, etc., thereby affecting the accurate recognition of characters. This results in a lower recognition rate in the variable domain than in the determined domain. The date area belongs to the variable domain, and the recognition rate of characters in this area is lower than that of other variable area areas. This is because when there is an overlap in the date, the recognition rate of the single character cut by the combination of the structural feature and the projection feature is low.

4.3. Comprehensive recognition result

In order to verify the effectiveness of the image processing algorithm based on convolutional neural network, this algorithm is compared with support vector machine algorithm and BP neural network algorithm. The experimental data is 230 VAT invoice data sets, and the 7:3 ratio divides the training set and the test set. The accuracy of character recognition in the entire invoice area is counted, and the experimental results are shown in Figure 2.

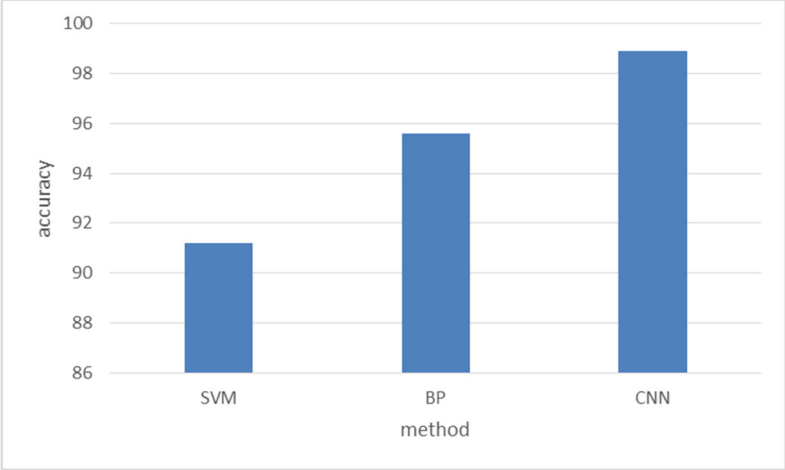

Figure 2. Accuracy of comprehensive identification of invoice area.

Analysis of Figure 2 shows that the accuracy of the invoice characters of the CNN-based recognition model reached 98.7%. The accuracy of the recognition model based on support vector machine and BP neural network is only 91.2 and 95.6%, which is much lower than the recognition model based on convolutional neural network. This is mainly due to the powerful self-learning ability of the convolutional neural network, which can learn the deep hidden features of the image information, and the intricate features of the invoice layout, so that the system achieves a high recognition rate.

The data information on the VAT invoice is printed by machine and has a uniform format. However, it may generate noise during the process of sorting and scanning, and a series of image processing processes such as image preprocessing and character cutting may lose some useful information. In this case, if only one feature extraction method is used for the recognition process, the effect obtained will be unsatisfactory. If combined with multiple feature extraction methods, the algorithm becomes complicated and the recognition speed is reduced. The convolutional neural network does not care about the characteristics of the data, and its unique hierarchical network model

can automatically combine the characteristics of the numbers and find the appropriate mode. So users only need to understand the network structure, and do not have to rely on the characteristics of the data as the feature extraction. Therefore, this paper uses the image processing and recognition method of convolutional neural network to identify invoice printed characters, which greatly ensures the rapid and accurate identification of accounting image information.

5. Conclusion

The 21st century is an era of information and intelligence. Highly informatized and intelligent algorithms emerge one after another. People's way of processing information has gradually changed into computer intelligent processing through traditional manual processing. China is the largest country in the use of invoices, and the information on bills that need to be processed in the accounting industry is also increasing. The method of manually inputting data has low work efficiency, is error-prone, and cannot manage the invoice information centrally, and it takes a lot of effort to query the data later. With the development of artificial intelligence in recent years, the automatic invoice identification system has received more and more attention. The development of image processing technology has brought convenience to the artificial intelligence of accounting information. Artificial intelligence technology based on image processing can solve the problem of invoice information collection. Combining artificial intelligence with the accounting industry can not only optimize the efficiency and speed of accounting information processing, but also reduce the work intensity of accounting personnel. Advanced computer intelligent algorithms such as image processing can identify most types of bill voucher information, which greatly improves the overall accuracy of accounting information processing, reduces the occurrence of artificial accounting information fraud, and fully integrates accounting information resources.

This paper uses image processing technology to achieve the acquisition of VAT invoice related information. Firstly, the invoice image is binarized preprocessing, then the tilting correction is performed based on the improved method of directional white run, and Wiener filtering is used for image denoising; the gray projection based method is used for character segmentation; finally, recognition model based CNN is used. The computer extracts the accounting information directly from the ticket voucher and intelligently identifies the content of the image. The simulation experiments show that the method is effective and can greatly improve the efficiency and accuracy of accounting information processing. It has great application value and is of great significance to the artificial intelligence of accounting information processing. Although this paper has carried out in-depth research on accounting information processing using artificial intelligence technology, there are still many deficiencies. The depth and breadth of this research is not enough, and my academic level research is also limited. In the future work, we will study solutions for accounting information processing from more perspectives based on the existing technology and level, and continuously improve the efficiency and quality of accounting information processing.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

References

1. J. Wang, Y. Su, Artificial intelligence and accounting model reform, *Commun. Finance Account.*, **22** (2017), 41–43. Available from: https://d.wanfangdata.com.cn/periodical/cktx201722011.
2. C. Zhang, Analysis of intelligent improvement of accounting information processing, *Commun. Finance Account.*, **34** (2017), 102–105. Available from: https://d.wanfangdata.com.cn/periodical/cktx201734030.
3. C. Alippi, F. Pessina, M. Roveri, An adaptive system for automatic invoice-documents classification, in *IEEE International Conference on Image Processing 2005*, **2** (2005), II-526. https://doi.org/10.1109/ICIP.2005.1530108
4. Y. Zhang, C. Zhang, S. Yu, J. Yang, Classification of bill image based on frame line detection, *J. Nanjing Univ. Sci. Technol. (Nat. Sci.)*, **31** (2007), 409–413. https://doi.org/10.14177/j.cnki.32-1397n.2007.04.022
5. F. Y. Bu, Q. G. Hu, Y. Wang, A valid frame line removal algorithm for financial document, *Comput. Knowl. Technol.*, **12** (2016), 148–150. Available from: https://d.wanfangdata.com.cn/periodical/dnzsyjs-itrzyksb201623062.
6. H. Jin, T. Xia, B. Wang, Research on adaptive character segmentation and extraction algorithm, *J. Xi'an Univ. Technol.*, **32** (2016), 399–402+415. Available from: https://xuebao.xaut.edu.cn/__local/2/53/FA/00833B6F761060DF2461CB46334_A0C213DD_120738.pdf?e=.pdf.
7. W. Sun, A study on XBRL based value chain accounting information processing, in *2017 6th International Conference on Industrial Technology and Management (ICITM)*, (2017), 171–175. https://doi.org/10.1109/ICITM.2017.7917916
8. W. Cui, L. Ren, Y. Liu, Invoice number recognition algorithm based on numerical structure characteristics, *J. Data Acquis. Process.*, **32** (2017), 119–125. https://doi.org/10.16337/j.1004-9037.2017.01.014
9. H. Ouyang, D. Fan, D. Li, Invoice seal recognition for multi-feature fusion decision making, *Comput. Eng. Des.*, **39** (2018), 2842–2847. https://doi.org/10.16208/j.issn1000-7024.2018.09.026
10. F. Jiang, H. Chen, L. J. Zhang, FCN-biLSTM based VAT invoice recognition and processing, in *Edge Computing – EDGE 2018*, (2018), 135–143. https://doi.org/10.1007/978-3-319-94340-4_11
11. J. Shen, L. Han, Design process optimization and profit calculation module development simulation analysis of financial accounting information system based on particle swarm optimization (PSO), *Inf. Syst. e-Bus. Manage.*, **18** (2020), 809–822. https://doi.org/10.1007/s10257-018-00398-0
12. Y. Xu, C. Lv, S. Li, P. Xin, S. Ma, H. Zou, et al., Review of development of visual neural computing, *Comput. Eng. Appl.*, **53** (2017), 30–34. https://doi.org/10.3778/j.issn.1002-8331.1709-0474
13. Q. Wang, P. Lu, Research on application of artificial intelligence in computer network technology, *Int. J. Pattern Recognit. Artif. Intell.*, **33** (2019), 1959015. https://doi.org/10.1142/S0218001419590158

14. X. Liu, Y. Li, Q. Wang, Multi-view hierarchical bidirectional recurrent neural network for depth video sequence based action recognition, *Int. J. Pattern Recognit. Artif. Intell.*, **32** (2018), 1850033. https://doi.org/10.1142/S0218001418500337
15. Y. Hou, Q. Wang, Research and improvement of content-based image retrieval framework, *Int. J. Pattern Recognit. Artif. Intell.*, **32** (2018), 1850043. https://doi.org/10.1142/S021800141850043X
16. Q. Peng, G. Ji, L. Xie, S. Zhang, Application of convolutional neural network in vehicle recognition, *J. Front. Comput. Sci. Technol.*, **12** (2018), 282–291. https://doi.org/10.3778/j.issn.1673-9418.1704055
17. X. Zhao, Z. Sun, M. Xia, Vehicle image recognition method based on local learning, *J. Zhejiang Univ. Technol.*, **45** (2017), 439–444. http://xb.qks.zjut.edu.cn/CN/Y2017/V45/I4/439
18. L. Shi, S. Qiang, License plate character recognition based on combined support vector machine. *Comput. Eng. Des.*, **38** (2017), 1619–1623. https://doi.org/10.16208/j.issn1000-7024.2017.06.040
19. Q. Gao, Y. Liang, Q. Pan, Y. Chen, H. Zhang, The problem existed in face recognition using SVD and its solution, *J. Image Graphics*, **11** (2006), 1784–1791. https://doi.org/10.11834/jig.2006012312
20. M. Adil, M. K. Khan, M. Jamjoom, A. Farouk, MHADBOR: AI-enabled administrative distance based opportunistic load balancing scheme for an agriculture internet of things network, *IEEE Micro*, **42** (2022), 41–50. https://doi.org/10.1109/MM.2021.3112264
21. K. C. Rim, P. K. Kim, H. Ko, K. Bae, T. G. Kwon, Restoration of dimensions for ancient drawing recognition, *Electronics*, **10** (2021), 2269. https://doi.org/10.3390/electronics10182269
22. A. Xing, X. Tao, R. Peng, Thinking about the accounting industry in the era of artificial intelligence, *Account. Learn.*, **160** (2017), 112+114. Available from: http://www.ckxx.cbpt.cnki.net/WKG/WebPublication/paperDigest.aspx?paperID=9d9ee325-d998-420c-9e18-d24984315f65.
23. T. Shi, The impact of the rise of artificial intelligence on the future accounting industry, *Mod. Bus.*, **28** (2017), 122–123. https://doi.org/10.14097/j.cnki.5392/2017.28.053
24. M. Ren, Research on the functional transformation of accounting personnel under artificial intelligence, *Mod. Bus. Ind.*, **38** (2017), 68–69. https://doi.org/10.19311/j.cnki.1672-3198.2017.23.030
25. R. Sarkar, S. Halder, S. Malakar, N. Das, S. Basu, M. Nasipuri, Text line extraction from handwritten document pages based on line contour estimation, in *2012 Third International Conference on Computing, Communication and Networking Technologies (ICCCNT'12)*, (2012), 1–8. https://doi.org/10.1109/ICCCNT.2012.6395873
26. W. Wang, An image skew correction method by using directional white run-length, *Sci. Technol. Eng.*, **12** (2012), 5642–5644. Available from: http://www.stae.com.cn/jsygc/article/abstract/121573?st=article_issue.
27. J. S. Goldstein, I. S. Reed, L. L. Scharf, A multistage representation of the wiener filter based on orthogonal projections, *IEEE Trans. Inf. Theory*, **44** (1998), 2943–2959. https://doi.org/10.1109/18.737524
28. Y. Yu, J. Li, Denoising research based on wiener filter, *J. Luoyang Norm. Univ.*, **36** (2017), 29–32. https://doi.org/10.16594/j.cnki.41-1302/g4.2017.02.008

29. S. Palanisamy, B. Thangaraju, O. I. Khalaf, Y. Alotaibi, S. Alghamdi, Design and synthesis of multi-mode bandpass filter for wireless applications, *Electronics*, **10** (2021), 2853. https://doi.org/10.3390/electronics10222853
30. H. Song, M. Brandt-Pearce, A 2-D discrete-time model of physical impairments in wavelength-division multiplexing systems, *J. Lightwave Technol.*, **30** (2012), 713–726. https://doi.org/10.1109/JLT.2011.2180360
31. L. Wang, Y. Chen, L. Liu, Research on text image layout segmentation algorithm based on projection contour analysis, *Digital Technol. Appl.*, **3** (2017), 164–165. Available from: http://www.cqvip.com/QK/95792B/20173/671781608.html.
32. J. Schmidhuber, Deep learning in neural networks: An overview, *Neural Networks*, **61** (2015), 85–117. https://doi.org/10.1016/j.neunet.2014.09.003
33. Y. Feng, S. Zeng, Y. Yang, Y. Zhou, B. Pan, Study on the optimization of CNN based on image identification, in *2018 17th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES)*, (2018), 123–126. https://doi.org/10.1109/DCABES.2018.00041
34. A. Krizhevsky, I. Sutskever, G. E. Hinton, Imagenet classification with deep convolutional neural networks, *Commun. ACM*, **60** (2017), 84–90. https://doi.org/10.1145/3065386

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