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Image Recognition-based Financial Reimbursement Voucher Preprocessing and Automatic Entry System

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ABSTRACT

In the current process of social development, reimbursement has become a generally accepted phenomenon. With the improvement of economic level and the improvement of people's living standards, all walks of life have developed rapidly, which also provides new ideas for the financial reimbursement system and financial management. At present, most of the financial reimbursement processing is conducted manually, which can not meet people's requirements for work efficiency. Moreover, there are many limitations, which are very unfavorable for enterprises. Therefore, it is necessary to take reasonable and effective measures to strengthen the improvement and optimization of the financial reimbursement system, so as to ensure the safe and efficient operation of funds. Image recognition technology is an indispensable and important means of modern information management. It can automatically extract data information and analyze statistics, which brings great convenience to financial reimbursement. This paper mainly studied the problems related to financial reimbursement based on the process of image recognition and denoising, and put forward some suggestions for the design of financial reimbursement image recognition system. It is hoped that it can promote its better application in practical work, so as to achieve the purpose of improving economic efficiency and ensuring the security of funds, and at the same time help further promote the healthy and orderly development of enterprise construction. This paper compared the traditional manual reimbursement method with the financial reimbursement automatic entry system based on image recognition. The results showed that the error of automatic input system was smaller than that of manual mode, and the degree of automation was higher; in addition, the accuracy rate of reimbursement voucher identification and review had also increased by about 6.34%. Therefore, this method has good advantages and practicability, and this method is conducive to reducing the workload of staff and facilitating the follow-up work. To sum up, electronic imaging technology can analyze and process data with the help of image processing means, thus obtaining corresponding results. It is convenient to adjust the accounting process as needed and timely in the process of financial management, so as to make the overall financial reimbursement work more standardized and unified.

Keywords: Image Recognition, Financial Reimbursement, Document Pre-processing, Automatic Entry System

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1. Introduction

Financial reimbursement is an unavoidable part of the operation of enterprises, educational institutions, medical institutions, etc., involving employee travel, transportation costs, office supplies procurement, etc. [1]. The traditional financial reimbursement process is usually cumbersome and time-consuming, need to fill out the reimbursement form, supervisor approval, financial audit, payment and other links [2-3]. With the development of science and technology, enterprises began to explore the financial reimbursement process intelligence, in order to improve efficiency and reduce costs.

Financial reimbursement intelligence not only realizes the supervisor and financial personnel to quickly review and improve the efficiency of approval, but also through intelligence, enterprises can better grasp the financial situation, timely understanding of the use of various costs, for the enterprise's business decision-making to provide more accurate data support [4-5]. The traditional reimbursement process requires employees to fill out a paper reimbursement form, while the reimbursement process intelligence can be achieved through the enterprise's internal financial management system to fill out the reimbursement form online [6]. Financial reimbursement process intelligence not only reduces the use of paper reimbursement, to avoid waste of resources, but also improves the convenience and efficiency of the operation. In the traditional financial reimbursement process, employees need to manually fill out the reimbursement form and submit it to the financial department, there may be inadequate storage of the reimbursement form lost, as well as manual operation and the use of paper documents can easily lead to errors, such as filling in the wrong amount, omission of vouchers and so on. The intelligent financial reimbursement is pre-processed through preset rules and logic, which can avoid these errors by instantly checking and reminding when submitting the application [7-10]. In addition, it can also have authority control and auditing functions to monitor and record the compliance and authenticity of the reimbursement audit process, effectively preventing internal fraud and improper use of financial resources [11-12]. Different enterprises or organizations have different reimbursement policies and reimbursement processes, and the requirements for reimbursement vouchers are also very different. Therefore, under intelligent technology or algorithms, setting reimbursement requirements through given constraints, recognizing vouchers for preprocessing, and then implementing automatic entry of reimbursement information is the key process of financial reimbursement intelligence.

In order to solve the problem of cumbersome and inefficient traditional financial reimbursement operation, this paper designed an automatic entry system for financial reimbursement based on image recognition technology. By using existing image processing technology and resources, it provided enterprises with a simple, efficient, safe and fast management platform that saved manpower and material resources, and improved the efficiency and quality of financial reimbursement. Compared with the common manual reimbursement method, this method not only saved time and labor, but also promoted the automation of financial workflow, which greatly improved the work efficiency and fund utilization rate. The automatic reimbursement system of intelligent financial vouchers based on image recognition can realize the digital processing of bill information and promote the process of industry informatization.

2. Background and research significance

2.1. Exploration Background

In the process of accounting business processing, due to the influence of various factors, information distortion and other phenomena often occur, which not only brings unnecessary economic losses to accountants and managers, but also seriously destroys the order of accounting work. Financial reimbursement is an important part of the process of economic activities between accounting

information users and accountants. It has the following characteristics: the first is the large amount; the second is the strong liquidity of funds; third, the scope of expenses is extensive. However, with the increasingly fierce competition among enterprises in the market economy, financial reimbursement management is facing many new situations and problems, such as the lack of uniform and complete regulations for financial reimbursement, non-standard reimbursement vouchers, cumbersome procedures, and complex content, which make many people feel at a loss, and even produce resistance. Therefore, how to do a good job in financial reimbursement has become an urgent problem to be solved.

2.2. Significance of Improving the Financial Reimbursement Process Based on Image Recognition

2.2.1. Simplification of Working Procedures and Improvement of Enterprise Financial Management Efficiency. Under the traditional financial management mode, due to the lack of necessary information management, the financial expenditure remains high, which causes great economic losses and seriously affects the development speed and efficiency of enterprises. Therefore, it is necessary to adopt advanced computer vision theory and obtain various economic and business-related information through image technology. The required objects are quickly and accurately segmented from the original photos, and converted into digital models for modeling and calculation, so as to facilitate decision support and efficiently complete the reimbursement task.

2.2.2. Strengthening of the Internal Audit Supervision and Promotion of the Quality and Authenticity of Accounting Information. Accounting is a very complicated and tedious work. The traditional method of financial reimbursement is completed by accountants by filling in various documents manually, and these documents need to be filled in manually, which is not only inefficient and error-prone, wasting human and financial resources, but also can not guarantee the authenticity and reliability of account information. The use of image recognition technology can accurately restore the accounts. The accuracy of the entire reimbursement process can be greatly improved through automatic computer audit, so as to avoid the occurrence of misstatement and omission.

2.2.3. Cost Reduction and Overall Social Competitiveness Enhancement. Finance is an important part of economic activities, and its expenses are directly related to the vital interests of the people. At present, most enterprises generally have the phenomenon of low capital utilization rate and capital shortage. The application of image recognition technology can effectively understand the financial status and operating status of enterprises from multiple perspectives, and transmit the results to relevant departments, so as to better monitor whether the enterprise management activities are reasonable and perfect.

3. Design of Automatic Entry System for Financial Reimbursement Vouchers

3.1. Establishment Process of Financial Reimbursement Pre-processing and Automatic Entry System

The establishment of the financial reimbursement automatic entry system can be divided into two situations. One is implemented manually, and the other is developed based on hypertext pre-processor technology. At present, most financial personnel complete financial management by filling in forms manually. For enterprises, daily business activities involve many aspects, including sales, procurement and other departments. If these data cannot be transmitted to the relevant person in charge timely and accurately, it would cause a lot of economic losses and even affect the entire company. Therefore, it is necessary to have a complete set of financial reimbursement automatic entry software to meet the daily management needs of enterprises, so as to provide enterprises with more efficient and convenient financial processing services. The system can be built in three stages, as shown in Figure 1.

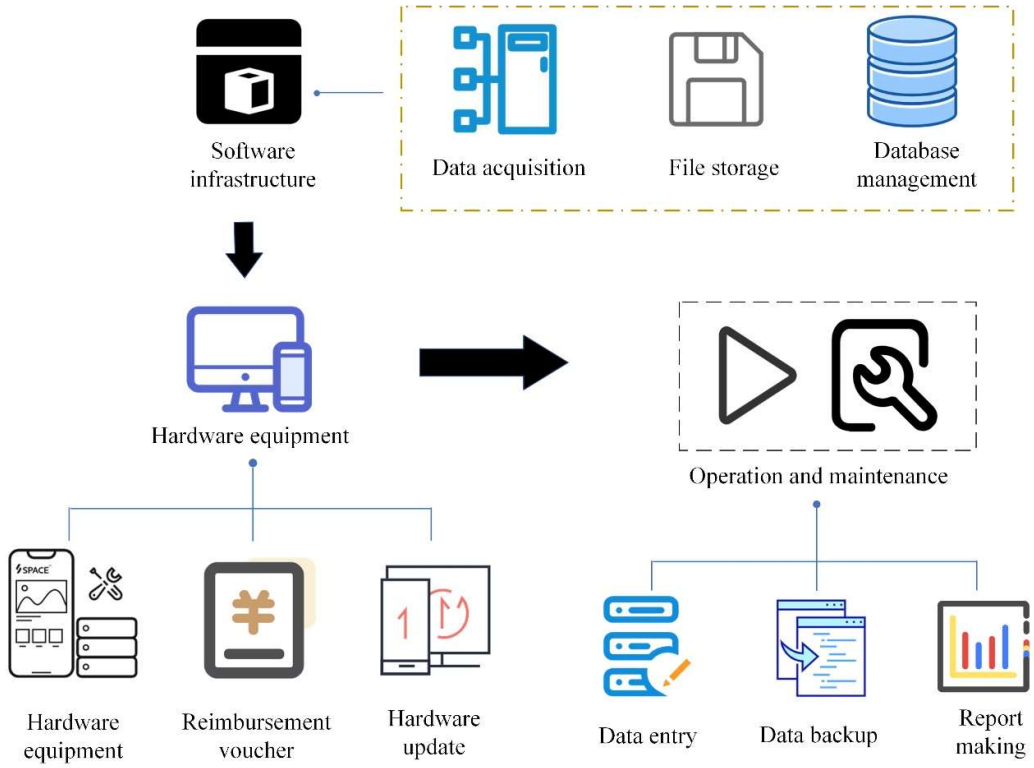


Fig. 1. Establishment of automatic entry system for financial reimbursement

The first stage is software infrastructure construction. At this stage, it is necessary to establish a complete database structure and corresponding management platform. It mainly includes data collection, data file storage, database management and other functions, as well as software development, financial reimbursement management system model construction, financial reimbursement business process design completion and financial management software package development. The second stage is hardware equipment procurement, installation and commissioning. This is the most critical part of the whole project implementation process. It mainly addresses the capital requirements for hardware equipment selection, installation and commissioning, as well as the software and hardware configuration, including the auxiliary modules that provide convenience for users to realize financial reimbursement business, and the generation of various forms of vouchers. The third stage is operation and maintenance. The task of this stage is to solve the actual problems encountered in the daily use of the financial reimbursement information system, such as data entry, data backup, report production, etc., which all require specialized personnel to complete. Therefore, the workload is large and the cost is high, so it must have a strong professional and technical level. By combining and integrating various tasks into a unified management platform, the whole financial reimbursement management system can be made to achieve good results.

3.2. Classification and Automatic Entry Principle of Financial Reimbursement Vouchers

The financial management work must be handled in accordance with the regulations. Generally, the payment is made in cash, and the reimbursement amount is limited. Financial reimbursement is mainly used in accounting work, including accounting vouchers, receipts, etc. Generally speaking, reimbursement vouchers are prepared by the accounting department. After filling, the data would be stored in the computer, and then reviewed and confirmed by the financial software. The financial reimbursement voucher can be used to reflect the expenses incurred by the enterprise in the production and operation process, and can handle or settle these payments in a timely manner. It is

characterized by authenticity, accuracy and completeness. It is a true and complete economic and business document. Its main function is to provide relevant information for daily management, supervision and inspection, and it can also serve as the basis for accounting. There are several main formats of financial reimbursement vouchers, including cash receipts, bank transfer vouchers, bank deposit sub-ledgers, receipts, invoices, etc. Financial reimbursement vouchers are mainly used for fund settlement and can also be used as the basis for financial management. Cheque reimbursement vouchers can be used directly without the cashier's signature formalities, while bank bills can only be used after examination.

The function of bookkeeping voucher is similar to that of traditional bookkeeping method, with certain flexibility. Its advantages are convenient for statistical accounting, cost saving and work efficiency improvement. Its disadvantage is that it can not guarantee the consistency between accounts and facts. It is easy to make mistakes during the audit, and there is forgery and alteration, which affects the realization of the business objectives of the enterprise.

The electronic bill reimbursement voucher is a new reimbursement tool that transmits electronic data to the financial department for management and supervision through the network. This form only needs to input the corresponding ticket number to realize the reimbursement function, which can effectively solve the problems existing in the traditional accounting model. In particular, the monitoring and control of information quality can enhance the transparency of accounting work.

The bank bill reimbursement voucher shall be issued by the payee or entrusted to other institutions for collection. The payee must apply to the deposit bank with relevant supporting materials and submit relevant materials before issuing. It is mainly paid in cash, and has multiple means of payment such as telegraphic transfer, telegram, fax and telephone.

Cheque reimbursement vouchers are made by special design, which can meet the reimbursement requirements and are easy to carry and save. Therefore, they are widely used in various industries, especially in institutions. Because of their flexibility, convenience and low price, they have become one of the most widely used reimbursement methods. In addition, financial reimbursement has also been widely used in official business transactions between government departments, production and operation activities within enterprises, and hospital outpatient treatment and inpatient settlement, which provides more convenient and fast services for enterprises and institutions.

The working principle of the automatic entry system of financial reimbursement vouchers is as follows: first, the enterprise's capital demand is analyzed, and the amount of capital required is transferred to the financial software through the network; the corresponding data is filled in as required and the financial reimbursement documents are generated; finally, after sending the financial reimbursement document and relevant information to the designated server, the filling, review and printing of the financial reimbursement voucher would be completed immediately. The specific process is shown in Figure 2.

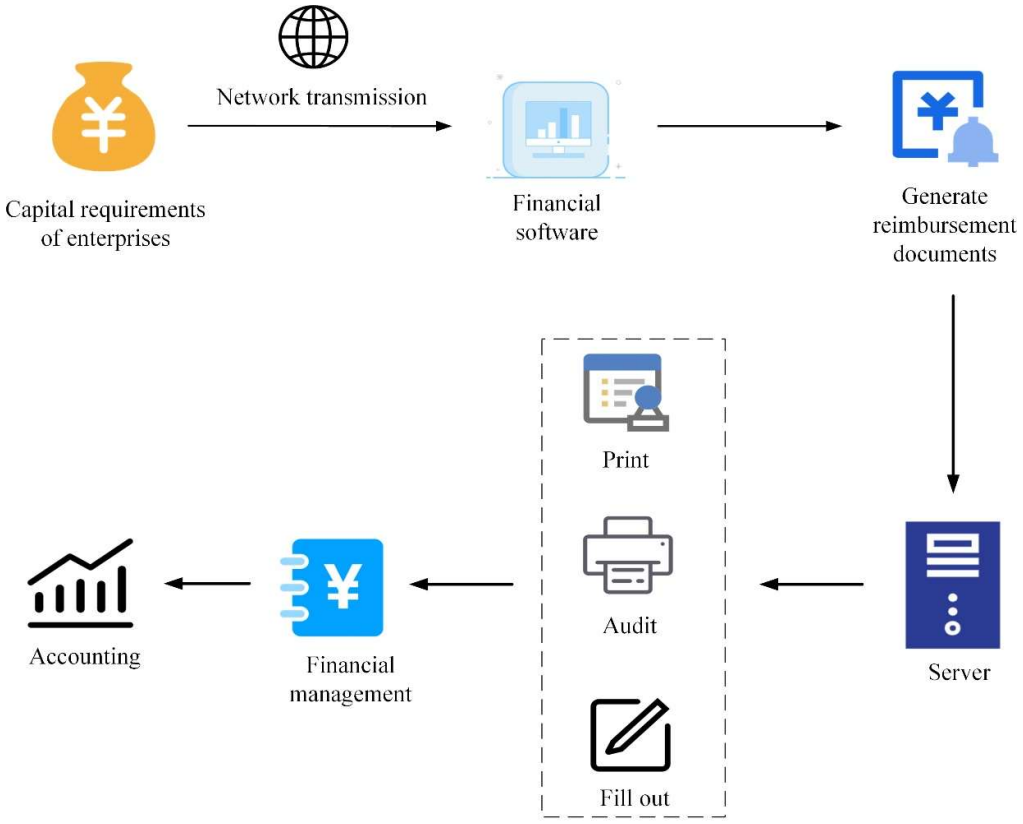


Fig. 2. Working principle of automatic entry system for financial reimbursement

The automatically entered financial receipt is the bill printed by the printer, which is equivalent to the cashier entering a document when filling in the original voucher. Therefore, it not only has the function of general reimbursement voucher, but also has its own special function. It can be used for financial management, accounting, management and statistics. After that, when printing out the required amount as the basis of payment as required, the financial personnel shall be responsible for checking, registering and filing to ensure the authenticity and accuracy of accounting information. From the perspective of implementation, the system simplifies the cumbersome and complex manual filling function and manual filling data process in the traditional financial reimbursement software, and forms a financial reimbursement automatic input management system that integrates financial management, bill management and accounting processing.

3.3. Financial Reimbursement Pre-processing Image Recognition and Denoising

Financial reimbursement pre-processing image recognition and denoising methods are currently the research focus in the field of image processing. However, the traditional image segmentation algorithm has the problems of slow processing speed and low accuracy, and does not consider the impact of noise on the detection effect, so it cannot effectively complete the classification of financial bills. To solve the above problems, by analyzing the existing gray histogram feature information and threshold extraction rules, a new operator based on the combination of improved adaptive morphology and Gaussian mixture model is proposed to achieve fast and accurate segmentation of financial bills, so as to improve the efficiency of feature extraction.

3.3.1. mage Equalization. In order to increase the contrast of the gray image of the reimbursement voucher, the histogram method is used to equalize the image. The gray statistical histogram obtained is a discrete function, and its definition formula is:

$$F(G_i) = \frac{N_i}{N} \tag{1}$$

Among them, G_i is the i-level gray value of the image; $i = 0,1,2,...,l-1$, and l is the number of gray levels; N_i is the number of pixels with gray value G_i, and N is the total number of pixels.

If the transformation function of the histogram is f, there are:

$$f_i = EH(g_i) \tag{2}$$

f_i is the transformed gray level, and g_i is the original gray level; $g_1 < g_2$, and $f_1 < f_2$.

Therefore, in practical applications, there are:

$$H_j = \frac{n_{lj}}{d \times h} \times 255 \tag{3}$$

Among them, H_j is the new gray value after point j transformation, and n_{lj} is the number of pixels less than or equal to the gray value of the pixel at point j.

3.3.2. Image Enhancement Methods and Classification. Commonly used image enhancement methods include mean filtering, low-pass filtering, edge enhancement, etc. Their principle is to eliminate the background information by denoising the original image, and mainly for the random noise in the image. The smoothing operator based on Gaussian mixture model can effectively remove the random noise in the image. Its definition formula is:

$$Y(a,b) = \frac{1}{n} \sum_{(x,y)\in A} S(x,y) \tag{4}$$

The performance of image smoothing operator would directly affect the accuracy of edge detection, so it is necessary to select appropriate brightness function and texture coefficient to achieve good results.

The enhancement operator is to transform the original image into a series of new images with the same pixel value and gray value according to certain rules, which can be expressed as follows:

$$Y(a,b) = 2S(x,y) - \frac{1}{n} \sum_{(x,y)\in A} S(x,y) \tag{5}$$

On this basis, the improved edge detection algorithm can obtain higher quality target area and better contrast distribution.

3.3.3. Image Normalization. Image normalization refers to a method of morphologically processing the original pixels with the same color characteristics without changing the original gray value and pixel value, so as to make them consistent or close to the original pixels. When processing the financial voucher image, different pre-processing algorithms can be used according to the actual situation to adjust the compression ratio size and clarity of the image after compression.

The calculation formula of gray mean value is:

$$P(H) = \frac{1}{d \times h} \sum_{x=0}^{d-1} \sum_{y=0}^{h-1} H(x,y) \tag{6}$$

The variance is:

$$C(H) = \frac{1}{d \times h} \sum_{x=0}^{d-1} \sum_{y=0}^{h-1} (H(x,y) - P(H))^2 \tag{7}$$

When $\sum_{y=0}^{h-1} (H(x,y) > P(H)$, there are:

$$K(x,y)=P(H_0)+\sqrt{\frac{C(H_0)\times(H(x,y)-P(H))^2}{C(H)}} \tag{8}$$

In other cases, there are:

$$K(x,y)=P(H_0)-\sqrt{\frac{C(H_0)(H(x,y)-P(H))^2}{C(H)}} \tag{9}$$

Among them, $H(x,y)$ represents the gray value of point (x,y) in the image after equalization of the image with size $d\times h$, and $K(x,y)$ represents the gray value of the normalized image point.

3.4. Design of Financial Reimbursement Automatic Entry System Based on Image Recognition

The automatic entry system of financial reimbursement based on intelligent image recognition has the advantages of convenient operation, high accuracy, and automatic identification of different types of bills. After simple operation and training for users, it can quickly complete the collection and processing of financial reimbursement data, which has certain significance for improving the level of enterprise financial management. The main design and composition of the system are shown in Figure 3.

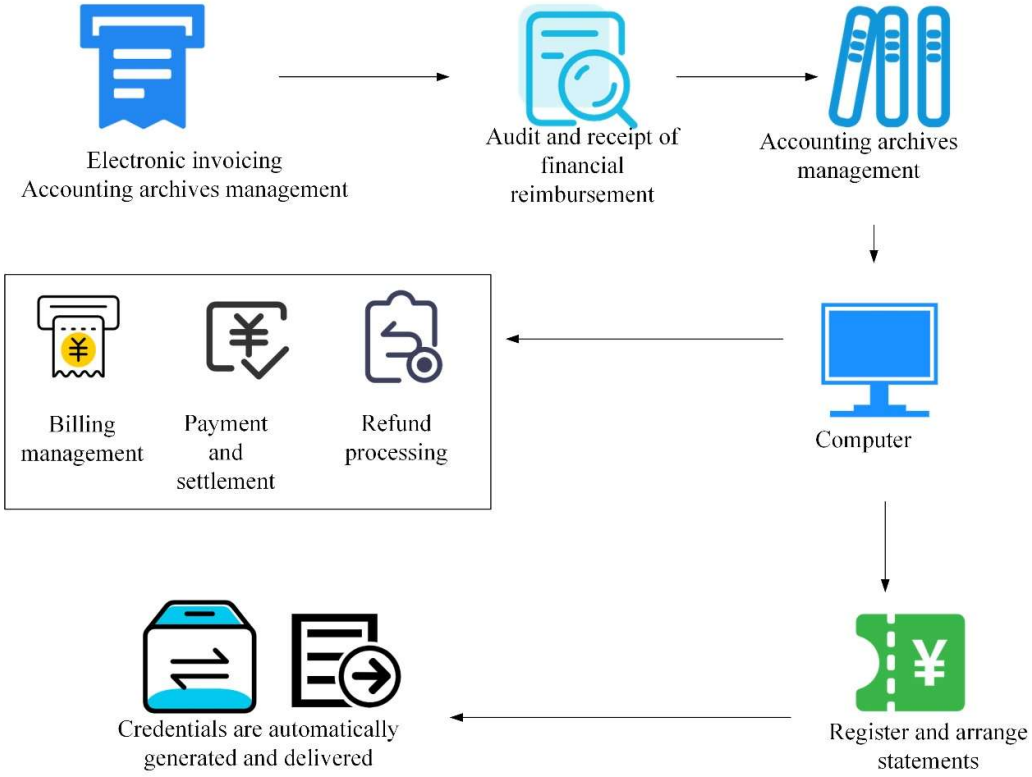


Fig. 3. Design of automatic entry system for financial reimbursement based on image recognition

The financial reimbursement automatic entry system based on image recognition is mainly composed of electronic invoice issuing module, financial reimbursement review and verification module, and accounting file management module. Among them, the electronic invoice issuing module includes the invoicing management module, payment settlement module, refund processing module, ticket payment module, accounting processing module, etc. The financial reimbursement review and verification module is the most critical and powerful part of the whole system. The main function of this module is to ensure the quality of financial management. It realizes the automatic generation and transmission of vouchers through computer software, and realizes the information

control of capital flow process, thus achieving the purpose of saving labor costs. The accounting file management module is responsible for the registration, collation and other management of various statements. The financial personnel can view relevant information at any time and provide relevant suggestions in a timely manner. It has the characteristics of friendly interface and simple operation, which lays a solid foundation for the efficient implementation of financial management. The combination of the above three subsystems can effectively improve the financial management level of enterprises, and reduce the possibility of financial risk and accounting information distortion, so that enterprises can better play their important role in economic construction.

Compared with the traditional manual input method, the financial reimbursement automatic input system based on image processing can improve the work efficiency without increasing the cost, and reduce the errors and errors caused by manual operation, which makes the financial management more scientific and standardized. The specific image recognition process and the specific role of each process are shown in Table 1.

Table 1. Image recognition process of automatic entry system for financial reimbursement

Identification process	Description
Filter enhancement	Ensure accurate and reliable image recognition results
Binarization	Retain the original image features and reduce noise interference
Refinement	Eliminate background noise while narrowing the edge outline
Classification of reimbursement vouchers	Form the certificate sample set, get the distribution rule, reduce the misjudgment rate
Feature extraction	Realize automatic processing of reimbursement review
Match	

The pre-processing image recognition process of financial reimbursement includes: filter enhancement, binarization, thinning, reimbursement voucher classification, feature extraction, matching, etc. Filter enhancement is the key technology to ensure the accuracy and reliability of image recognition results, including threshold selection and smoothing, pixel histogram generation and analysis, and template selection. Binarization can better retain the original image features and reduce noise interference, and the fine-grained gray information can be easily used to extract the attributes needed in the training data, which provides a basis for feature extraction. Filter enhancement and binarization are the basis of image pre-processing and segmentation, and also the key to improve the accuracy. Thinning is to use edge detection operator to subdivide rough and poor areas. The thinning image can effectively eliminate background noise, and reduce the range of edge contour to make it closer to the real texture structure, thus further improving the requirements for image quality. The reimbursement vouchers are classified and identified according to the detailed results. On this basis, the cluster algorithm is used to organize all types of reimbursement vouchers according to certain rules to form a complete sample set. The similarity distribution rules under different categories are obtained, and then the correlation between them and corresponding labels is determined to reduce the rate of misjudgment. After that, the reimbursement vouchers are accurately clustered and matched with the feature point extraction method, which can realize the automatic processing of reimbursement review based on feature selection and feature extraction, so as to achieve the purpose of fast and efficient completion of reimbursement review.

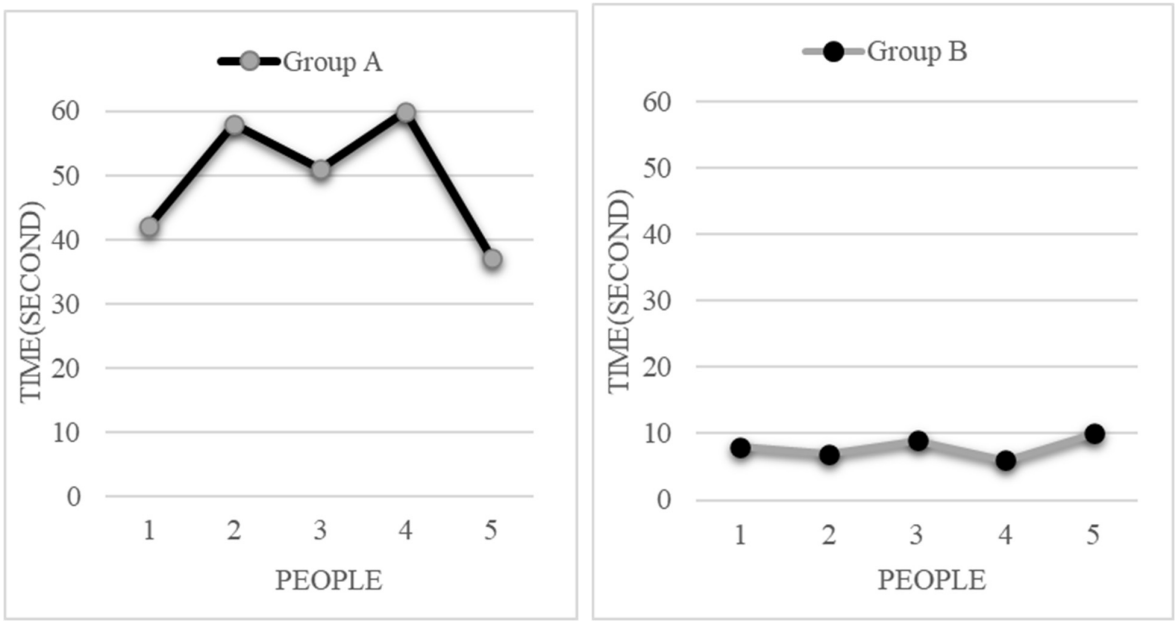
4. Comparative Experiment of Automatic Entry System of Financial Reimbursement Voucher Image Recognition

4.1. Experimental Method

Two leading enterprises in a certain industry were the experimental objects. Five employees were selected from the financial departments of the two enterprises to conduct a questionnaire survey. The two enterprises were named Enterprise A and Enterprise B, and the randomly selected employees were divided into Group A and Group B according to different companies. In the face of the same batch of financial reimbursement documents, Group A adopted the traditional manual identification method for statistical review, while Group B adopted the automatic entry system based on image recognition. It was known that the workload of the two groups of employees was the same and the professional level was similar. A comparative test was set up from three aspects of accuracy, recognition speed and entry efficiency, and the experimental data was recorded and analyzed.

4.2. Data Evaluation

4.2.1. Identification Speed. The speed of two groups of employees was measured by counting the time it took to identify a reimbursement voucher. The results are shown in Figure 4.

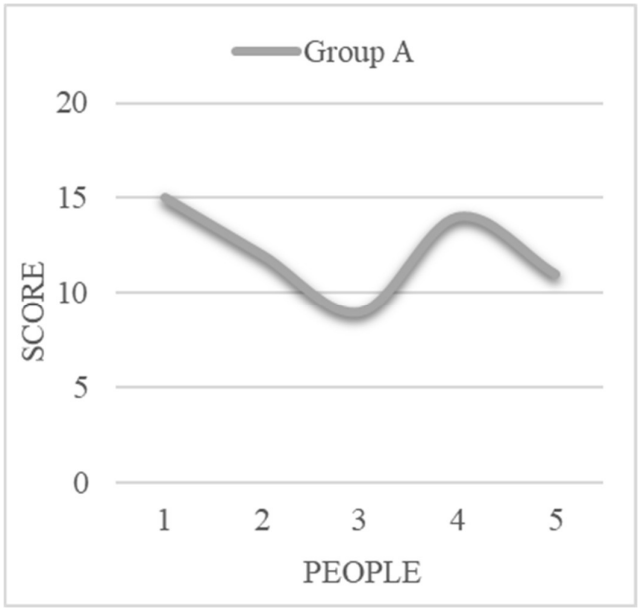


(a) Group A identification speed (b) Group B identification speed

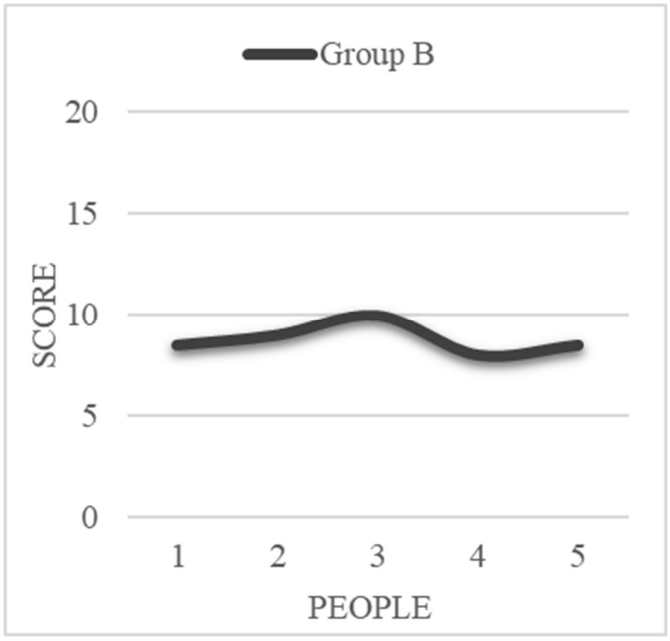
Fig. 4. Comparison of identification speed of the two groups of reimbursement vouchers

Figure 4a shows the recognition speed of Group A, and Figure 4b shows the recognition speed of Group B. It was obvious that the data difference between the two groups of images was very obvious, and even some data of Group A was almost 5-6 times that of Group B. The time for Group A employees to identify a reimbursement voucher was about 30-60 seconds; the highest was even 1 minute, and the lowest was about 37 seconds. In Group B, it only took less than 10 seconds to fully identify a certificate, which greatly shortened the work process. Employees only need to operate the computer program to make the machine complete automatic identification, which greatly improved the work efficiency.

4.2.2. Entry Efficiency. The total time taken by the two groups to complete the entry of this batch of vouchers was counted to test the entry efficiency, and the results are shown in Figure 5.



(a) Time spent by Group A to complete entry



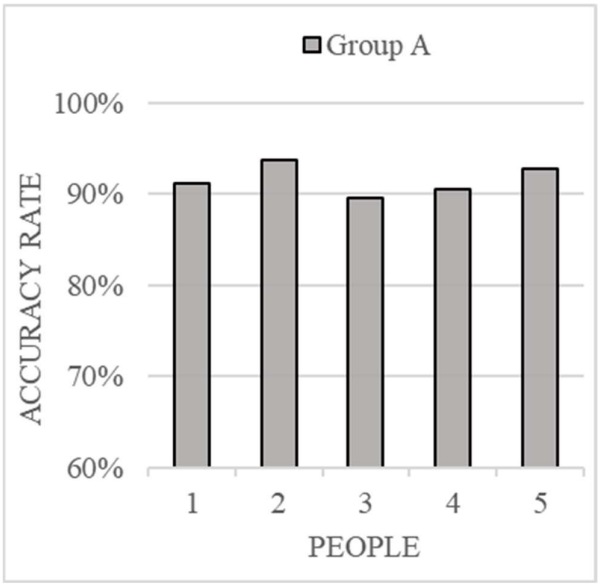
(b) Time spent by Group B to complete entry

Fig. 5. Comparison of input efficiency between the two groups

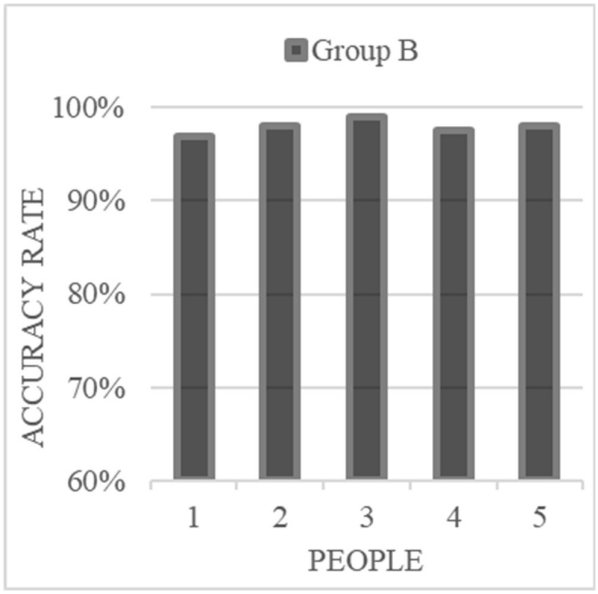
Figure 5a shows the time taken by Group A to complete the entry, and Figure 5b shows the time taken by Group B to complete the entry. The curve of Group A experienced a downward trend at first and then an upward trend at last; due to the influence of external interference and identification difficulty, the differences between employees were large. The curve of Group B was almost a flat straight line, which showed that the identification of this group had no obvious hindrance in the process of entry. Therefore, it can be considered that when manual collection was used, the entry efficiency was low, and it was easy to cause work backlog, even missing entries and misjudgment,

which was not conducive to enterprise production management. However, the automatic input system can achieve fast input, timely output, and reduce error losses, so as to reduce costs, improve efficiency, save costs, and enhance competitiveness.

4.2.3. Accuracy. The accuracy of the entry results of two groups of reimbursement vouchers was reviewed, as shown in Figure 6.



(a) Group A accuracy



(b) Group B accuracy

Fig. 6. Comparison results of recognition accuracy of two groups

Figure 6a shows the accuracy rate of entry results of Group A, and Figure 6b shows the accuracy rate of entry results of Group B. It can be seen from Figure 6 that the accuracy of both groups was at a relatively high level; in particular, in Group B, the accuracy rate of all employees was more than 95%, and even that of some employees was about 99%, which meant that the machine can automatically process data and analyze results during the recognition and entry of reimbursement

vouchers. Therefore, when employees find errors in a file, they can quickly judge whether the file is correct through computer software, thus improving work efficiency and accuracy, and the whole work process is also very smooth. The accuracy rate of Group A hovered around 90%, indicating that there were certain errors in the reimbursement process; however, on the whole, the task was well completed. After calculation, the average accuracy rate of Group A was about 91.56%, and that of Group B was about 97.9%, which was about 6.34% higher than that of Group A. It can be seen that the computer automation technology based on image recognition can greatly improve the efficiency of manual operation and reduce the labor cost, thus enabling enterprises to obtain more benefits.

5. Conclusions

The automatic entry system of financial reimbursement is a new financial management mode, which takes computer as the core and adopts advanced computer technology and network technology. It combines advanced technologies such as computer vision technology, database management and intelligent information processing, which frees financial personnel from the tedious and complicated manual accounting. By introducing image recognition technology into the system, all accounts can be fully and accurately filled in and saved to the database, so as to realize rapid and accurate automatic recognition and processing of enterprise financial information. It provides a quick and convenient working platform for financial management personnel, and effectively improves the level of enterprise financial management.

This paper mainly introduced the design and implementation of the financial reimbursement automatic entry system based on image recognition. Firstly, the concept and function of financial reimbursement automatic entry software were described, and then the problems faced in the actual application of financial reimbursement were discussed in detail. On this basis, the paper put forward the important significance of image recognition automatic entry system for financial personnel in financial management, improving work efficiency and saving labor costs. It can not only effectively reduce labor costs, but also reduce errors in the production and operation process of enterprises, improve management efficiency and product quality, and thus promote the development of economic construction. It has high practical value.

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Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Conflicts of Interest

These are no potential competing interests in our paper. And all authors have seen the manuscript and approved to submit to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

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