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The Restoration of Defocus Images with Linear Change Defocus Radius

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Abstract

A novel approach is proposed to restore the defocus image with the linear change defocus radius. Firstly, by studying the space-invariant defocus blurring model, the space-variant defocus blurring model with the linear change defocus radius is obtained. Then, a nonlinear coordinate transforms for blurred image is used to convert the space-variant images blurring into space-invariant blurring images, which is easier restored. The experimental results demonstrate the restoration image has more details and fewer ringing. The restoration effect of the proposed method reveals its practicability in the space-variant defocus image restoration.

Keywords: Defocus image, Linear change defocus radius, Space-variant blurring.

1. Introduction

Defocus blurred images are produced when the focus is not accurate in the processing of shooting process. Defocus blur is one of the most important blur. So the defocus blurred image restoration is particularly important[1-2].

Image point spread to spot while image plane is out of focal plane, which result in out of focus. These spread are described by PSF(point spread function). The PSF is space invariant when image plane is parallel with focal plane. Conversely, the point spread variant following a point on the image surface. At this time, the defocus blur is space-variant. All this time many scholars, both at home and abroad, have made great efforts to space-invariant defocus blur and work out a lot of achievement[3-5]. However, because of the complexity of space-variant defocus blur, there is no effective restoration algorithm for space-variant defocus blur.

Considering the cause of defocus blur, due to arbitrariness of location of image plane and focal plane, the PSF of space-variant defocus blur is very complex. So it is very difficult to restore the space-variant defocus images. The blind restoration algorithm is mostly used to solve the restoration problem in many domestic and foreign literatures. However, the restoration result is often very poor because of little prior knowledge[6-7]. In order to simplify the problem, in this paper we only consider a simple space-variant defocus blur, namely there has an angle between the image plane and focal plane, by this time, the defocus radius of the blurred image is linear change. By studying the PSF of space-invariant defocus blur, this article first derives the PSF of space-variant defocus blur with the image plane is not parallel with focal plane. Then the restoration algorithm is proposed for this space-variant defocus blur images so as to solve the restoration problem that the image plane is not parallel with focal plane.

This paper is organized as follows. In Section 2, we present the PSF model of space-variant defocus

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image with linear change defocus radius. In Section 3, we present a novel restoration method of the above defocus image. Experiments are demonstrated in Section 4, and conclusion is presented in Section 5.

2. PSF model of space-variant defocus blur

2.1 Image plane is parallel with focal plane

A simple optical imaging system consisting of lens is illustrated in Fig.1[8]. Where p_1 represents object point, p_2 represents image point, u represents object distance and v represents image distance, s denotes the distance from the len to the image sensor, f denotes the focal length. So the Gaussian imaging formulas is:

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f} \tag{1}$$

When s=v, the point p_1 is imaging in the point p_2, which is called focusing. When $s \neq v$, the image point p_2 will spread in the image sensor. According to the principle of geometrical optics, the image point p_2 spread into the circular with the radius r, which results in the defocus blur of the image. Apparently, the greater the distance between s and v is, the more serious the focal is. And so the image is more blurring.

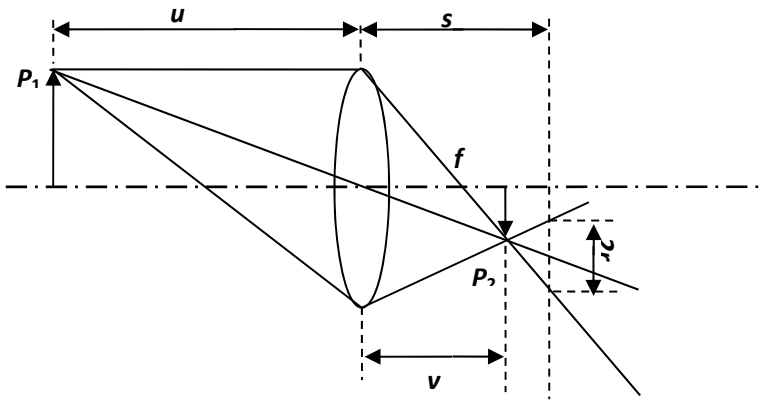


Figure.1Optical imaging system schematic diagram when the image plane is parallel with focal plane

And then through the geometrical relation of Fig.1, to be seen

$$\frac{r}{a}=\frac{s-v}{v}=s\left(\frac{1}{v}-\frac{1}{s}\right) \tag{2}$$

From formula (2), as long as the focal plane is parallel with the image plane, the focal radius r would not change. This is the so-called space-invariant defocus blurring. Its PSF is able to use a simple disk model to simulate. Then the restoration result is perfect by using the existing restoration algorithm such as Wiener filtering.

2.2 Image plane is not parallel with focal plane

When the image plane is not parallel with focal plane, as illustrated in Fig.2, Suppose the angle between image plane and focal plane is

The intersection of image plane and optical axis is *J*, *s* denotes the distance from *J* to the center of optical axis. *Q* represents any point in the image plane and *z* represents the distance from *J* to *Q*. The

defocus radius of point *Q* is deduced by the formula (2).

$$r_0 = as\left(\frac{1}{v} - \frac{1}{s}\right) \tag{3}$$

$$\begin{aligned} r &= a\left(s - z\cos\theta\right)\left(\frac{1}{v} - \frac{1}{s}\right) \\ &= as\left(\frac{1}{v} - \frac{1}{s}\right) - a\left(\frac{1}{v} - \frac{1}{s}\right)\cos\theta z \\ &= r_0 + kz \end{aligned} \tag{4}$$

Where $k = a\left(\frac{1}{v} - \frac{1}{s}\right)\cos\theta$, so when there has only one angle between image plane and focal plane, the defocus radius is linear change. Similarly, according to the space-invariant PSF, the current PSF model is:

$$PSF = \frac{1}{\pi r^2} = \frac{1}{\pi\left(r_0 + kz\right)^2} \tag{5}$$

The next step is to study how to implement the restoration of defocus image with the above PSF.

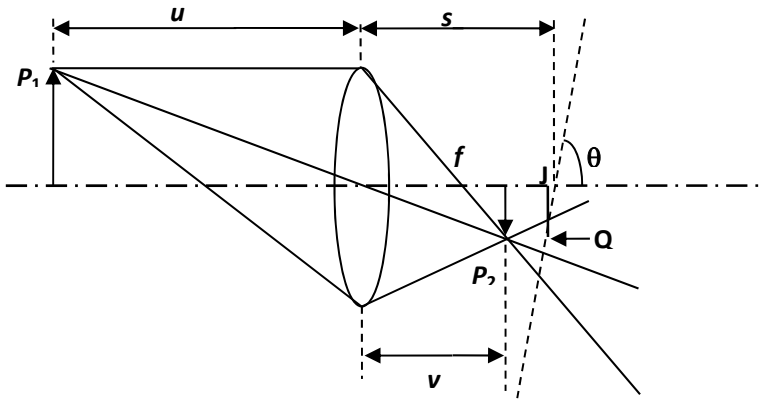


Figure.2 Optical imaging system schematic diagram when the image plane is not parallel with focal plane

3 The restoration of defocus image with the linear change defocus radius

The mathematical model is[9-10]

$$g\left(x,y\right) = \iint f\left(\alpha,\beta\right)h\left(x,\alpha;y,\beta\right)d\alpha d\beta + n\left(x,y\right) \tag{6}$$

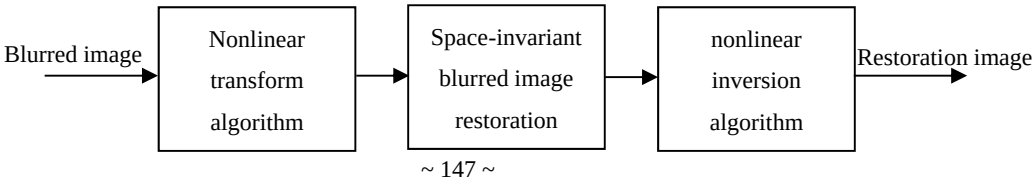


Figure 3. The method of nonlinear transform

Considering the defocus radius is linear change and the PSF is simultaneously related to the location between the image plane and the scene plane, the mathematical model is the space-variant model. So the model cannot be further simplified as a convolution model.

For space-variant model, there are two methods. The one is that the image is divided into many blocks so as to make every image blocking approximate to space-invariant mode, along with much obvious artificial trace in the connection part among image blocks. The other is to make a nonlinear transform for blurred image so that the space-variant blurring is converted into space-invariant blurring. The process is shown as in Fig.3

For linear variety defocus radius $r(z)=r_0+kz$, we do non-uniform sampling in interval [0,Z]. In any point z, if the sampling points are the same in interval r, the scale of space-variant PSF is irrelevant to the spatial location of the resulting sample sequence. In other words, the resulting sample sequence represents the space-invariant blurred image. So we can convert the space-variant PSF into the space-invariant PSF by using a non-uniform sampling.

After a non-uniform sampling, we get the following formula,

$$p(z)r(z) = A \tag{7}$$

where $p(z)$ denotes density function, A is constant. If $\lambda(z)$ represents the distribution function of $p(z)$, then by the theory of probability knowledge, $p(z)=d\lambda/dz$, so there will be,

$$\frac{d\lambda}{dz} = \frac{A}{r(z)} = \frac{A}{r_0 + kz} \tag{8}$$

Then:

$$\lambda(z) = c_1 \ln(r_0 + kz) + c_2 \tag{9}$$

After nonlinear transformation, the size of images needs to remain the same, that is, $\lambda(0)=0$， $\lambda(Z)=Z$, so the coefficient can be obtained,

$$c_1 = \frac{Z}{\ln(1 + kZ / r_0)}, \quad c_2 = -c_1 \ln r_0 \tag{10}$$

In order to obtain uniform sampling interval, the inverse function of $\lambda(z)$ is obtained by formula (9)

$$z = \frac{1}{k}\left[\exp\left(\frac{\lambda - c_2}{c_1}\right) - r_0\right] \tag{11}$$

This is the nonlinear transformation function which converts space-variant defocus blurring with the linear change defocus radius into space-invariant defocus blurring with the changeless defocus radius. The equivalent of the changeless defocus radius is

$$r_\lambda = r_0 + \frac{k}{2}Z \tag{12}$$

So the restoration image is obtained by the restoration algorithm of the space-invariant defocus image[11-12]. And at last, by using the inverse function of formula (9), the restoration image is converted into the images in original coordinates.

For defocus radius, if the linear coefficient k are less than zero, formula (4) should be rewritten as $r=|r_0+kz|$. When nonlinear coordinate transformation is used, we have to compute the value of z which meets $r_0+kz=0$, denoted as z_0. Taking z_0 as the boundary, the image is divided into two blocks. When r_0+kz are greater than zero, namely r_0+kz, the image is converted and restored by the above method. When r_0+kz are less than zero, the formula is rewritten as $r=-r_0-kz$, the image is also converted and restored by the above method. Finally, the restored image is the combination of these two pieces of images.

The following is test and verification in experiment.

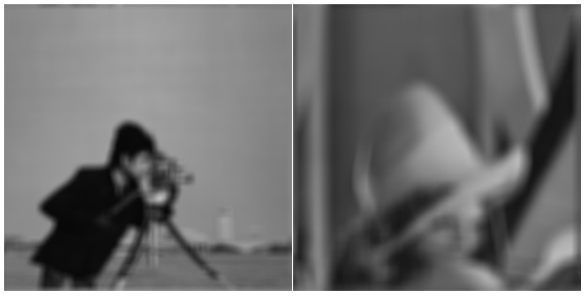
4 The experimental results and discussion

4.1 Linear change defocus image simulation and their restoration results

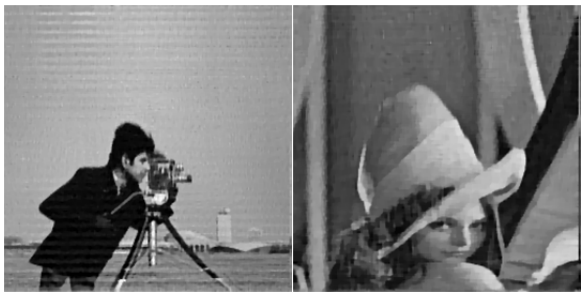
To demonstrate the validity of the proposed method, we tried some experiments on some synthetically focus images and real focus images. The image “Cameraman” and image “Lena” are derived from image database and their defocus radius are respectively $r(z)=1+0.06z$ and $r(z)=3+0.1z$. For synthetically focus images, We compare our algorithms with the other restoration algorithms[12], namely conventional restoration algorithm with the equivalent radius in formula (12). The restoration results are all displayed in Fig.4.

(a)

(b)

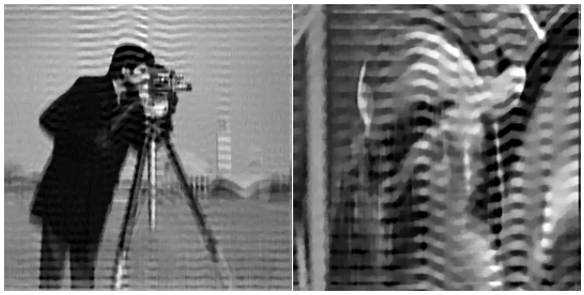


(c)



(d)

(e)



(f)

Figure.4 Restoration results of the conventional restoration algorithm and our algorithm (a)original image (b) defocus blurred image (c) space-invariant defocus image after nonlinear transform (d) the restored image of (c); (e) the restored image after nonlinear inversion transform from (d); (f) the restored image using conventional method from (a)

From restoration results, if the linear change defocus images are restored by using conventional restoration algorithm for space-invariant images, the ringing effect is very serious. Moreover, the greater the linear change is(the greater the value of coefficient k), the more serious the ringing effect is and the worse the restoration result is.

However, by using our algorithms, the ringing effect of restoration image apparently reduce. The PSNR of the restoration results are shown in Table 1, which also demonstrate our method is better than the conventional space-invariant method, especially for great linear change coefficient k.

Table 1 PSNR of the two methods

Restoration results	PSNR/dB	
	Camera man	L ena
Fig.4(f), Conventional restoration	19.51	1

method		7.58
Fig.4(e),our method	19.88	2 1.59

4.2 The restoration of linear change defocus image with the negative coefficient k

We choose the barche image for testing the algorithm for the negative coefficient k. The defocus radius is set $r(z)=10-0.1z$. According to the algorithm proposed in this paper. First, the image is divided two piece and then block processing. The restoration images are shown in Fig.5

(a)

(b)

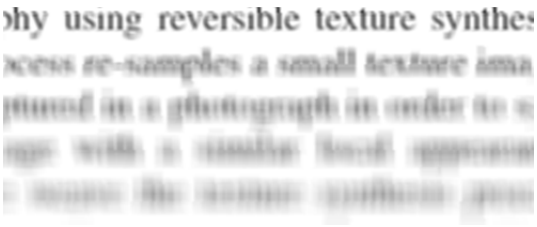
(c)

Figure.5 The restoration of linear change defocus image with the negative coefficient k:(a) original image (b)defocus image (c)restored image

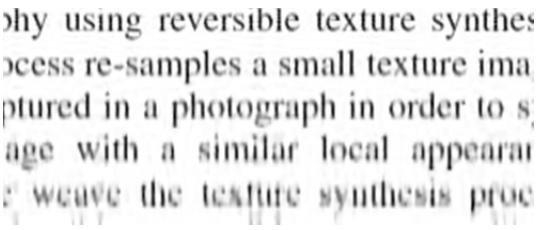
From Fig.5(b), due to linear change defocus radius, the center of the image is clear than the other parts of the image. After restoration, compared the blurred image, the restoration image is clearer, shown in Fig.5(c). So this experiment showed our method performs well with the negative coefficient k

4.3 Real defocus image restoration with linear change defocus radius

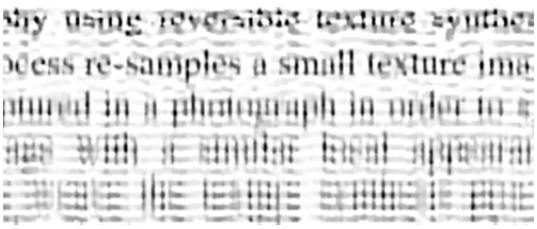
In order to test the algorithm for the real defocus image with linear change defocus radius. We build the optical imaging system, shown in Fig.2. The restoration results are displayed in Fig.6. From the restoration images, the words are clearly identified, but in the blurred images, the words are hardly identified. So this experiment demonstrated our method performed well for the real defocus image with linear change defocus radius.



(a)



(b)



(c)

Figure.6 Real defocus image restoration: (a) real defocus image; (b) restored image using the method in the text; (c) restored image using the conventional method

5. Conclusion

After the summarization of defocus blurring model, this paper proposes a novel approach to restore the image with the linear change defocus radius. The success of our method benefits from two aspects. Firstly, based on space-invariant defocus blurring model, we extended to the space-variant defocus blurring model with the linear change defocus radius. Then, a nonlinear coordinate transforms for blurred image is used to convert the space-variant blurring into space-invariant blurring. Compared with the conventional restoration method, the presented method performs apparent advantages under most circumstances.

However, the space-variant defocus blurring is very simply only with the linear change defocus radius. So a future research direction would be to consider more complex space-variant defocus blurring.

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The research and design of filter in the detection of ECG

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Abstract

According to statistics, the number of people who die from cardiovascular diseases is increasing, and cardiovascular diseases are becoming the biggest killer of human health. The detection of ECG signal is a direct and effective method to early detection of cardiovascular disease, it can reflect the changes in the activities of the heart and all parts of the heart. In the ECG signal through the serial port to receive the medical device, because the ECG signal and the noise has overlapping each other so that the software filtering process is needed. In this paper, an integer IIR digital filter is designed, which is based on the 50Hz's power line interference and the baseline drift. In order to suppress the noise, a composite filter can be designed in different noise intensity.

Keywords: ECG signal; integer IIR filter; composite filter.

1. Introduction

Many diseases can be detected and controlled in advance, and cardiovascular diseases are among them. Heart is an important organ that transports blood to each physical system of human body and excretes metabolites. Malfunction of circulatory system may result in cardiovascular diseases that have similar pathogeny, pathogenic progress and therapeutic methods. Timely detection and monitoring can effectively reduce morbidity[1] . Detection of blood pressure, ECG, oxyhemoglobin saturation and other physical parameters is an effective way to prevent such cardiovascular diseases. It is also an important method to diagnose heart diseases and hypertension in clinic.

IIR filter and FIR filter that were applicable in different environment were used in this paper to preprocess ECG signals. Firstly, the IIR filter was used to get rid of the interfered frequency bands. Then the slope was calculated based on the minimum and maximum values in the cycle of noise. FIR filter was used to further filter the noise in the case that the slope could not meet requirement until the noise met the requirement.

2. Processing of ECG signals

ECG pulse automatically originates from sinus node and transmits to all parts of heart. The ECG-pulsing signals transform into mechanical motion of cardiac muscle fibers, which causes regular contraction of ventricle and atrium and provides the power of blood circulation. The process is called Excitation Contraction Coupling. As the motor of human body, heart consistently beats to provide steady power for blood circulation while transporting nutrients and oxygen to different parts of human body. Primary electric pulse of myocardial cell drives heart to beat. It derives from sinus node and transmits to cause contraction of atrium. Then the electric pulse passes through atrioventricular bundle, left bundle branch and right bundle branch in order to the whole heart and causes contraction of ventricle. At the same time the atrium stretches. This is the whole process of a complete heartbeat.

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ECG signal [2] produced by cardiomotility can be measured on body surface as human body is a conductor. In a same cycle, different bands of ECG signal originate from different parts of heart, thus the potential difference can be measured at different measurement points on body surface. ECG signal is the biological signal shown by voltage changing curve. The changing curve can be divided into different bands which indicate the transmission of electrical stimulation at different parts of heart. It is the base for research on the mechanical motion of heart. ECG signals change correspondingly when there are structural or functional lesions in heart.

3 .Frequency distribution of ECG signals

ECG signals could be collected by data acquisition board. The signal is a kind of time-domain signals. The first step to do frequency domain analysis was the transformation of time domain into frequency domain. Fourier Transform was used here. The method was put forward by the scientist Fourier in 19th century. According to Fourier Transform, all waves can be constituted by sine waves and cosine waves of different amplitudes, frequencies and phases. Generally, Continuous Fourier Transform is represented by integration:

$$F(w) = \int_{-\infty}^{\infty} f(t) e^{-jwt} dt \quad (3.1)$$

Spectral function F(w) can be obtained by integrating $f(t)$. It represents the corresponding relation between frequency and amplitude in the whole frequency domain.

$$F(w) = |F(w)| e^{j\varphi(w)} \quad (3.2)$$

Fourier Transform aims at continuous signals, but the ECG signals collected by data acquisition board are discrete digital signals. Therefore, Discrete Fourier Transform (DFT) must be used here.

$$X(k) = DFT[x(n)] = \sum_{n=0}^{N-1} x(n) W_N^{nk} \quad (3.3)$$

DFT is the basic method to process signals at present, but it needs so large amount of computation that previous computers could not hand it. US scientists in 1960s simplified the computational process when they researched the symmetry of DFT matrix. The method is called FFT that is often used in current signal processing. The sampling frequency of ECG signals could be 480 points per second and FFT transform was made to sampling data. Time domain of ECG signal and frequency domain are descried as in Figure 3.1 (x-coordinate indicates time, y-coordinate indicates amplitude) and Figure 3.2 (x-coordinate indicates frequency, y-coordinate indicates amplitude) as below.

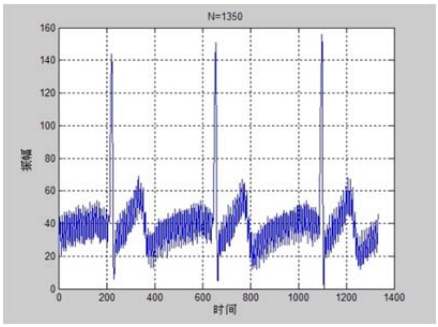

Fig. 3.1 time domain diagram of ECG signal

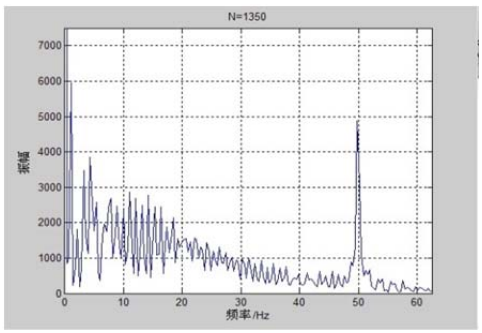

Fig. 3.2 frequency domain of ECG signal

We can see the relationship between amplitude of signal and time t from the time domain diagram, and we can get the relationship between amplitude of signal and frequency after FFT, which is the reason why FFT is widely used in signal processing. Once the signal frequency is known, we can begin to design digital filter and filter signals.

Firstly, Fourier Transform was conducted to get frequency distribution diagram. We could see from the diagram that main information of ECG signals distributed below 100Hz. Information below 30Hz contained P wave, QRS wave, T wave and other important waves of ECG signals. Related materials showed that QRS wave mainly distributed between 7Hz and 27Hz, and 17 Hz was the commonest frequency. The frequency of other waves such as P wave and T wave was much lower than that of QRS wave. We can see from Fig.3.2 that there is a significant external interference source when the frequency of ECG signal is 50Hz, which is the power frequency interference of 50Hz emerging in coupling progress. The significant interference is also easy to be found at 3Hz, which is inevitably caused by the low-frequency noise of human breathing. After determining the interferential frequency band, the key problem is to choose filtering method. Currently, main filtering methods include IIR filter, FIR filter, smoothing filter and wavelet transform (WT) filter. The paper firstly used IIR filter as it is real time and the computing process is simple. We also designed a new type multi-adaptive filter (MAF) that combines IIR and FIR.

4. Filter design

4.1. IIR filter design

IIR filter belongs to recursive filtering, thus the base of the filter is FIR filter. It is also a kind of linear filter. In such a structure, the output structure is related to previous input and output. Unlike FIR filter, the poles of IIR filter, except null point, have real values of $a_i (i = 1, 2, \ldots, M)$ in the formula 1-1. IIR filter has recursive structure and better filtering effect than FIR filter in similar filter structures. The design of IIR filter is much more complicated than that of FIR filter. In addition to attenuation coefficient, IIR also has feedback loop. According to the stable theory, it is unsteady and the stability of filter needs to be considered, so the position of pole must be restricted. Firstly, the pole must be in the unit circle of Z domain. Then a null point should be set to cancel the pole. While software filter can be used to get attenuation coefficient of any value in theory, the word length of processor and computation complexity must be considered in projects.

Design methods of IIR filter falls into direct design and indirect design. Direct design is to construct IIR filter by constraining the pole-zero location of transfer function in Z domain. Indirect design is based on existing analog filters and sets up each parameters as required. Then it goes through the transform from S domain to Z domain. Finally Laplace Transform is used to map analog filters from S domain to Z domain. The filter becomes a digital filter that can process digital signals. This paper used the indirect design method.

As to the template issues for analog filter mentioned above, Butterworth filter is the most frequently used method in signal processing. Its amplitude-frequency expression is as below in analog frequency domain:

$$|H(j\Omega)|^2 = \frac{1}{1+\varepsilon^2\left(\frac{j\Omega}{j\Omega_p}\right)^{2N}} \tag{3.4}$$

If $\Omega < \Omega_p$, $\frac{j\Omega}{j\Omega_p} < 1$, when the order N increases, $\frac{1}{1+\varepsilon^2(\frac{j\Omega}{j\Omega_p})^{2N}}$ is slow to decrease. That means the rate of decay is slower as the frequency increases.

If $\Omega < \Omega_p$, $\frac{j\Omega}{j\Omega_p} > 1$, when the order N increases, $\frac{1}{1+\varepsilon^2(\frac{j\Omega}{j\Omega_p})^{2N}}$ is fast to decrease. That means the rate of decay is faster as the frequency increases.

In design of Butterworth filter, general design objectives include maximum pass band attenuation $A_p(dB)$, pass band cut-off frequency Ω_p, stop band cut-off frequency Ω_s and minimum stop band attenuation $A_S(dB)$. And the minimum order of filter is:

$$A_p = -20\lg(|G(j\Omega_p)|^2)^{1/2} = 10\lg[1+(\Omega_p/\Omega_p)^{2N}] \tag{3.5}$$

$$A_s = -20\lg|G(j\Omega_s)|^2 = 10\lg[1+(\Omega_s/\Omega_p)^{2N}] \tag{3.6}$$

Compare the two formulas above:

$$\frac{10^{0.1A_p}-1}{10^{0.1A_s}-1} = (\frac{\Omega_p}{\Omega_s})^{2N} \tag{3.7}$$

设 (if) $\varepsilon = \sqrt{(10^{0.1A_p}-1)}, \lambda = \sqrt{(10^{0.1A_s}-1)}$。则(then) $N \geq \frac{\lg(\lambda/\varepsilon)}{\lg(\Omega_s/\Omega_p)}$

Following formula can be used to calculate the pole of transfer function:

$$s_k = (-1)^{\frac{1}{2N}}(j\Omega_p) = \Omega_p e^{j[\frac{1}{2}+\frac{2k-1}{2N}]\pi} = -\sin(\frac{2k-1}{2N}\pi) + j\cos(\frac{2k-1}{2N}\pi), k = 1,2,...,2N \tag{3.8}$$

Second order subsystem:

$$H_k(s) = \frac{\Omega_p^2}{(s-s_k)(s-s_{N+1-k})} \tag{3.9}$$

The system function when N is even:

$$H(s) = \prod_{k=1}^{N/2} H_k(s) \tag{3.10}$$

4.2. Realizing of Butterworth filter

When designing a low pass filter of 50Hz, the filter has following parameters: low pass band frequency: 42Hz, low pass stop-band frequency: 47Hz, pass band damping: 3dB, stop band damping: 60dB. MATLAB can be used to get the difference equation for Butterworth low pass filter as below:

$$y(n) = 9*10^{-4}x(n-2) + 1.8*10^{-3}x(n-3) + 5*10^{-4}x(n-4) + 4.2965y(n-1) - 7.8728y(n-2)$$
$$+7.8205y(n-3) - 4.4627y(n-4) + 1.3735y(n-5) - 0.1783y(n-6) \quad (3.11)$$

```
 int LowPassFilter(int data)
{static int y12=0,y22=0,y32=0,y42=0,y52=0,y62=0,x2[10],n2=4;
  int y0;
  x2[n2]=x2[n2+5]=data;
  y0=42965*y12-78728*y22+78405*y32-44627*y42+13735*y52-1783*y62+9*x2[n2-2]+18*x2[n2-
3]+5*x2[n2-4];
  y62=y52; y52=y42; y42=y32; y32=y22; y22=y12; y12=y0;
  if(--n2<0)
       n2=4;
  return (y0);
}
```

According to computation, its break bound run failed. Although it could be modified by lowering precision, the timeliness and performance of filter using long-character algorithms decreased noticeably and could not achieve the target of filtering. In addition, it only ran on DSP.

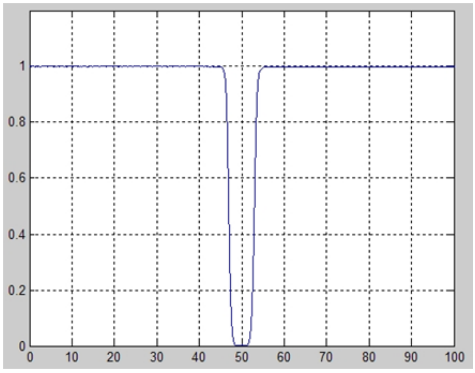

Fig. 3.3 frequency response chart of bandpass filter

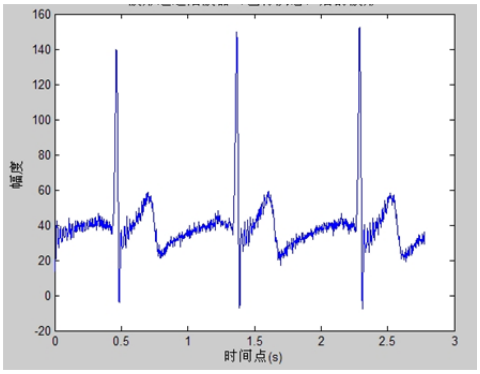

Figure 3.4 filter after the waveform

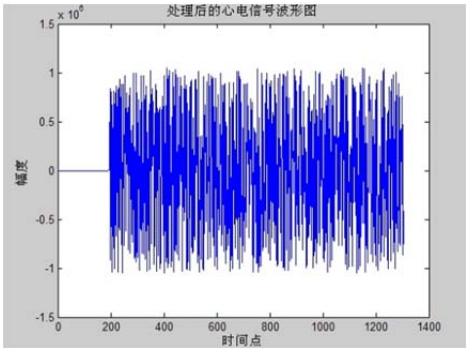

Figure 3.5 Butterworth running over the results

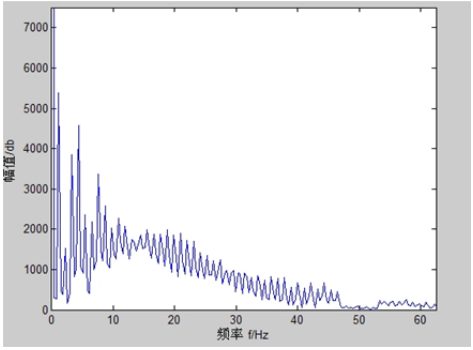

Figure 3.6 the signal frequency after filtering

4.3 .A new-type IIR and FIR multi-adaptive filter

ECG signals has different noises in different environments even they have same strength. IIR filter designed earlier was able to filter noises in ECG signals, but it was unable to eliminate the influence caused by environment changes. Thus the paper introduced a multi-adaptive filter which was consisted of an integer IIR filter and a FIR filter. Integer IIR filter performed main attenuation for interference bands. According to the feedback of filtering effect by the first-level integer IIR filter, the second-level FIR filter could be used frequently. The feedback was based on whether the slope efficiency of signal was bigger than a certain threshold value when the reciprocal of interfering frequency was in a cyclic period. Therefore, the multi-adaptive filter was based on the design of integer filter and eliminated the frequency of noise as required. The position of the frequency on unit circle was calculated and marked as zero point. Then poles were distributed on pass-band frequency points that overlapped filtering frequency to make zero points and poles offset each other. The angular frequency of each number and the distance of zero points on the unit circle in Z domain were multiplied and taken as numerator, and the distance between angular frequency of each number and poles was taken as denominator. The specific value of numerator and denominator is the frequency response of filter. In the design of the second-level FIR filter, attenuation coefficients were used to decide the coefficients of numerators of transfer function for flange-type FIR filter. Meanwhile the denominator was 1.

Deign method of adaptive feedback ring was used to get the reciprocal of filtering wave frequency and calculate the time interval T for difference sampling. It was easy to get the maximum value and the minimum value in T cycle. Finally the corresponding slope was calculated. When the slope was bigger than a certain threshold value, FIR filter was used to do filtering until it was smaller than the threshold value to meet the design requirements.

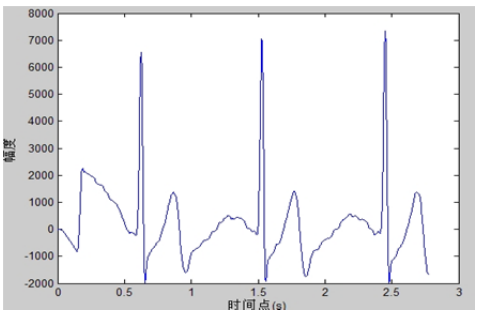

Fig. 3.8 filtering results of the composite filter

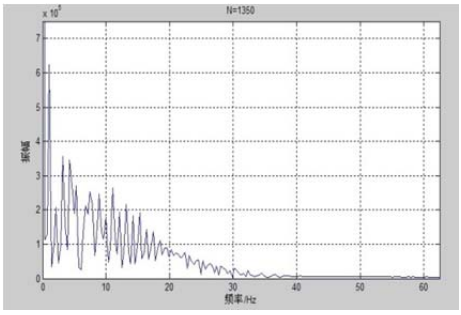

Fig. 3.9 frequency domain distribution of the composite filter

5 .Conclusion

The paper concluded the main frequency of noise distribution in ECG signals based on the frequency domain distribution diagram of original ECG signals. Then the direct design method for IIR filter was used to design the suitable filter. According to the filter effect of filter, the paper also introduced a multi-adaptive IIR and FIR filter. Firstly, integer filter was used to eliminate interference bands. Then the maximum and minimum values were found in the noise cycle and their slopes were calculated. FIR filter was then used to further eliminate noise until it met the filtering requirements. As shown in frequency domain distribution diagram, power frequency interference at 50Hz was eliminated. The advantage of the

filter was that it automatically adjusts attenuation coefficients according to different environments and reduces the signal delay caused by recursive filter by lowering the order of IIR filter.

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Research on Stochastic Modeling in Wide Aisle Order Picking System Blocking

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Abstract

It studies the influencing factors on the wide aisle order picking system, and founds the blocking time ratio influenced by picking density and picking face number. In the condition of picking and walking speed of one to one, it constructs the discrete time Markov state transition probability matrix. The research result can provide reference for picking strategy selection, and it is the theoretical basis of random process application research in the logistics operation system.

Key words： Order picking, Markov chain, State transition matrix, Wide aisle

1 Introduction

Order picking systems are an momentous elementary of facility logistics. Even though the possibilities of organizing such systems seem to be unlimited, most warehouses use Picker-to-parts configurations. Data from real distribution centers collected in the Warehouse Excellence study show that 80% of costs can be attributed to such manual systems. A wide-aisle order picking system where the picker walks along picking locations is similarity to a picker-to-parts system. Most of previous studies in picker-to-parts warehousing systems researched on only single-picker operations and are therefore adequate to evaluate order picking efficiency by travel distance as aisle congestion never takes place in such systems. In real world applications, the congestion unavoidably occurs when a system has multiple person picking together within the same picking face. Congestion is the bottleneck affecting the efficiency of the election system. Overcoming the picking of congestion and improving the picking efficiency is an effective way to improve customer satisfaction, reduce logistics costs and improve service level of supply chain. Through the reading of domestic and foreign literature, scholars from different perspectives, using different methods studied the main factors affect the picking time and cost of goods location layout, storage strategy, Picking Strategies and paths and methods, but research on the problem of congestion in formed in the picking process is still relatively small. for instance, queuing models have been applied to observe and study the waiting time of pickers, those studies just regarded the warehouse as a workstation and calculated the waiting time of pickers queuing to enter the warehouse. Caron, Marchet, and Perego (1998)[1] put forward traveling distance models considering COI-based storage policies for traversal policy, besides return policy in manual picking low-level narrow systems. For a middle-aisle warehouse, Caron, Marchet, and Perego (2000a)[2] expanded an anarchically approach for traversal and return policies under COI-based storage policies to estimate different layout parameters in terms of the number and length of aisles to minimize the expected traveling distance with a given set of

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operating policies. Caron, Marchet, and Perego (2000b)[3] put forward a simulation method to gauge the average traveling distance of a tour considering stochastic and COI-based storage policies. For a parallel-aisle warehouse, Hwang, Oh, and Lee (2004)[4] develop anarchically models for the expected order picker traveling distance under three routing policies, that is the return, traversal and midpoint policies, and COI-based storage assignment. Besides they estimated and compared the impacts of system behavior. For a manual bin-shelving system, Petersen and Aase (2004a)[5] adopted a simulation model that confirmed the total fulfillment time (total travel time plus picking time) of a picking tour to estimated and compared simultaneously the impacts of the picking, routing, and storage policies, and confirmed which one has the strongest effects on system behavior. Petersen, Aase, and Heiser (2004b)[6] found that the impact of class based storage policy can be realized with traversal routing, which is now the most extensively adopted routing method in warehouses because of its ease of use and near-optimal behavior. Ruben and Jacobs (1999)[7] combined batching construction heuristics with storage assignment policies, and applied simulation modeling to analyze the impacts of workforce level and batching size for the walk and manual picking systems. In the paper we focus on establishing stochastic model whose state transfer probability matrix is constructed by the present progressive of the pickers, of wide-aisle picking system congestion rate using Markov model.

2. State description of the wide aisle single picking system

In this paper, we construct a congestion model of wide aisle picking system, and describe the state of the system as follows:

(1) The order picking system consists of a total of N picking faces. And a picking face represents a column tray shelf, this column shelves can contain a plurality of storage location. The current column shelves where the picker stay who are in order to pick the goods can be viewed as the current pick-face.

(2) The picker is to follow the S type path picking strategy, i.e., the picking path of the picker is to extend one direction through all the aisles.

(3) In each aisle, the pick-face of the right and left sides is considered as the 1 unit , that is, the right and left sides contain 1/2 picking face. Or that each aisle is merged into one side of the left and right sides, It is the 1 picking face, and the other is the 0 picking face.

(4) if the picker average pick $I(I \le N)$ items, the probability that the picker stay at the pcik-face (also known as the density) is $p = I/N$.

(5) assuming that the average picking time is t_p , and the average walking time of a pick-face is t_w , and t_p is determined by the average number of times required for the average inventory unit picked from a picking face.

(6) there are only two people in the picking system, and their t_p , t_w , p values are the same.

(7) the status of the pickers may be a pick, walk, or idle waiting for the congestion.

2.2 the congestion model when one time picking one item.

Consider a storage area with a n picking faces, in a given time period, one picker may be picking at picking face with picking probability p; may be walking to the next picking face with walking probability $q(=1-p)$ .Suppose that the person is picking at a given time, the next time the walking probability that picker walk to the next picking face is 1. Two scenarios can now be considered, one is pick-walk speed ratio is 1:1, the other is the speed ratio of picking and walking is $1:\infty$ .Other time ratios (e.g. 5:1, 10:1, or 20:1) can be estimated by the simulation model to estimate the congestion rate.

3 Single picking system congestion with $P:W=1:\infty$

3.1 Random distribution of the distance of the pickers

In this section we consider picking and walking speed ratio of 1:∞ for the situation, that is, the walking speed of the picker is infinite, so there are only two conditions for pickers: One is being picking, one is because of congestion and waiting for picking, without the condition of being or to walk. After analysis, the distance changes between the two pickers with Markov no aftereffect. Denote x_t^1 and x_t^2 are moving distance of picker No.1 and picker No.2 in the period of time t.

x obey the geometric distribution:

$$f(x) = q^{x-1} p \tag{1}$$

In any one picker as an example, in the beginning of a period of time, with the following occurs:

When $x = 0$, the picker is not in place, and can continue to pick the next item;

When $x = 1$, picker remove one pick-face location, and the probability of moving is $f(1) = q^0 p = p$

When $x = n, 2n, 3n, \ldots$, picker respectively, walk a lap, two laps, three laps,... and the back in place, which means it will be to pick a number of items in place;

When $x = n + 1$, this is equivalent to pickers are more walking a circle and then go around back to move only 1 pick-face location from the original location, That is to say, before the next picking occur, picker more walk at least one circle. This is completely unnecessary.

Through the above analysis, $x = 0, n, 2n, \ldots$ does not meet the assumption of single picking system, suitable for multi piece picking system.

Therefore, x obey the geometric distribution:

$$f(x) = q^{x-1} p \qquad x = 1, 2, \cdots \quad , \quad x \neq 0, n, 2n, \ldots \tag{2}$$

3.2 state transfer matrix

Denoted d_1^{t-1}, d_2^{t-1} are the position of the picker 1 and picker 2 respectively in the $t-1$ period, and d_1^t 、 d_2^t are the position of the picker 1 and picker 2 respectively in the t period , and then from $t-1$ period to t period ,

The distance change of the picker 1 is : $x_1^t = d_1^t - d_1^{t-1}$;

The distance change of the picker 2 is : $x_2^t = d_2^t - d_2^{t-1}$;

The distance between picker 1 and 2 in the $t-1$ period is $d_{12}^{t-1} = d_1^{t-1} - d_2^{t-1}$;

The distance between picker 1 and 2 in the t period is $d_{12}^t = d_1^t - d_2^t$;

And under the wide aisle, $0 \le d_{12}^{t-1} \le n$, $0 \le d_{12}^t \le n$;

The distance between the two is 0, which means the 2 is congestion by the picker 1;

The distance between the two is n, which means the 1 is congestion by the picker 2;

$Y^t = x_1^t - x_2^t$ represents the distance change between the two pickers,

$Y^t = x_1^t - x_2^t = (d_1^t - d_1^{t-1}) - (d_2^t - d_2^{t-1}) = d_{12}^t - d_{12}^{t-1}$, $-n \le Y^t \le n$;

When the distance between the two pickers is $d_{12}^{t-1} = 0$ or $d_{12}^{t-1} = n$ in the last period, the state of system is congestion, and in the next period there will be $0 \le Y^t \le n$ or $-n \le Y^t \le 0$;

When the distance between the two pickers is $d_{12}^{t-1} = 1, 2, ..., n-1$, the state of system is non-congestion, and in the next period there will be $1-n \le Y^t \le n-1$.

x_t^1 and x_t^2 are Independent and identically distributed, and Y_t is an integer, then the probability density function of Y_t is:

$$g(y) = P(Y_t = y) = \sum_{x=1}^{\infty} P(x_t^1 = x+y) \bullet P(x_t^2 = x) = \sum_{x=1}^{\infty} f(x+y) f(x)$$

$$= \sum_{x=1}^{\infty} q^{x+y-1} pq^{x-1} p = p^2 q^y \sum_{x=1}^{\infty} (q^2)^{x-1} = p^2 q^y \frac{1}{1-q^2} = \frac{pq^{|y|}}{1+q} \quad (3)$$

When the distance between the two pickers over the 1 pick-face will not produce congestion, if the distance between the two pickers is d_{12}^{t-1} in the last time, when the next distance of time is 1 or *n*, it's the limit. Therefore, the state transition probability of non- congestion is:

$$P(Y_t = y) = g(y) = \frac{pq^{|y|}}{1+q} \quad (4)$$

Here we analyze the probability of generating congestion.

When $1 - d_{12} \le y \le n - 1 - d_{12}$, there will be non-congestion, but when the change of the distance between the two pickers is reduced more than d_{12} pick-faces, that is when $Y_t \le -d_{12}$, the state of picker No.2 is congestion caused by picker No.1; when the change of the distance between the two pickers is expanded to more than $n - d_{12}$,that is $Y_t \ge n-1$, The picker No.1 is back to the roadway, while picker No.2 is congestion.

Analysis of the probability distribution function shows, because the person's walking speed tends to infinity, the system will be congestion when the state is 0_{pp} or n_{pp}, which means respectively picker 2 is congestion caused by the picker 1, and picker 1 is congestion caused by the picker 2; while when the distance is $1, 2, \cdots, n-1$, there will be non-congestion, that is the state $1_{pp}, 2_{pp}, \ldots, n-1_{pp}$ will not cause congestion, thus the state transition matrix of the Markov process can be calculated:

$$T_{1:\infty}^{W}=\begin{array}{c} \\ 0_{pp} \\ 1 \\ 2 \\ 3 \\ \vdots \\ n-2 \\ n-1 \\ n_{pp} \end{array}\begin{array}{c} \begin{array}{ccccccccc} 0_{pp} & 1 & 2 & 3 & \cdots & n-2 & n-1 & n_{pp} \end{array} \\ \begin{bmatrix} \frac{1}{1+q} & \frac{pq}{1+q} & \frac{pq^2}{1+q} & \frac{pq^3}{1+q} & \cdots & \frac{pq^{n-2}}{1+q} & \frac{pq^{n-1}}{1+q} & \frac{q^n}{1+q} \\ \frac{q}{1+q} & \frac{p}{1+q} & \frac{pq}{1+q} & \frac{pq^2}{1+q} & \cdots & \frac{pq^{n-3}}{1+q} & \frac{pq^{n-2}}{1+q} & \frac{q^{n-1}}{1+q} \\ \frac{q^2}{1+q} & \frac{pq}{1+q} & \frac{p}{1+q} & \ddots & \ddots & \ddots & \frac{pq^{n-3}}{1+q} & \frac{q^{n-2}}{1+q} \\ \frac{q^3}{1+q} & \frac{pq^2}{1+q} & \frac{pq}{1+q} & \ddots & \ddots & \ddots & \frac{pq^{n-4}}{1+q} & \frac{q^{n-3}}{1+q} \\ \vdots & \vdots & \vdots & \ddots & \ddots & \ddots & \vdots & \vdots \\ \frac{q^{n-2}}{1+q} & \frac{pq^{n-3}}{1+q} & \frac{pq^{n-4}}{1+q} & \ddots & \ddots & \ddots & \frac{pq}{1+q} & \frac{q^2}{1+q} \\ \frac{q^{n-1}}{1+q} & \frac{pq^{n-2}}{1+q} & \frac{pq^{n-3}}{1+q} & \cdots & \cdots & \frac{pq}{1+q} & \frac{p}{1+q} & \frac{q}{1+q} \\ \frac{q^n}{1+q} & \frac{pq^{n-1}}{1+q} & \frac{pq^{n-2}}{1+q} & \cdots & \cdots & \frac{pq^2}{1+q} & \frac{pq}{1+q} & \frac{1}{1+q} \end{bmatrix} \end{array}$$

$T_{1:\infty}^{W}$ is an $(n+1)\times(n+1)$ matrix.

3.3 stationary distribution and congestion rate $b_{1:\infty}^{W}$

The first column and the last column of the matrix $T_{1:\infty}^{W}$ represent the congestion state. Solving the state transfer matrix $T_{1:\infty}^{W}$, obtain the stationary distribution $Z_{1:\infty}^{W}$, For the equation $Z_{1:\infty}^{W}T_{1:\infty}^{W}=Z_{1:\infty}^{W}$, the solution is obtained:

$$Z_{1:\infty}^{W}=\{1,p,p,\cdots,p,1\}$$

In this case, the average rate of congestion is

$$b_{1:\infty}^{W}(k=2)=\frac{1}{2+(n-1)p} \tag{5}$$

By the formula (12), $b_{1:\infty}^{W}(k=2)$ is a decreasing function of n. In order to obtain the value of the relative probability of picking when the average congestion rate is the maximum, firstly we seek the first order derivatives of formula $b_{1:\infty}^{W}(k=2)$. So

$$b_{1:\infty}^{W}(k=2)\Big|_{p}^{'}=\frac{1-n}{[(n-1)p+2]^2} \tag{6}$$

We can obtain $b_{1:\infty}^{W}(k=2)\Big|_{p}^{'}<0$, so Average congestion rate function is a decreasing function of p.

3.4 Analysis of factors affecting congestion rate b_{∞}

When n take different values, the relationship between the picking probability p and congestion rate $b_{1:\infty}^{W}$, namely, to select the case when the storage area is 2, 10, 20, 50, respectively, in the graphics, respectively, with different curves. The situation of the change of congestion rate when the size of the picking region is changed. From the congestion rate formula (6) can be known, with the increase of n , the picking congestion rate decreases. when the picking region is fixed, with the increase of picking density, the average congestion rate of pickers decrease; when the density of the picking is certain, the average rate of the picking is decreased with the increase of the picking surface. Visible, when the system is only two pickers, and one can only pick one item at a picking surface,, although the aisle is wide, congestion may still exceed 30%.According to the size of the picking region and the picking density determined by the market, it can be appropriate to reduce congestion by adjusting the layout, storage strategy or path strategy.

4 Conclusions and Outlook

The following preliminary conclusions are drawn from the above modeling and analysis process.First, the congestion rate of the wide aisle order picking system is associated with the picking density and the number of the picking faces (i.e., the number of the storage bits).Because no aftereffect between distance and the state. This relationship can be described by a discrete time Markov modeling method.The relationship between congestion rate, the number of the picking face and the density of the picking can be resolved.

Second, in the discrete picking or batch picking, With the increase of the density of the picking, the time ratio of the congestion is increased, which can be considered to reduce congestion, but with the picking density increasing, the congestion time ratio decreases, and then can be turned into discrete picking or batch picking. Therefore, according to the setting interval of the picking density, it is helpful to select a batch or a partition strategy. which is one of the main contributions of this paper.

Third, with the increase of the number of the selected area (the number of storage), congestion time ratio in the two pickers order picking system decreased rapidly. This is because the more people who pick to be, the greater the area to which the picker is to face. and for the large storage area, it is difficult to meet, so the congestion rate is very low. Then it can be considered to improve the selection efficiency of the large area, which can be considered as one of the following studies.

Fourth, this paper only studies the case of the same ratio of the picking time and walking time in a wide channel system, and one item at a time. In the follow-up study, the ratio of the picking time and walking time are arbitrary, and multiple item at a time, and the model is extended to a narrow aisle system.

Fifth, there are some random factors such as arrival time and number of orders in the order picking system.

These random factors can be through probability theory analyzed, combined with the stochastic process model to understand and master the inexorable law ,and using these inexorable law, to manage and control, helping to improve the efficiency of the whole system. This paper is the application of stochastic process theory in the logistics system, played a theoretical foreshadowing on the choice of subsequent location assignment, picking path, picking strategy research .

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Research on the factors affecting the picking congestion rate

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Abstract: The picking process related research questions chosen blocking layout, picking strategy, storage assignment, routing strategy and solutions are discussed and summarized.

Keyword: Picking; Congestion; Picking Strategy; Storage assignment

1. Introduction

In the traditional sense, we comprehend the warehouse is the space regions which protect cargo. Has always been, the main function of warehouse is storage and reserve, and mainly in the field of production and the life [1].

With the rapid increase of commodity circulation, a new trade form is emergence: order miniaturization, product diversification and diverse needs of customers. So that forcing manufacturers continue to seek ways to reduce logistics costs to pursue higher economic efficiency [2]. Distribution centers are becoming an important part to shorten logistics system cycle time, reduce costs, educe inventory levels and increase customer service satisfaction.

Order picking is the operation process which based on customer order requirements, then picking the items from the storage quickly and accurately and classified, concentrated, wait for the delivery according to a certain manner [3].

Improved material handling equipment makes picking corresponding aisle will become narrow, and then the blocking between pickers will reduce the operating efficiency. So we need to increase labor costs to ensure that the original efficiency. Some companies adopt wide aisle strategy, but there would still be picking face blocking problems up to result to some pickers to wait for a short time and affect the entire picking system operating efficiency.

2. Review of Current Research

All aspects of warehouse layout are strong coupling, and it is difficult to get clear boundaries between in each problem, so the various aspects of layout design can not make decisions independently.

2.1 Cargo Layout

(1) Review of Foreign Studies

Warehouse layout design can influence the future optimize the operation and would make a significant impact on the order picking and pickers' picking route [4]. Here we mainly discuss the second picking system of internal layout issues, mainly related to the number of partitions and aisles' length, width, number of each region. [5] Build a minimize picking route model in the condition of the S-type and maximum spacing method path policy which by select of aisles length, numbers, P & D position. Finally concluded the picking route strategy to some extent affected the warehouse size and layout. Originally designed warehouse optimization main consideration is to increase the storage density in order to improve

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utilization of storage space. But the research on operating costs by Tompkins (2003) caused the attention of researchers, so it began to sacrifice part storage area to add chosen aisle. In [6] find the shortest path in intermediate aisle cargo layout use Dynamic programming method. But the article is to consider the case up to three aisles. Although the presence of an intermediate aisle will save travel time, too much middle of aisle will increase the travel time [7]. [8] Analyze the application environment, pros and cons of the existing three most common traditional layout modes, then calculate and draw the optimal layout aisle (cross aisle) are not in the middle of the warehouse but slant a bit. Traditional shelf layout is restrained by roadway parallel to each other and perpendicular to the roadway picking aisle. [9] By reducing these constraints then proposed to the case of two single constrained solely new Flying-V and Fishbone layout based on nonlinear optimization model and its practical application. And this layout design has shorted 10%-20% effect on the travel time. [10] Optimization on the Fishbone warehouse, and structure and optimized under multi constraints than traditional travel distance to reduce 10% -15%. The above literatures are in conditions of only one P&D. In [11] the Flying-V and Inverted-V layout which consider the multi P&D position, and obtained the appropriate size distribution center by constructing route model. But Flying-V only shorten the 3%-6% of travel distance and Inverted-V only shorten the 1%. This is because with the increase in P & D points, the operational performance gets lower. In so doing, P&D should be close to the middle position when design the layout. Picking aisle in layout mainly narrow aisle, although it is possible at the lowest cost to achieve the highest space utilization, it will cause more blocking between the pickers [12].

(2) Review of Domestic Studies

Literature on the internal layout of the manual order picking system is not rich in Domestic. In [13], it considers the layout design includes overall architecture design, division of the layout, size of warehouse, warehouse equipment, operating policies. [14] By analyze the situation of Decathlon, establishing Slotting Optimization Model according to genetic algorithm and Hybrid algorithm based on Pareto for this distribution center. Then that would improve the efficiency of goods out of storage and shelf stability effectively. In [15], they combining foreign proposed new Fishbone layout warehouse and study the optimization of logistics warehouse interior layout design issues. Mathematical model to minimize the total travel distance. This approach can shorten the total sorting distance also ensure the utilization of warehouse space effectively.

2.2 Storing Assigned

To speed up the picking speed and improve the operating efficiency of the pickers, Goods need to follow certain principles assignment is stored in the buffer zone or picking area [16].

(1) Review of Foreign Studies

The purpose of sorting assigned strategy is reducing picking time by a certain way stored goods in the warehouse [17]. In [18], divided the sorting assigned into three categories: random storage, turnover rate storage, sorted storage. Because the random storage take up less space and easy to implement, and also able to take full advantage of the characteristics of roadway, so it become the most widely used storage policy [19]. [20] Will take the smallest order stored in the location of the closest to the access point based on the order of frequency. Sorted storage is sort the Goods in accordance with property or demand characteristics into different classes, and each class takes up a fixed area then random placement within the region [21]. Classification is usually use COI or picking quantity as index. In inventory control, the most commonly used classification of the goods is based on Pareto. But [22] propose that should not only consider the picking costs but ignore the cost of storage space, so they construct an integer programming

model based on the cost of storage space and order picking costs. And use simulated annealing algorithm to solve the model. Finally, the results show that this method better than using Dynamic Solver classification based COI on storage strategy. In [23], using data mining association rule mining determine the strength of association between the goods. And accordingly proposes an improved classification storage algorithms (MCBH) and particle swarm optimization (MCBH). MCBH will shorten the travel distance by 4% than conventional free storage, and MCBH will shorten the travel distance by 13% .That greatly improving the efficiency of order picking. [24] Propose the use of clustering algorithm to determine the cargo assignment policy. And the metric standard is the relationship strength of numbers which two SKU appears in the same order. The purpose of clustering is store the goods to the nearest which often appear in the same order. This method will reduce travel distance by 20%-30% after validated.

(2) Review of Domestic Studies

The principle of sorting assigned is storage strategy. An appropriate storage strategy can reduce the moving distance of storage operations, shorten work time, take full advantage storage space [1]. The warehouse will choose a different storage policy according to the different needs. For the comparative study of the various storage strategies usually use the travel distance or travel time as the index. In [25-29], lists several major storage types and analyze the advantages and disadvantages of each storage policies. [30] Using the packing optimization theory to solve the wave picking strategy in sort assignment problem, and then build Mixed Integer Programming Model which take the picking time as the target between SKU. Proposed the intensity and location of strength based on SKU and collaborative optimization algorithm relationship model solution. The results show that the method has good convergence and the operating speed, and it can improve the picking efficiency by 20%-30% than COI strategy. But the effect of picking efficiency by correlation between the strength and relevance of probability need to further study.

2.3 Picking Strategy

(1) Review of Foreign Studies

Order picking is a process for goods picking from storage area to meet the needs of the customer. Warehouse operations are recognized as the most labor intensive and most time-consuming work activity [31]. Order picking is increasingly importance subject to distribution centers, logistics industry and manufacturing industry in order to remain competitive. [32] Propose the Ant picking method which is similar to Continuous zone picking in order to alleviate the problem of uneven load which is resulted by regional zoning picking. Pickers are not strictly in a fixed picking area, so it greatly reduces the load imbalance between regions. This method can improve picking efficiency by 34% when operating efficiency has a big difference among pickers. The drawback is that it can work only in the picking work was assembly line form. In [33], they consider the main purpose of picking strategy is to increasing production capacity, reducing costs and quick response. It is easy to make blocking in an order picking because of the impact by other pickers or other external factors. To better understand the blocking, [34] they study on the factors of blocking in narrow picking aisles which apply Markov process and the Simulation. Compare to [34], [33] study the blocking in wide aisles, but they all construct the state transition matrix in condition of the state transition to another when certain action is completed in [33-34]. However, [35] only use the distance state transition matrix and by solving the model. It draws three important conclusions: blocking is inevitably, distance-based close to the optimal solution would encounter less blocking, picking strategy itself will produce different degrees of blocking.

(2) Review of Domestic Studies

Picking is in accordance with the needs of the customer's order or distribution center delivery program. It is a process for Goods removed from the shelves quickly and accurately and then classify in accordance with certain principles in [36-37]. In [36], they divided Order picking into manual and automatic sorting picking system according to the degree of automation of order processing. Most current still take a manual order picking, where we focus on manual order picking systems. In [38], they used EIQ charts and Activity Based Classification tables approach to determine the distribution center mode, and then select the corresponding picking strategy combining the characteristics of each type of Goods. With the diversification of customer needs, more and more enterprises in order to reduce the risk as much as possible and to maintain good market competitiveness, they use delay tactics constantly. It is reflect the diverse needs of customers and differentiated links to adopt time-based Postponement strategy. In [39], they introduce the idea of delay into order batches policy. Analyze the deficiencies and shortcomings of existing static-based batch time window, so they proposed dynamic -based batch time window batch strategy. This strategy eliminates the currently exists uneven busy picking system and greatly enhancing the operational efficiency of order picking and the continuity and proportionality of picking. It can make better use of the method has potential when combined with the EIQ analysis method. In [40], they make a review about orders batch and batch time windows in domestic and foreign. However, targeted research needs to be done for the orders randomness. Considering the distribution of the order item location based on packing algorithm, they construct a mathematical model about batch orders and then use algorithms to verify the validity and practicality in [41]. Firstly, they analyze algorithms of order batches strategy optimization in S-type route strategy. Secondly, Building and optimization an objective function about route based on Genetic Algorithms.

2.4 Route Policy

(1) Review of Foreign Studies

Picking route problem is an NP problem, and precise mathematical algorithm would make effective only for the layout of two picking aisles. More and more scholars try to use heuristics research. In [7], they improve traditional aisles of the existing, and use Hybrid path policy to make a comparative analysis. Mixed strategy is superior to the traditional path policy. Some scholars concluded that the travel distance decrease 47% through intelligent LKH algorithm than traditional route in [43]. It is best to know the number of items in each picking order when in route strategy decision. In [44], researching on different route policy by SPSS in different layouts warehouse. Composite heuristic is more suitable for picking orders contain a large number of goods according to ANOVA results and Mid-point strategy and Largest-gap strategy is suitable for picking orders contain little goods. But here only consider the traditional aisle layout, so it is needs to further study. They construct a Index batch model (IBM) in [45]. By using mixed integer programming methods to control the external and then use simulated annealing algorithm to solve practical problems. Experiments show that this method shortens 5% -15% of the total search time but only work in narrow aisles.

(2) Review of Domestic Studies

In a distribution center, reduce order picking travel Distance can effectively reduce costs and to improve customer satisfaction. Creative chosen the state must pass through as the state point which from a roadway tunnel to the next by using dynamic programming method. In the condition of Assigned Strategy in classification storing, [47] build a Stochastic models of picking distance in S-shape strategy and Return policy respectively. It concluded the situation for apply by compare the travel distance between the two

strategy. The previous literature study focused on one aspect of the order picking system, but [48] make a collaborative study on picking strategies, route policy, storage strategies and design strategies in combination with a representative. The results show that reduce the total picking time largely use batch picking strategy than the other strategy and shorten large distance use classification storage strategy than others. [49] Consider the manual order picking system under ABC storage policy, establish route optimization model and solve it by genetic algorithm when in a random condition. [50] They study on efficiency of the service of order picking system in a logistics distribution center which using manual order picking. And take picking distance as the target. In the literature, the authors constructed stochastic in model return policy and S-type in the condition of random storage strategy and then verify the validity of the model by the simulation. It proved that S-type will do better than return policy when the number of items is large. The study can provide a reference for the select of picking distance, picking time, picking manner. [51] Discuss manual order picking system when single order input in Poisson can be as M / G / 1 Stochastic Service System. And study the efficiency of the service system picking optimization problem. For the blocking appear by multi pickers simultaneous operation, [52] propose a picking route algorithm based on colony algorithm (ACO) and verify the validity of the algorithm by simulation. Finally, experimental results show that new algorithm can decrease blocking and improve order picking efficiency.

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Guidance of Student Employment based on Hierarchical Model

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Abstract

As higher education from elite education to mass education in China, the employment situation of college graduates is becoming more and more serious, and the number of graduates is growing every year. The student's employment rate has become an important part of each college that evaluates teaching performance. Because the students are not enough to understand themselves, and not to know how to choose a job before employment. In this paper, fuzzy AHP is explored to study work choice of the students. Finally, an important basis for the employment of students is provided and gets the solution of employment options. Through the experiment test, good results are achieved.

Keywords: hierarchy analytic; employment; fuzzy maths

0. Introduction

With the Education Ministry of Education launched in June 2010, "the Excellence Engineer education and training program",its purpose is to promote the teaching reform in Colleges and universities, systematically train the practical talents with strong practical ability, and improve the quality of employment. The level and quality of graduate employment has become an important manifestation of the level and quality of colleges and universities.At present, the lack of correct positioning of the students' career choice and analysis of the use of the employer recruitment information is not comprehensive that Make them a waste of a certain experience and financial. Through the comprehensive analysis of the hierarchical model, choosing a better unit is a good choice[1,2]. Analytic Hierarchy Process[3,4]is a systematic analysis method of quantitative and qualitative analysis, which is proposed by T.L.Satty et al. 70's in twentieth Century. Its basic idea is that the problem to be analyzed is hierarchical first,then according to the nature of the problem and the overall goal to achieve the problem is decomposed into different components. According to the relationship between the factors and the subordinate relationship, the factors will be gathered at different levels,and a multilevel analysis structure model is formed.At last, the ultimate resolution is the problem of the relative importance of weight or relative merits of the highest level (scheme, measure, index, etc.) relative to the highest level. At the same time, because of the uncertainty of the students' employment information, the fuzzy analytic hierarchy process is used to solve the problem.

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1. Fuzzy analytic hierarchy process

1.1 Principle

Set C as a rule, M1, m2,..... Mn is n elements, and the relative importance of Mi and Mj for the two different elements is compared to the standard C[5], they were recorded as mij and mji, and met:

$$\begin{cases} m_{ij} \geq 0, m_{ji} \geq 0, m_{ij} \times m_{ji} = 1, i \neq j \\ m_{ij} = 1, i = j \\ 1 \leq i \leq n, 1 \leq j \leq n \end{cases}$$

The n rank matrix A= (aij) which is composed of mij is called the attribute judgment matrix.

1.2 Concrete steps of constructing the hierarchical model

(1) According to the relationship between the various elements of the employment problem, a hierarchical structure is established. Structure is divided into three layers.

The first layer: the highest level (the target layer), only one element, that is the analysis of the problem of the intended target.

The second layer: the intermediate layer (layer), which includes the intermediate links, that can be made by some levels.

The third layer: the bottom layer (layer), that includes the various measures and decision-making plan for the realization of the target's choice.

The weights of the relative attributes are calculated by the pairwise comparison matrix of each level.

(2) The weights of the relative attributes are calculated by the pairwise comparison matrix of each level.

(3) The synthetic weight of the target is calculated.

(4) According to the conditions of the calculation, so as to make judgments and decisions.

2 .Scheme selection and determination

2.1 Establish evaluation hierarchy model

In view of the college students' employment selection problem for a certain research work. First,a discussion or survey of 380 students, who were four students accounted for 60%, three of the students accounted for 28%, two of the 12% students.Then, twenty-six teachers and counselors who were responsible for the work of the Institute had an informal discussion. Fifteen the personnel department or human resources questionnaire and conversation of recruitment of personnel was included. Results found graduates choose to the ratio of the state organs and foreign-funded enterprises were most concentrated, accounted for 30.1% and 28.6%, state-owned enterprises accounted for 10.1%, scientific research units accounted for 11.6% school 9.9 percent. And the ratio of private enterprises and other (including entrepreneurship, education, military, abroad, etc.) were very low, less than 5%, the choice of other 5.3%. In the end, it was concluded that the following factors were mainly considered in the selection of the students in the choice of employment units:

(1) The basic situation of employing units, including the unit area, unit type and size, wages and welfare, work stability, post requirements, work environment and comfort and so on.

(2) Institution or state-owned enterprise.

(3) Government agencies, universities and other institutions work.

(4) All kinds of civil servants and public institutions work.

(5) Personal development and promotion, interest in the job itself

(6) Parents will and teacher recommendations.

Comprehensive analysis of the results of the above analysis, and combined with some of the relevant content of the university employment information network analysis of the students' employment options information level model as shown in figure 1.

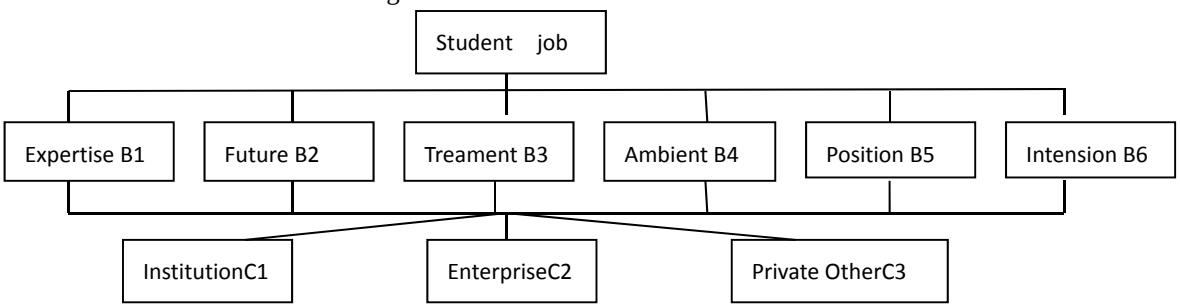

Figure 1 hierarchical structure model

2.2 Determine the weights of the pairwise comparison matrix and calculate the weight of each layer

According to the hierarchical structure model, the judgment matrix is constructed from the upper to the lower level. Each element is represented by a classical 1-9 method, and the AHP method is used to construct the judgment matrix, which is based on the adjacent upper level elements. First, in the first layer, the students choose to work as the evaluation criteria, the second layer of the various factors of the two two comparison, get the results matrix (as shown in Table 2 (a)). Then, for each factor of the second layer, the third layer is compared with two two (as shown in Table 2 (b)).

Table 1 scale of AHP method

Aij	**Language description**	**Aji**
1	Element and Element II are equally important	1
3	Element I and Element II are slightly important	1/3
5	Element I and Element II are obviously important	1/5
7	Element I and Element II arestrongly important	1/7
9	Element I and Element II are extremely important	1/9
2, 4, 6, 8	Intermediate values of two adjacent judgments	1/n

Table 2 (a) pairwise comparison matrix of the target layer

job(A)	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
B1	1	2	1	4	1	1/2
B2	1/2	1	2	3	1	1/3
B3	1	1/2	1	2	3	1/2
B4	1/4	1/3	1/2	1	1/4	1/3
B5	1	1	1/3	4	1	1/3

B6	2	3	2	3	3	1

Table 2 (b) criterion layer pairwise comparison matrix

B1	**C1**	**C2**	**C3**
C1	1	1/5	1/3
C2	5	1	3
C3	3	1/3	1

B2	**C1**	**C2**	**C3**
C1	1	1/4	1/5
C2	4	1	1/2
C3	5	2	1

B3	**C1**	**C2**	**C3**
C1	1	4	7
C2	1/4	1	3
C3	1/7	1/3	1

B4	**C1**	**C2**	**C3**
C1	1	1/5	3
C2	5	1	7
C3	1/3	1/7	1

B5	**C1**	**C2**	**C3**
C1	1	1	9
C2	1	1	9
C3	1/9	1/9	1

B6	**C1**	**C2**	**C3**
C1	1	9	7
C2	1/9	1	2
C3	1/7	1/2	1

2.3 Hierarchical ordering and consistency checking

The judgment matrix is subjective, and it is inevitable to have errors, so it is necessary to carry out the consistency test. According to the fuzzy theory, the calculation is consistent with the proportion of CR=CI/RI. Where $CI = \frac{\lambda_{\max} - n}{n-1}$ ($\lambda_{\max}$ is the maximum eigenvalue of the judgment matrix, n is the order of the matrix), RI is the corresponding average random consistency index given by Satty, as shown in table 3. When CR<0.10, it is considered that the consistency of the judgment matrix is acceptable, and the judgment matrix is satisfied.

Table 3 mean random consistency index

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

In the following, according to the level of attribute judgment matrix of the choice work of a student, the level of the total sort results is calculated as table 4.

Table 4 general order

principle	**Expertise**	**Future**	**Treament**	**Ambient**	**Position**	**Intention**	**Total order**
Weight of principle	0.1798	0.1516	0.1675	0.0575	0.1313	0.3122	

Single order weight of scheme layer	Institution	0.1047	0.0974	0.7049	0.1884	0.4737	0.7959	0.4732
	Enteprise	0.6370	0.3331	0.2109	0.7306	0.4737	0.1211	0.3424
	Foreign Other	0.2583	0.5695	0.0841	0.0810	0.0526	0.0830	0.1844

Criteria layer CR=0.0799<0.1, Cr scheme layer respectively {0.0332,0.0212,0.0279,0.0559 0,0.0861}. Each element is less than 0.1, total ordering of CR=0.0440<0.1, all passed the consistency test.Through the analysis and comparison of the above data, the students for the research unit of the employment intention is more intense,,and employment success probability is very big. At the same time, the method has been used to test the employment of some other students, the conclusion is more accurate and reliable.

3 .Concluding remarks

Analytic hierarchy process model (AHP) is used to make an analysis of students' employment choice and an objective, comprehensive, scientific and fair evaluation of the recruitment unit, thus the use value of the program is come. Not only for students who want jobs provide a scientific basis and provides a role of career guidance for school students, but also conducive to improve their own quality, for the arrangement of the teaching mission of the school also has certain significance.

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Data Storage Algorithms of Digital Video Surveillance System

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Abstract

At present, the video surveillance system uses round robin inspection type as multi-use storage type, in the case of, the storage efficiency is low, and there is an exception interrupt because of hard disk space memory insufficient. In this paper, with the actual video surveillance system, to discuss the storage of video data and use a multi-disk scheduling algorithms for equally distribution in more than one hard drive ,to fully enhance the efficiency of memory access. Designed to achieve the time detect and to increase disk space left ,to ensure that the remaining disk space is always maintained at a certain capacity, to solve the problem of storage abort.

Keywords: multi-disk storage scheduling; storage scheduling; storage management.

0. Introduction

In the applications of Video surveillance, the video information storage requires a lot of disk space, and a single hard disk storage is often very limited, in order to solve the problem of inadequate storage space, the surveillance systems generally use the way of multiple external hard, but using this method need to solve another problem, it is how to effective schedule in the case of multiple disk storage, and allow multiple simultaneous storage, to ensure a high efficiency.

The easiest way is to use the method of disk Round robin inspection type, it forms all disks as a circular linked list, and storages the video information in a disk until the disk filled, then the information is stored to the next disk, so the cycle continues, if the last one is full, then coverage the video information first of the disk. The method is simple and can work very well in the case of less ones. If the system requires more memory for large ones, with the wheel inspection method resulting in multiple simultaneous access to a disk storage for a long time, and long time no other disk access, it easy to reduce the efficiency of disk access, the system′s stored data is lost, thus become the bottleneck of the whole system, system reliability and stability are all poor.

To address the above issues, this paper presents multi-disk storage scheduling algorithm based on the remaining disk space and disk access frequency [1] [2].

1. Multi-disk storage scheduling algorithm

The basic idea of the algorithm is to assign multiple storage as evenly as possible to each disk, and avoid multiple storage concentrated in a hard which caused I/O access bottleneck. The simplest approach is to store the large ones divided by the total number of disks, and get the storage channels of each disk, but this simple program will bring new problems, in the case of disk storage space relatively large difference, a small disk in the storage can be filled easily at first, causing the back stores are all concentrated in the big disk, resulting in inefficient disk access. To this end, this paper present the disk scheduling algorithm based on the current size of the disk free space and the access frequency, the

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algorithm firstly distributes a memory access request thread for residual space and disk access frequency relatively low .

1.1 The data structure of algorithms

The data structure used in algorithm as shown in Table 1.

Table 1 disk information table

Hard disk	The remaining space (G)	Remaining space/The total free space	The currently access number of threads	The maximum access number of threads/ 2	The maximum access number of threads
C::	10	10%	0	1	1
D:	20	20%	0	1	2
E:	5	5%	0	1	1
F:	10	10%	0	1	1
G:	5	5%	0	1	1
H:	50	50%	3	3	5

the meanings of each item in Table 1 as following:

Hard items: recording all the system of disk;

Free space: recording the size of each disk space;

Free space ratio: record the proportion of between remainder of the disk space and remaining of the total;

The current number of threads to access: recording the number of threads accessed the disk when the access request Provides storage space in the new thread;

Maximum number of threads to access: the maximum allowed number of threads to access;

Maximum number of threads to access =the remaining disk space ratio * way.

1.2 Algorithm overview

This store scheduling algorithm is as follows:

Step1: calculate the size of hard disk space.

Step2: calculated the ratio between each hard disk space and the total free space.

Step3: the way of the system stored multiplied the ratio of each free hard disk space ,gets the largest number of threads, and made it as the maximum number of threads access and 1 / 2 the maximum number of threads to access.

Step4: The sort of hard disk array elements of information structure According to the hard disk space available from big to small.

Step5: judging the elements of the information on the hard drive structure in the array as to following, if remaining space and the largest hard disk threads access number does not reach the maximum 1/2 access number, select the hard disk as storage hard the access request; if the disk thread access number reached 1/2 maximum number of visits, select the remaining space under a relatively large and the number of threads to access does not meet the 1/2 hard disk , assigned the new thread access request.

Step6: When all the hard threads access numbers reach 1/2 the maximum number of visits, the latest request for access to storage space in the remaining space which is large and has not reached the maximum number of threads access number to access the hard disk allocation.

Step7: If the hard disk information structure of the array to access the last element has reached the maximum number of access number, return no available hard disk can be used.

1.3 Algorithm Analysis

In the implementation process of the algorithm, all of the hard disk free space and the number of threads in the current visit always be considered, in order to avoid small hard disk space was soon full in the algorithm implementation, and eventually causing all video writing to a hard, when allocate storage hard disk, the algorithm according to the proportion of current hard disk space left in the total remaining space to give priority to a large hard disk storage allocation, only a certain number of the number of disk access in the current thread and then consider the storage allocation in second big hard disk. This could soon be better to avoid the phenomena that small hard drive is full quickly, to make multiple different according to the size of the remaining space more evenly distributed to each drive, each drive's storage space will be proportionally reduced[3].

In the process of algorithm construction, using half of the maximum number of threads as an intermediate access standard, when all the current hard disk access is less than the standard number of threads, firstly allocation the big remaining hard disk space, if the disk is full, allocation the second largest hard disk space, until all the current disk access thread reached half of the number the maximum number of threads to access, then a second allocation of the remaining space, until the number of current visit thread reaches the maximum number of threads access number, then redistribution the second largest hard disk free space. If the case of the way of system and the hard disk capacity of the relatively large difference, not set the amount of the middle, in the beginning of the algorithm, can also cause multiple messages simultaneously to the maximum disk storage space left, forming bottleneck of disk access . the benefits of using this number is that in the beginning of the algorithm implementation phase, it can reduce the number of simultaneous access threads and be more evenly distributed to each hard drive to improve the efficiency of disk access .

2.The algorithm of timing detection to increase disk space

In multi-drive control system, if using a simple round robin inspection type stores, it will not enough storage when the storage space immediately filled, so it need to release a certain portion of space to store by using some algorithms. The usual practice is to stop the current store when finding storage space not enough, using delete the old file, and release a part of space. However, this way easy to cause storage of non-normal interruption, and causing the problem of losing video data. Timing detection algorithm is going to solve these problems[4].

2.1 Algorithm idea

The main idea of regular detection increase disk space algorithm is to try to stay current disk free space in a given threshold (bSpace), to ensure the ongoing storage. We can use a disk space detection thread and run in the background. It uses a pre-set time frequency, detect the disk's free space timing, when finding the current disk free space (rSpace) is less than the predetermined threshold value, delete old files, delete files loops, free up disk space until the remaining disk space reaches the set current

threshold value[5].

It needs to choose an appropriate value for the threshold set. If the threshold is too large, may result in frequently free space, affecting performance of system; if the threshold is too small, may lead storage interrupt due to the phenomenon of not enough free space. Therefore, the threshold need to balance between large and small, according to the actual hardware configuration (such as disk total capacity), for different storage requirements, through experiments, choose an appropriate threshold. Similarly, for the detection time interval (iTime) have the same problem, but also according to the actual situation, through the various considerations and experiments to determine[6].

2.2 Algorithm Description

Step1: Initialization: set initial of threshold (bSpace); set detection time interval (iTime), start the clock

Step2: detection time is reached, if not then returned

Step3: get the current disk free space (rSpace)

Step4: rSpace> = bSpace return

Step5: Find the oldest file, delete, turn Step3

2.3 Algorithm Analysis

From the implementation of the algorithm can be seen, it makes the remaining disk space maintainat a predetermined value, which can solve the storage problem of jitter. The algorithm implementation is good or bad, the key is the setup of disk free space threshold (bSpace) and the selection of detection time interval (iTime). If the testing frequency is too high, it will take up too much system resources and affect system performance; if it is too low, it can not be detected whether to meet the storage requirements in the remaining disk space, easily lead to memory abort, lost video data. In the development of a real system, tested, bSpace value of 800M, iTime take 2 minutes, and achieved good results. Of course, these two values are different with the system environment varies.

3. Summary

With the development of video surveillance systems, the video surveillance systems with high-resolution images and multi-channel (especially 16 or more systems) widely used,so a large amount of video information need to store, which raised new challenges.In this paper, multi-drive storage scheduling and timing to increase disk space detection algorithm is based on the background generated, the algorithm takes advantage of the feature of multiple hard drives large storage capacity, average distribution the multi-channel storage to one more hard drive to solve the multi-store centralized storage on a hard drive to bring inefficiencies. using regular disk free space detection algorithm to ensure that the remaining disk storage space in a given value, to ensure the storage can be set in the progress of time, to avoid lossing of video data because of lack of storage space.The algorithm is simple, easy to ensure accuracy and has been used in practical application, it shows that using this algorithm can improve the efficiency of multi-channel storage.

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The different types of Transfer Functions in Volume Rendering

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Abstract

The more that flexibility is generally unconstrained; the most important parameter in producing a meaningful and intelligible volume rendering is also one of the hardest parameters to set appropriately. That is why the study of transfer function design was important. This paper notes attempt to describe the current state of the art of transfer functions in direct volume rendering.

Keywords: volume visualization, volume rendering, transfer functions, data exploration

1. Introduction

Transfer functions (TF), as an important classification method, have been proposed to produce images that display or highlight the region of interest in the dataset, especially in large-scale data. It is important to identify the domain and range of transfer function in question. The extent to which a data value is visible in the final data is determined by how much opacity it contributes. Opacity functions can be generalized to different types of transfer function by augmenting the function's range. The range often includes color, because color is a simple and natural way to visually distinguish between structures.

Generally, we can think of a transfer function as a mapping from a cartesian product of scalar fields F to a cartesian product of optical properties O:

$$\tau: F_1 \times F_2 \times \cdots \times F_n \rightarrow O_1 \times O_2 \times \cdots \times O_m$$

Due to user interaction problems, the values of n and m are usually small in practice. Typically, a transfer function maps density values (n=1) to opacity and color (m=2), while other optical properties are determined by an illumination model.

On a user's mind, even in this restrictive case ($n,m \leq 2$), it is a problem to specify such a transfer function. Finding good transfer functions for rendering medical volumes is difficult, non-intuitive, and time-consuming. Now, we will introduce some types of transfer function.

2.Types of transfer function

Multi-dimensional transfer function

Transfer functions can also be generalized by increasing the dimension of the function's domain. These can be termed *multidimensional* transfer functions. Multi-dimensional transfer functions are widely used to provide appropriate data classification for direct volume rendering. Nevertheless, the design of a multi-dimensional transfer function is a complicated task.

Most direct volume renderings produced today employ 1D transfer functions which assign color and opacity to the volume based solely on the single scalar quantity which comprises the data set. However, identifying good transfer functions is difficult enough in 1D. Some multi-dimensional transfer functions

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emerge as the times require and develop prosperously. A new multi-dimensional transfer function was designed by X. Zhao using parallel coordinates, and the result showed that this approach has two major advantages: (1) Combining the information of spatial space (voxel position) and parameter space; (2) Selecting appropriate high-dimensional parameters to obtain sophisticated data classification[1]. Kniss et al. [2,3] have introduced dual domain interaction to facilitate identification of 3D boundaries using a probe that facilitates manual segmentation of various materials. Caban [4] et al. have used several order local statistical texture properties to effectively assign voxels to different opacities and colors using texture-based transfer function. They also had considered multi-resolution texture analysis and multi-scale pyramids to better enhance different structures. Maciejewski[5] et al. have proposed a novel non-parametric clustering method to design TF. Although only 2D TF shown as examples, the clustering method can also be extended to design nD TF. Tzeng[6] et al. have presented a new approach to the volume classification problem, relying on an intelligent system to abstract high dimensional mapping functions from the user. The user works in the volume data space by directly painting on sample slices of the volume and the painted voxels are used in an iterative training process. TFor all the above methods, however, the user only specifies the classification in parameter space directly, limiting the visualization effects of data properties that can be used simultaneously. Shibukawa[7] proposed an intuitive system that allows the user to directly design the appearance of the volume by specifying colors of the volume with a set of control points. The system solves an inverse problem to determine the transfer function such that the color of the rendered image becomes the same as those of the control points.

Multi-dimensional transfer functions are a very effective way to extract materials and their boundaries for both scalar and multivariate data. It has proven to be an effective way to extract specific features with subtle properties. Multidimensional transfer functions can perform more sophisticated classification of volumetric objects when comparing to 1-D transfer functions. However, visualizing and manipulating the transfer function space is non-intuitive when its dimension goes beyond 3-D, thus making user interaction difficult. A new function[8] was proposed to address the multidimensional transfer function design problem by taking a two-level clustering approach, where the first-level clustering by the self-organizing map (SOM) projects high-dimensional feature data to a 2-D topology preserving map, and the second-level clustering on the SOM neurons reduces the design freedom from a large number of SOM neurons to a manageable number of clusters. According to results, we can conclude that a novel volume exploration scheme that provides top-down navigation to users exploring the volume. There are also a lot of researches on design of multi-dimensional transfer functions[9-13].

Curvature-Based Transfer Functions

According to Lichtenbelt, the more general transfer functions are those that assign opacity, color, and emittance. Other ideas to extend the *range* of transfer functions can be found by studying optical models. The domain presented magnitudes of the principal-curvatures. Although originally developed for smooth analytic surfaces, in recent years curvature information is also used in a variety of applications in the field of volume visualization.

For a specific point *P* on a regular surface, the principal directions $\overrightarrow{s1}$ and $\overrightarrow{s2}$ give us an idea about where the surface bends the most and the least, respectively. The corresponding quantitative measure (i.e. how much does the normal change in these directions) is expressed by two real numbers known as principal curvatures $\kappa 1$ and curvatures$\kappa 2$.

With the help of principal directions and curvatures, a surface can be locally approximated, up to order

two, by a quadratic patch. According to the signs of κ1, κ2 ,then we know whether the surface is locally approximated by a

(i) plane (iff κ1=κ2= 0),

(ii) parabolic cylinder (iff κ1>κ2 =0 or 0= κ1 >κ2)

(iii) paraboloid (iff κ1.κ2 >0) or (iv) hyperbolic paraboloid (iff κ1.κ2<0).

The transfer function we are going to design will map pairs of principal curvatures to optical properties, e.g. traditional color and opacity in the RGBα model:

$$\tau: \kappa 1 \times \kappa 2 \rightarrow R \times G \times B \times \alpha$$

There are a lot of previous research in volumetric curvature measurement and its application to volume visualization. Hladuvka[14] et al. describe volume renderings with two-dimensional transfer functions using a simplified space of principal curvatures, and the result showed that surface shape is an intuitive space in which to specify color and opacity. Treavett and Chen [15] create pen-and-ink style visualizations of volume data with a combination of volume-space and image-space measurements, including a simple curvature measure.

Context-preserving volume rendering(CPVR) sets up the opacity attenuation function through the information of lighting and gradient by XL Dong[16,17]. The experimental results show that the new model can increase the opacity of the sampling points which lie in the contour and weaken the effect of light. By the introduction of curvature information, the proposed model can accurately analyze internal structure of the datasets and retain the context information of the region of interest, which will help the physician to locate the lesion areas.

Size-based Transfer Functions

Size, understood as the magnitude of the spatial extents of a given part of a volume, is an intuitive concept that can be manipulated more easily than high-dimensional values. With size-based transfer functions (SBTF), it is now possible to map color and opacities based on the relative size of features. Large and small features alike often appear with similar or identical density in MR imaging or angiography. With a size-based transfer function, it is now possible to highlight sizes of interest.

The study of scale-space in visualization has been limited, partly due to the increased computational complexity of 3D volumes. Previous alternatives to represent the scales of a volume used Laplacian pyramids [18] or Wavelet transforms [19-21]. Vincken and Lum[22] et al. use pyramid representations to improve volume classification.

Stroke-Based Transfer Function

Transfer function specification has been an ongoing research topic in the past. Component functions, as described by Castro [23] et al. introduced a higher level of abstraction into the transfer function design process to allow a more intuitive transfer function specification. In medical visualization such an abstraction would be the characterization of different tissue types. König and Gröller have gone further and propose an image-centric user interface for transfer function specification [24]. A painting interface, which allows the user to directly draw on 2D slices was proposed by Tzeng[25,26] et al.

Based on this drawing a transfer function is generated and a 3D visualization is updated rapidly. Similarly, Huang and Ma [27] allow the user to draw on a 2D slice to initiate a region growing process. The results indicated that a partial region growing can be sufficient to derive a 2D transfer function. Chen[28] et al. combine 3D sketching with region growing for segmentation. Initially, they selected multiple sketches as a region of interest, and the result was very good. A similar approach is also described by Sherbondy[29] et al. Wu and Qu [30] in order to find a new transfer function, proposed a framework for combining existing volume renderings by using genetic algorithms, which allows to

visualize all relevant structures visible in the source images.

Texture-based Transfer Functions

It has been demonstrated that the generation of textural properties can be used to enhance classification and characterization of individual image regions[31]. The design of effective transfer functions for direct volume rendering has been a widely researched topic. There has been some work in the field of analyzing the spatial characteristics around the voxel under consideration to apply some smart classification techniques. Roettger[32] et al. used the voxel barycenter and the region variance to assist manual specification of colors for similar features in the process of volume rendering. Sato [33] et al. characterized tissues of interest such as edges, sheets, lines, and blobs for each local structure by explicitly defining rules and filters. Lum [34] et al. suggested the use of local textures, scale-based filtering, and parallel coordinates to better classify volume data interactively. Jesus J. Caban[35] demonstrated their texture-based transfer function for direct volume rendering with synthetic and real-world medical data to show the strength of their technique.

3. Further work

In recent years, the design method of transfer function is more and more diverse, and the application is more and more widely. However, there are many potential problems to be solved. For example, most of the transfer function still needs a lot of manual intervention to achieve satisfactory results.

Further work includes the effective scheme of assigning the opacity in transfer function, the design of function for dynamic volume rendering, and the multi-resolution visualization via hierarchical fuzzy clustering. The automatic function design based on visual clustering algorithms[36,37] is also a promising direction.

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The Design of Eight-digit Password Lock

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Abstract: With the increasing development of technology, electronic password lock control system is more and more consistent with the requirements of people because of low cost and safe. This design is a eight-digit password lock based on STC89C51, it has many functions such as password setting, password setting, password displaying, voice prompting of password wrong, password error sound and light alarm. The digital signal encoding and the second modulation is used to improve the immunity of signal transmission, with the performance of low consumption, low power, fast response, high transmission efficiency, it is stable and reliable.

Key words: password lock ; MCU ; voice prompt

0 Introduction

With the rapid development of electronic technology and computer technique, the intelligence and miniaturization electronic products have been widely used in various fields of life. In the field of security technology, electronic code control system with anti-theft alarm function has replaced the traditional mechanical code control system gradually. It can overcome the shortcomings of the mechanical password control password with the performance of less password and poor safety. From the perspective of simple and practical, this paper has designed a eight-digit password lock that can change the password and has the false alarms prompt. The password lock has the features of reasonable design, simple using, low cost, safety and practical. It has a high practical value, products are small and easy upgrade to improve.

1 Basic principle

The main control unit of the design is STC89C51,the main input unit is keyboard with unlocking device, alarms and display units. It has appropriate hardware circuits to complete the password settings, storage, identification, display, drive the electromagnetic actuator and detect the receiving signals sent by the sensor, realize transmission data and other functions. System block diagram is shown in Figure 1[1].

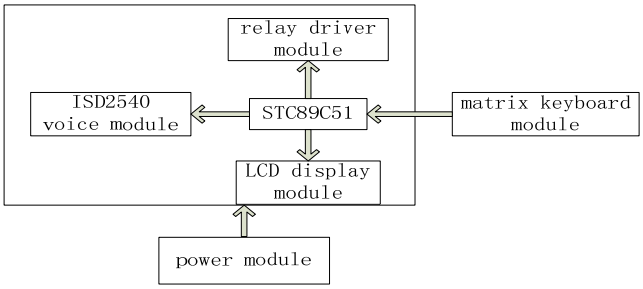

Fig. 1 System block diagram of the eight-digit password lock

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Analysis of working principle: STC89C51 is the core of the system, the relay driver module is controlled by the output of high-low level through its I/O port to achieve the digital lock switch functions.The matrix keyboard input module is used to inputting a user password; LCD display module is used to display user-entered password and the number of the wrong password user enters.ISD2540 voice module is used to prompt right or wrong of the user when he enter a password. In order to reduce the interference of power supply ripple noise, a linear regulator power supply is used to provide + 5V DC voltage.

2 Hardware circuit design

2.1 Main system circuit design

89C51 microcontroller is a high-performance 8-bit microcontroller of MCS-51 series made by Intel Corporation of the United States.It requires an 12M or 11.0592M external crystal and an external microcontroller reset circuit to ensure normal work, under normal circumstances it can ensure normal working voltage for 5V. Password lock is done by keyboard input[2]. The system uses 4 * 4 keyboard, not only to enter a password, it can also do special function such as clearing the display . Each key function keyboard settings in programming such as "the number keys (0-9)", "Enter", "toggle keys", "Clear digit key", "clear all numeric key", "set key". “The number keys” is used to input digital passwords by user; "Enter"is used to confirm whether a user complete enter a password and set a new password; "toggle keys" is used to switch the user's mode; "clear digit key" is used to clear the last digit; "clear all numeric key" is used to clear all numbers; "set key” is used to set original password, universal unlock code, eliminate alert passwords.LCD12864 display is used to display the user mode, digital input and output times of wrong password. Circuit is shown in Figure 2.

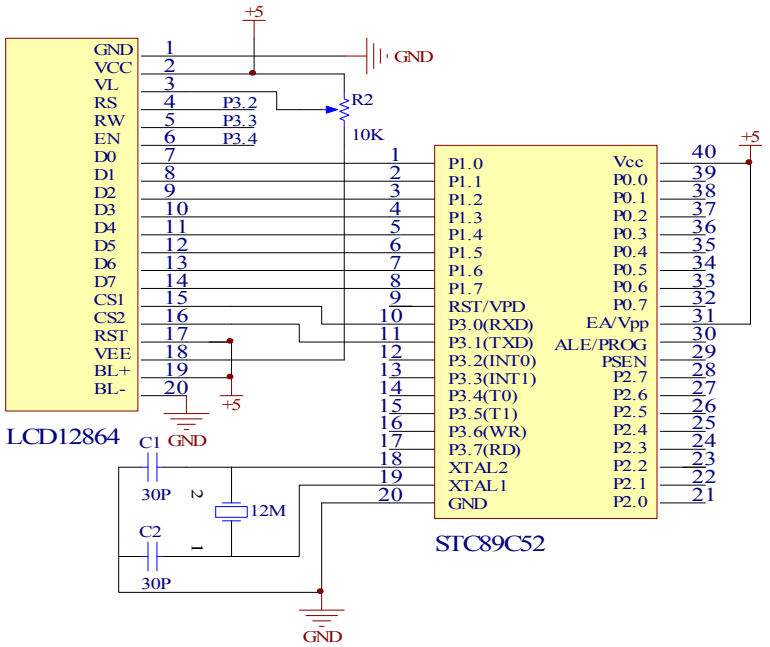

Fig.2 circuit diagram of the main system

2.2 Sound and light alarm circuit design

When the password is entered, contrast with the setting password, if the entered password is incorrectly,

then the device will output an alarm signal to the alarm circuit. Sound and light alarm circuit is shown in Figure 3. Because of the continuous sound will not be able to cause the attention of people, so the intermittent sound and strobe lights is used to achieved to the function. This task has accomplished mainly depend on software.

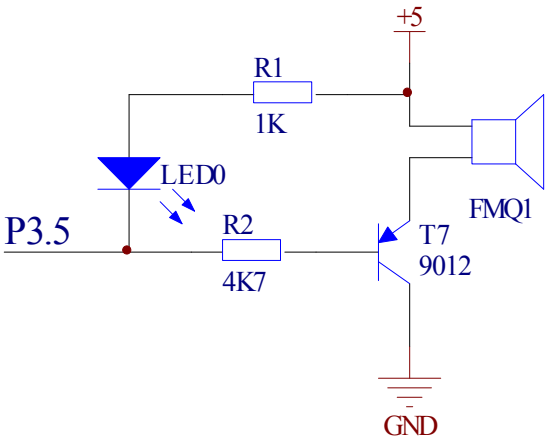

Figure 3 sound and light alarm circuit

2.3 Design of unlocking electronic circuit

After contrast the entering password with the set password, if the password is correct, the microcontroller will output the unlock signal to unlock the implementing agencies to achieve unlocking. In general, unlocking mechanism is the use of electromagnetic locking with the principle of electromagnetic absorption. The output weak signal from MCU should be amplification disposal by driving circuit to drive the electromagnetic lock pull, in order to achieve the purpose of unlocking. D2, R1 and T1 are composed of a drive circuit of unlocking circuit[3].Where, D2, C1 is used to eliminate the possible of electromagnetic lock reverse high-voltage and the possible of electromagnetic interference. T1 is amplified current and used to switch .Unlocking electronic circuit is shown in Figure 4.

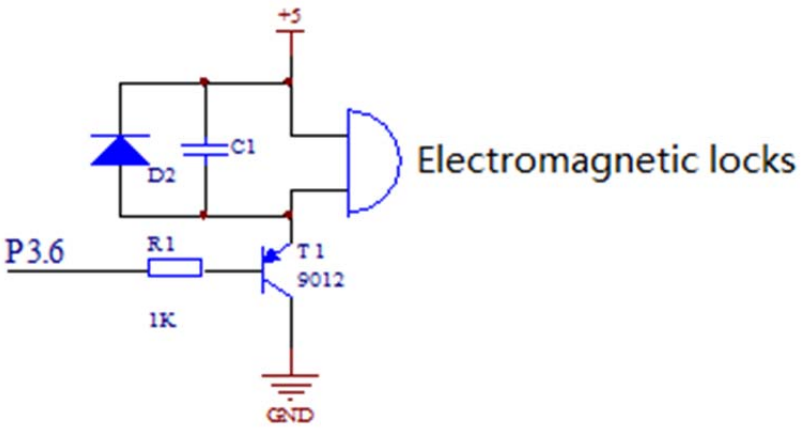

Fig. 4 unlocking circuit

2.4 Design of voice prompt circuit

The voice broadcast function is achieved by Voice prompt circuit based on ISD2540 core. The chip

uses a direct analog storage technology (DAST), the original speech signal is stored in analog form directly into the semiconductor memory without A/D and D/A conversion. When recording, press the record button, set the starting address of voice segment by MCU via port line, and then start recording by setting the low level of PD side, PR side and CE side. At the end, release the button, let CE side return to high level and the record a voice has completed. It is worth noting, recording time can not exceed a pre-set time each voice[4]. Previously,using MCU control voice chip to play a recorded message, each message set a fixed recording time, it helps to call the first address of the segment speech segment at play to realize issue the appropriate voice prompts at the end of a certain operation. Voice prompt circuit is shown in Figure 5.

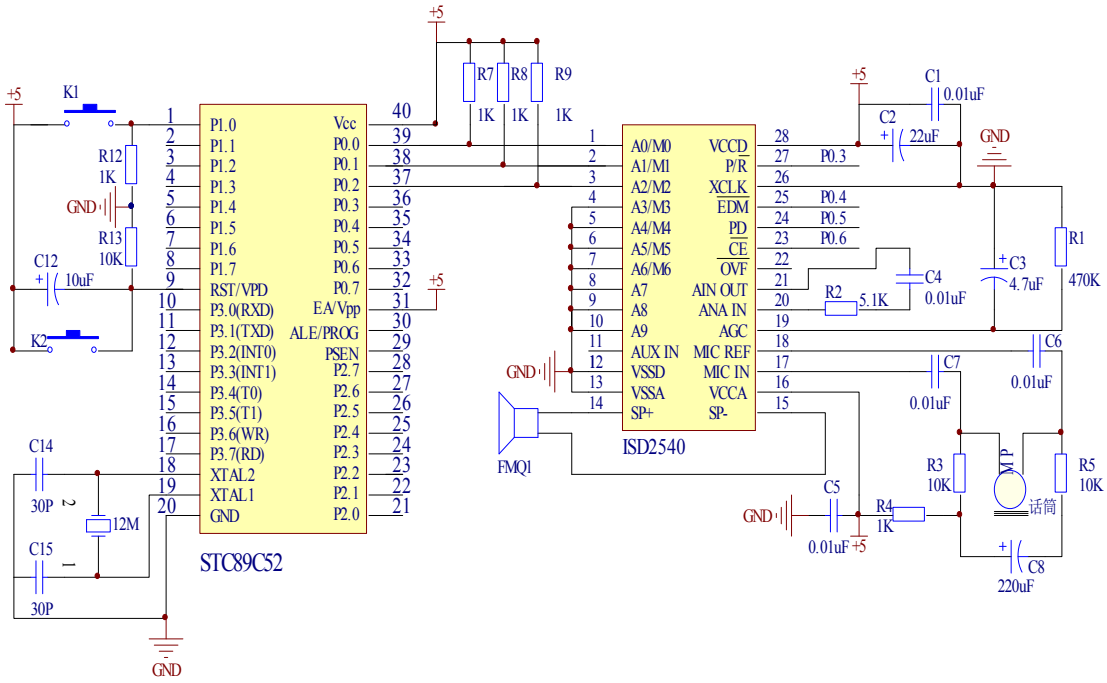

Fig.5 Voice prompt circuit

3 Program Design

A modular design ideological has used, it mainly includes the following sections: the main program, the keyboard scanner, key recognition program, delete the program and change the password program, voice reminder, unlock the program, sound and light alarm program and display procedures. First, the initial password is written to the password storage area, the initial password is 01234567, then continue to invoke the keyboard scanner in order to checking whether a signal input from the keyboard and then calling the key password identification procedures to identify and complete the password comparison, then checking whether it is consistent with the setting password[5]. After a delay, return to the main program began to wait for a new password input. System program flow chart is shown in Figure 6.

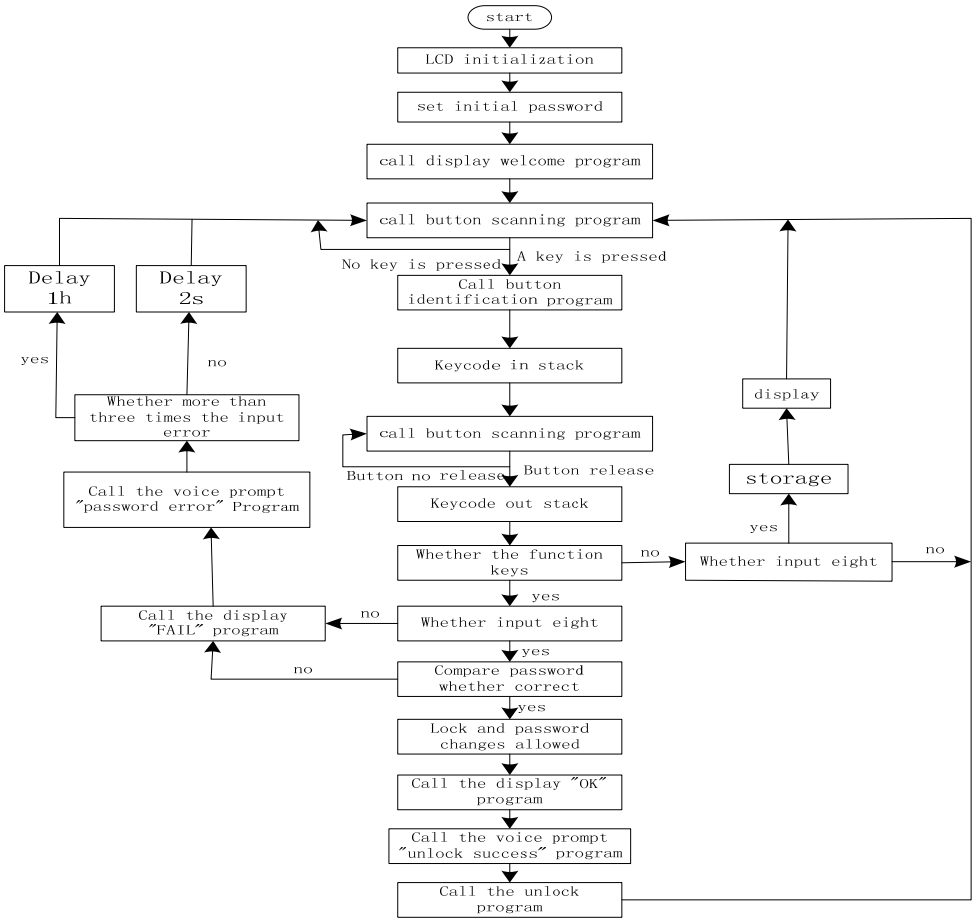

Fig. 6 System program flow chart

4 Conclusion

This design uses STC89C51 chip to design the simple eight-digit password lock, the functions of read data and the output control and so on has achieve by I/O port, combine the hardware and software together. The system has functions with high security, high number of passwords, and a voice error sound and light alarm. In addition, it has delete, modify the password functions. The system has the features of reasonable design, simple using, low cost, safety and practical with good prospects.

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Transfer functions (TF), as an important classification method, have been proposed to produce images that display or highlight the region of interest in the dataset, especially in large-scale data. It is important to identify the domain and range of transfer function in question. The extent to which a data value is visible in the final data is determined by how much opacity it contributes. Opacity functions can be generalized to different types of transfer function by augmenting the function's range. The range often includes color, because color is a simple and natural way to visually distinguish between structures.

Generally, we can think of a transfer function as a mapping from a cartesian product of scalar fields F to a cartesian product of optical properties O:

$$\tau: F_1 \times F_2 \times \cdots \times F_n \rightarrow O_1 \times O_2 \times \cdots \times O_m$$

Due to user interaction problems, the values of n and m are usually small in practice. Typically, a transfer function maps density values (n=1) to opacity and color (m=2), while other optical properties are determined by an illumination model.

On a user's mind, even in this restrictive case ($n,m \leq 2$), it is a problem to specify such a transfer function. Finding good transfer functions for rendering medical volumes is difficult, non-intuitive, and time-consuming. Now, we will introduce some types of transfer function.

2.Types of transfer function

Multi-dimensional transfer function

Transfer functions can also be generalized by increasing the dimension of the function's domain. These can be termed *multidimensional* transfer functions. Multi-dimensional transfer functions are widely used to provide appropriate data classification for direct volume rendering. Nevertheless, the design of a multi-dimensional transfer function is a complicated task.

Most direct volume renderings produced today employ 1D transfer functions which assign color and opacity to the volume based solely on the single scalar quantity which comprises the data set. However, identifying good transfer functions is difficult enough in 1D. Some multi-dimensional transfer functions emerge as the times require and develop prosperously. A new multi-dimensional transfer function was designed by X. Zhao using parallel coordinates, and the result showed that this approach has two major advantages: (1) Combining the information of spatial space (voxel position) and parameter space; (2)

Selecting appropriate high-dimensional parameters to obtain sophisticated data classification[1]. Kniss et al. [2,3] have introduced dual domain interaction to facilitate identification of 3D boundaries using a probe that facilitates manual segmentation of various materials. Caban [4] et al. have used several order local statistical texture properties to effectively assign voxels to different opacities and colors using texture-based transfer function. They also had considered multi-resolution texture analysis and multi-scale pyramids to better enhance different structures. Maciejewski[5] et al. have proposed a novel non-parametric clustering method to design TF. Although only 2D TF shown as examples, the clustering method can also be extended to design nD TF. Tzeng[6] et al. have presented a new approach to the volume classification problem, relying on an intelligent system to abstract high dimensional mapping functions from the user. The user works in the volume data space by directly painting on sample slices of the volume and the painted voxels are used in an iterative training process. TFor all the above methods, however, the user only specifies the classification in parameter space directly, limiting the visualization effects of data properties that can be used simultaneously. Shibukawa[7] proposed an intuitive system that allows the user to directly design the appearance of the volume by specifying colors of the volume with a set of control points. The system solves an inverse problem to determine the transfer function such that the color of the rendered image becomes the same as those of the control points.

Multi-dimensional transfer functions are a very effective way to extract materials and their boundaries for both scalar and multivariate data. It has proven to be an effective way to extract specific features with subtle properties. Multidimensional transfer functions can perform more sophisticated classification of volumetric objects when comparing to 1-D transfer functions. However, visualizing and manipulating the transfer function space is non-intuitive when its dimension goes beyond 3-D, thus making user interaction difficult. A new function[8] was proposed to address the multidimensional transfer function design problem by taking a two-level clustering approach, where the first-level clustering by the self-organizing map (SOM) projects high-dimensional feature data to a 2-D topology preserving map, and the second-level clustering on the SOM neurons reduces the design freedom from a large number of SOM neurons to a manageable number of clusters. According to results, we can conclude that a novel volume exploration scheme that provides top-down navigation to users exploring the volume. There are also a lot of researches on design of multi-dimensional transfer functions[9-13].

Curvature-Based Transfer Functions

According to Lichtenbelt, the more general transfer functions are those that assign opacity, color, and emittance. Other ideas to extend the *range* of transfer functions can be found by studying optical models. The domain presented magnitudes of the principal-curvatures. Although originally developed for smooth analytic surfaces, in recent years curvature information is also used in a variety of applications in the field of volume visualization.

For a specific point *P* on a regular surface, the principal directions $\overrightarrow{s1}$ and $\overrightarrow{s2}$ give us an idea about where the surface bends the most and the least, respectively. The corresponding quantitative measure (i.e. how much does the normal change in these directions) is expressed by two real numbers known as principal curvatures $\kappa 1$ and curvatures$\kappa 2$.

With the help of principal directions and curvatures, a surface can be locally approximated, up to order two, by a quadratic patch. According to the signs of $\kappa 1$, $\kappa 2$,then we know whether the surface is locally approximated by a

(i) plane (iff $\kappa 1=\kappa 2= 0$),

(ii) parabolic cylinder (iff $\kappa1>\kappa2 =0$ or $0= \kappa1 >\kappa2$)
(iii) paraboloid (iff $\kappa1.\kappa2 >0$) or (iv) hyperbolic paraboloid (iff $\kappa1.\kappa2<0$).
The transfer function we are going to design will map pairs of principal curvatures to optical properties, e.g. traditional color and opacity in the RGBα model:

$$\tau: \kappa1\times\kappa2 \rightarrow R\times G \times B \times \alpha$$

There are a lot of previous research in volumetric curvature measurement and its application to volume visualization. Hladuvka[14] et al. describe volume renderings with two-dimensional transfer functions using a simplified space of principal curvatures, and the result showed that surface shape is an intuitive space in which to specify color and opacity. Treavett and Chen [15] create pen-and-ink style visualizations of volume data with a combination of volume-space and image-space measurements, including a simple curvature measure.

Context-preserving volume rendering(CPVR) sets up the opacity attenuation function through the information of lighting and gradient by XL Dong[16,17]. The experimental results show that the new model can increase the opacity of the sampling points which lie in the contour and weaken the effect of light. By the introduction of curvature information, the proposed model can accurately analyze internal structure of the datasets and retain the context information of the region of interest, which will help the physician to locate the lesion areas.

Size-based Transfer Functions

Size, understood as the magnitude of the spatial extents of a given part of a volume, is an intuitive concept that can be manipulated more easily than high-dimensional values. With size-based transfer functions (SBTF), it is now possible to map color and opacities based on the relative size of features. Large and small features alike often appear with similar or identical density in MR imaging or angiography. With a size-based transfer function, it is now possible to highlight sizes of interest.

The study of scale-space in visualization has been limited, partly due to the increased computational complexity of 3D volumes. Previous alternatives to represent the scales of a volume used Laplacian pyramids [18] or Wavelet transforms [19-21]. Vincken and Lum[22] et al. use pyramid representations to improve volume classification.

Stroke-Based Transfer Function

Transfer function specification has been an ongoing research topic in the past. Component functions, as described by Castro [23] et al. introduced a higher level of abstraction into the transfer function design process to allow a more intuitive transfer function specification. In medical visualization such an abstraction would be the characterization of different tissue types. König and Gröller have gone further and propose an image-centric user interface for transfer function specification [24]. A painting interface, which allows the user to directly draw on 2D slices was proposed by Tzeng[25,26] et al.

Based on this drawing a transfer function is generated and a 3D visualization is updated rapidly. Similarly, Huang and Ma [27] allow the user to draw on a 2D slice to initiate a region growing process. The results indicated that a partial region growing can be sufficient to derive a 2D transfer function. Chen[28] et al. combine 3D sketching with region growing for segmentation. Initially, they selected multiple sketches as a region of interest, and the result was very good. A similar approach is also described by Sherbondy[29] et al. Wu and Qu [30] in order to find a new transfer function, proposed a framework for combining existing volume renderings by using genetic algorithms, which allows to visualize all relevant structures visible in the source images.

Texture-based Transfer Functions

It has been demonstrated that the generation of textural properties can be used to enhance classification

and characterization of individual image regions[31]. The design of effective transfer functions for direct volume rendering has been a widely researched topic. There has been some work in the field of analyzing the spatial characteristics around the voxel under consideration to apply some smart classification techniques. Roettger[32] et al. used the voxel barycenter and the region variance to assist manual specification of colors for similar features in the process of volume rendering. Sato [33] et al.
characterized tissues of interest such as edges, sheets, lines, and blobs for each local structure by explicitly defining rules and filters. Lum [34] et al. suggested the use of local textures, scale-based filtering, and parallel coordinates to better classify volume data interactively. Jesus J. Caban[35] demonstrated their texture-based transfer function for direct volume rendering with synthetic and real-world medical data to show the strength of their technique.

3. Further work

In recent years, the design method of transfer function is more and more diverse, and the application is more and more widely. However, there are many potential problems to be solved. For example, most of the transfer function still needs a lot of manual intervention to achieve satisfactory results.

Further work includes the effective scheme of assigning the opacity in transfer function, the design of function for dynamic volume rendering, and the multi-resolution visualization via hierarchical fuzzy clustering. The automatic function design based on visual clustering algorithms[36,37] is also a promising direction.

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