The Application of Visual System in Fundus Diagram

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Abstract: In order to reduce the workload of medical workers, improve work efficiency, reduce errors, this paper studied a can learn human retinal fundus image difference system, for the purpose of this vision system in the application of fundus figure, can automatically determine the difference between the eye diagram of the different people and make a basic analysis, in order to do the preliminary screening of disease, whether the person will have the risk of diabetes, high blood pressure, etc. This paper makes the following contents based on image processing technology. First browsed the traditional visual algorithm is relatively simple in the SIFT (Scale-invariant feature transform) algorithm, which is a computer vision algorithm, used to detect and describe the local characteristics of image, it seeks extreme value point in the space Scale, and extract its location, Scale and rotation invariant, eventually fundus figure by the standards of the already sick with the generation of mapping similarity comparison, to determine the generation of fundus photographs himself at risk. Secondly, after recognizing the shortcomings of the traditional algorithm, such as the weak anti-interference ability for outliers, sometimes fewer feature points, and inability to accurately extract feature points for targets with smooth edges, etc. This paper finally uses CNN deep learning algorithm and successfully realizes it in retinal fundus image processing. The results show that the application of the retinal fundus image in the CNN algorithm can effectively eliminate the interference of abnormal points.Finally, the fundus images of different patients were classified to match the corresponding diseases.

1. The introduction

1.1 The research background

The eye is one of the most important sensory organs in the human body. Generally, ophthalmology can be divided into ophthalmic diagnosis and treatment, optometry and visual science, and the field of optometry can be subdivided into medical optometry and commercial optometry. From the perspective of market size, the size of China's ophthalmic medicine market in 2015 has exceeded 8 billion yuan, and it is expected to approach 20 billion yuan in 2020. The current market size of eye disease diagnosis and treatment has exceeded 20 billion yuan. In view of the low treatment penetration rate of cataract, glaucoma, refractive correction, and other diseases, there are at least two times more room for future eye disease diagnosis and treatment.

Cataracts, glaucoma, diabetic retinopathy and age-related eye disease has a high, aged 60 and above of 2015, China's population has reached 222 million, 16.15% heavier than total population, the proportion in 2020 is expected to exceed 17%, more than 20% in 2025 into an aging society, namely the deepening of aging degree will directly lead to eye disease diagnosis and treatment of a surge in demand. In China, the residents' awareness of ophthalmic health keeps improving and their concept of seeking medical treatment is gradually enhanced. From 2005 to 2014, the compound growth rate of the number of ophthalmic emergency department and ophthalmic admission has reached 13% and 20%, respectively. It is expected that the number of ophthalmic diagnoses will remain at a high level in the future.

From the perspective of professional talents, our ophthalmologist number significantly lower than the developed countries, the number of eye doctors per million people is now 20% in Japan and 30% in Brazil. The cultivation of the future of ophthalmology specialists will increase medical supplies is

the most need to solve the bottleneck, and in the light of the scarcity and professionalism of the ophthalmic resource, specialized marketing advantage of the enterprise will have higher voice and channel advantages, however, it is because of the scarcity and professionalism, and cultivate an ophthalmologist need cycle long, difficult, so there are not as many people who become eye doctors as people think.

From the perspective of the disease itself, fundus vascular disease is a universally recognized treatment problem. Due to the lack of effective drugs, early prevention is the best method.

1.2 Research status

1.2.1 Dividend brought by computer vision technology

After the first computer, with the upgrading of the computer in recent years. The first electronic computer performs about 15000 times per second, until now the highest quadrillion per second (1000000000000000), and we are ordinary users' laptop computing speed, and general level to gigabit levels.

1.2.2 Combination of computer vision technology and deep learning

When people see the "smart" alpha dog defeat Lee Se-dol on the go, many people began to use deep learning approach to solve some problem, despite deep learning's Development time earlier, but it experienced too much frustration, now it's a relatively new field

In 2018, some famous universities have started to build artificial intelligence colleges, and a series of enterprises represented by Internet giants BAT, such as Baidu, Tencent, Alibaba, JD, NetEase, touting, 360, Sohu, etc.

These companies have their own ai research institutes (divisions), of which the Department of visual is very more

1.2.3 Combination of computer vision technology and fundus images

In China, many papers have discussed the analysis of fundus images with traditional visual algorithms, and many methods have been proposed to extract blood vessels and their exudate from retinal fundus lesions.

However, no company in SiChuan has carried out ophthalmic research in the field of deep learning, so the development prospect is evident.

2. Study on CNN algorithm

2.1 How the computer stores images

First, we found a picture of the star "Tony leung" and put him into the MCU, then we saw his picture.

Fig. 1. A picture of star Tony leung.

But computers don't "see" the world the way we do. We zoom in and select an area.

Fig. 2. The enlarged image "Tony leung"

Amplified again

2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
14	0	23	0	9	10	0	0	4	7	3	1	4	6	9	12	12	8	2
6	19	0	12	8	5	3	0	0	3	7	0	3	6	2	0	0	0	0
0	0	15	0	0	1	14	13	0	0	0	29	2	0	5	16	8	2	7
18	16	0	12	44	104	168	213	237	253	255	211	207	156	64	0	0	4	5
18	0	44	176	207	240	255	255	255	250	243	251	234	244	255	208	97	15	0
0	64	204	243	255	255	255	249	252	255	252	241	255	255	245	255	250	146	19
82	252	255	248	250	249	246	245	250	255	255	244	255	251	240	252	255	244	201
207	255	255	255	249	249	255	255	255	251	254	255	251	252	255	255	248	250	255
244	255	246	255	255	255	255	255	255	255	255	254	254	254	254	254	254	254	254
255	252	255	255	255	255	255	255	255	255	255	254	254	254	254	254	254	254	254
255	255	246	255	255	255	255	255	255	255	255	253	253	253	253	253	253	253	253
251	255	247	255	255	255	255	255	255	255	255	253	253	253	253	253	253	253	253
255	239	255	255	255	255	255	255	255	255	255	253	253	253	253	253	253	253	253
250	255	250	255	255	255	255	255	255	255	255	254	254	254	254	254	254	254	254
246	255	242	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	235	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	244	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	244	254	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	244	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	245	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	247	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
255	247	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255

Fig. 3 The final enlarged image " Tony leung "

Now you can see rows and rows of Numbers in the picture, and in fact, this is how computers are stored.

2.2 CNN network principle:

2.2.1 Basic steps of the convolutional network

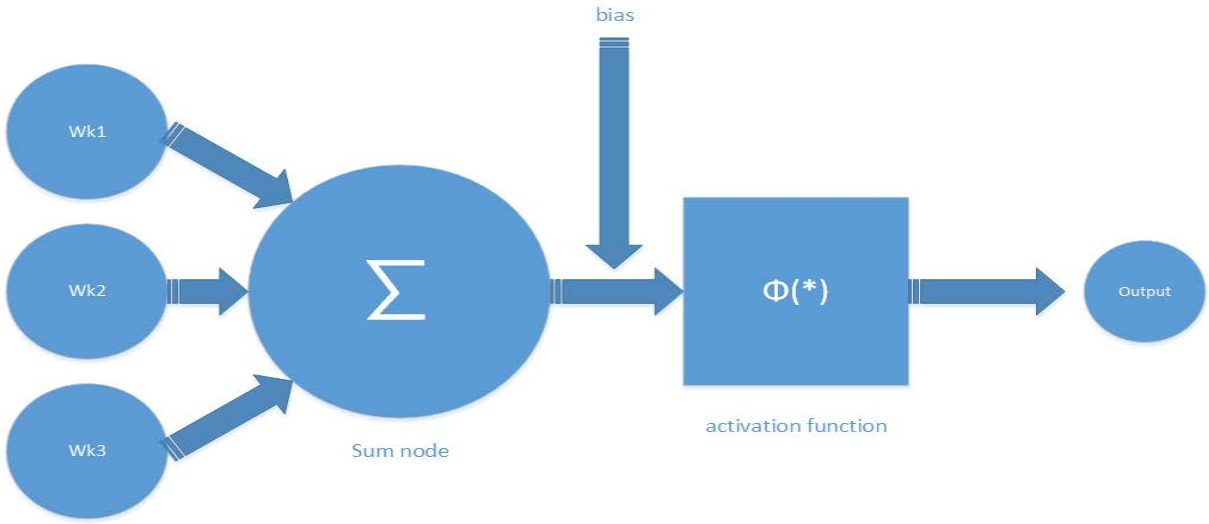

Fig. 4. A basic schematic of a picture passing through the CNN network

1) Firstly, the picture goes through the first layer of convolution, constantly scroll through the image to collect information in the image, each time collecting only a small area of pixels, then collate the information collected, at this time, the sorted information has some actual presentation, for example, the neural network can see some edge information.

2) In the same process, a similar batch filter is used to scan the generated edge information, from which the neural network summarizes the higher-level information structure (such as the veins in the eyeballs).

3) Through the pooling layer, the input feature graph is compressed. On the one hand, the feature

graph is reduced to simplify the network computing complexity and reduce the computing burden of the computer; on the other hand, the feature graph is compressed to extract the main features.

4) At last, we put the high-level information (information of the whole fundus image) into several layers of common fully connected neural layers for classification, to get the result of which category the input image can be divided into.

2.2.2 Principle and significance of convolution

$$\sigma\left(b+\sum_{l=0}^{4}\sum_{m=0}^{4}w_{l,m}a_{j+l,k+m}\right)$$

Fig. 5. Steps of the filter to scan the image pixels

Convolution can be thought of like a filter, and a filter in an image is an operation that filters by checking each bit in the image, and we'll do a couple of examples in a visual way.

0	0	0
0	1	0
0	0	0

Fig. 6. A convolution kernel without any function

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

Fig. 7. A convolution kernel that ACTS as a smoothing filter

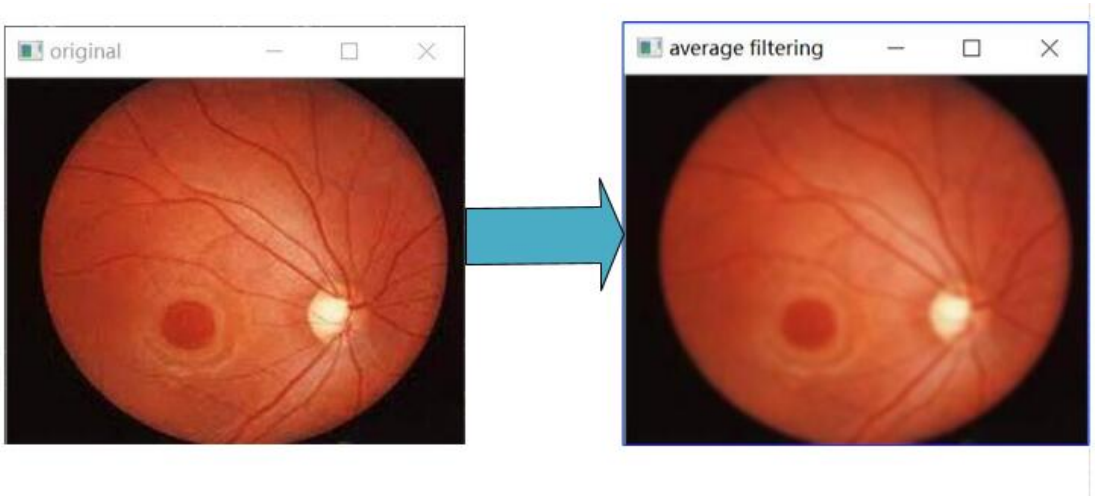

Fig. 8. Rendering

(Can be used to blur and eliminate noise)

-1	-1	-1
-1	9	-1
-1	-1	-1

Fig. 9. A convolution kernel for image sharpening

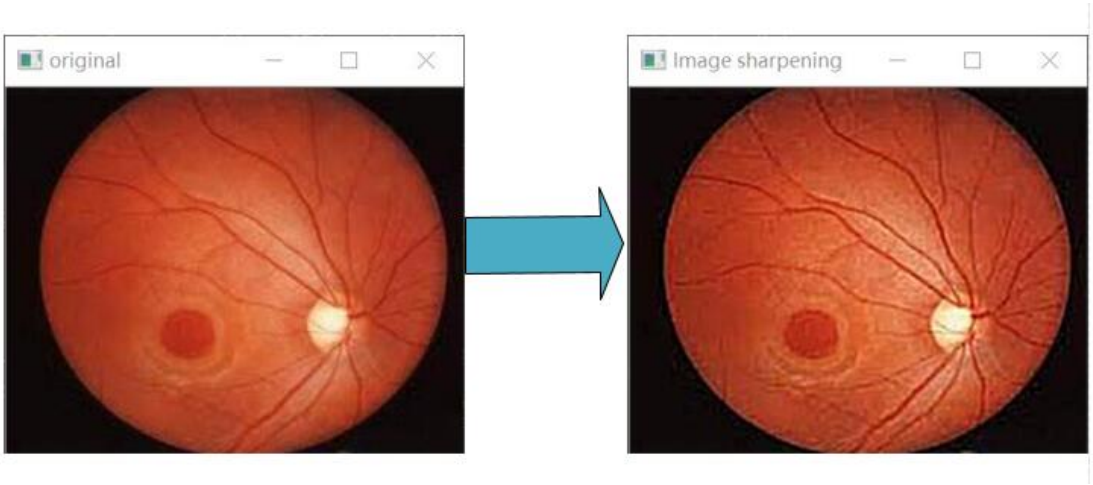

Fig. 10. Rendering

(Can be used to compensate the image contour, enhance the image edge and gray jump parts, so that the image becomes clear)

2.2.3 The principle and significance of pooling layer

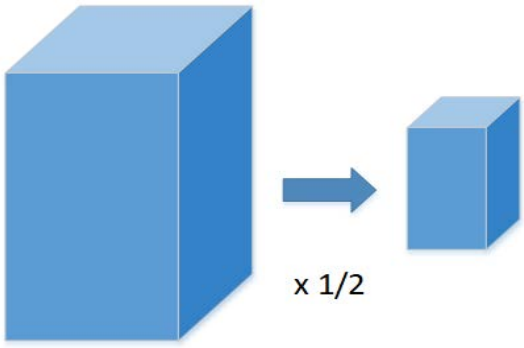

Fig. 11. Schematic diagram of pooling

At the time of each convolution, the neural layer may unintentionally lose some information, and then pooling can well solve the problem. Besides, pooling is a screening and filtering process, which can screen out the useful information in the layer for the analysis of the next layer, and reduce the computational burden of the neural network

2.2.4 The principle and significance of the full connection layer

The result of convolution is a node, which corresponds to a neuron in the full connection layer and ACTS as a "classifier" in the whole convolutional neural network. If the operations of the convolutional layer, pooling layer and activation function layer are to map the original data to the hidden layer feature space, the fully connected layer will play the role of mapping the learned "distributed feature representation" to the sample tag space.

3. The retinal fundus image processing technology

3.1 Overview of fundus visual system

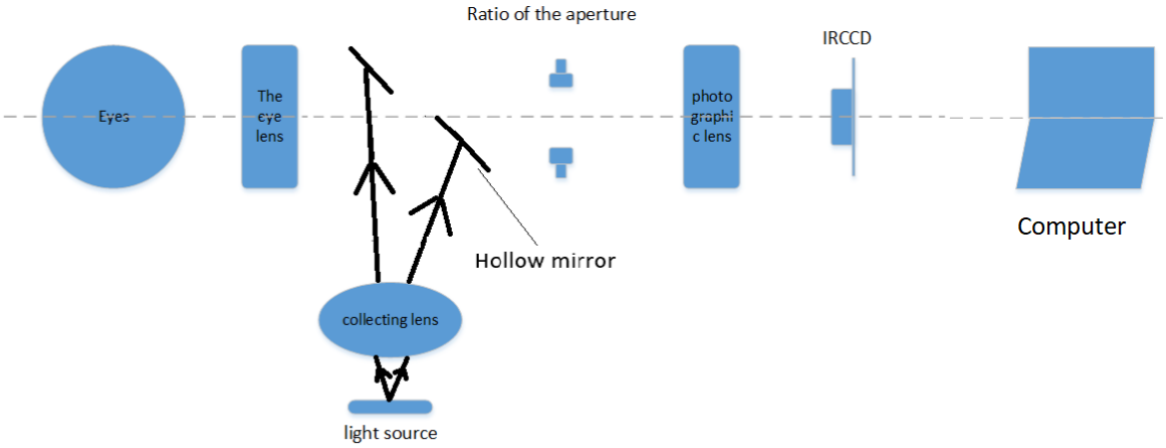

Fig. 12. fundus visual system

Pupil-free fundus camera mainly provides low-intensity infrared light as the focus light source. Such a light source is not seen by the eyes tested, so it will not cause reflex pupil contraction.

3.2 Optical schematic of the mydriatic - free fundus camera

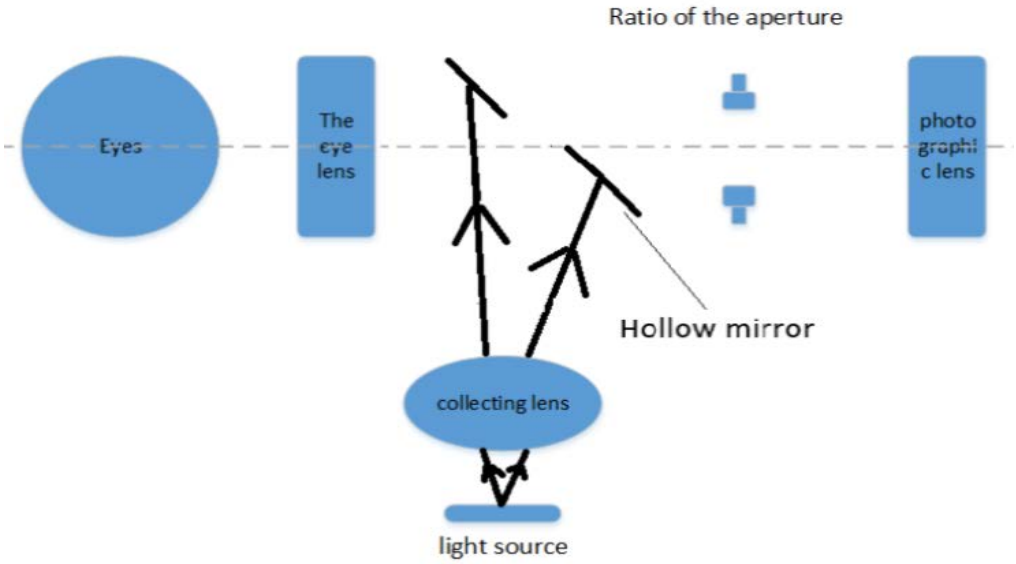

Fig. 13. Optical schematic diagram of the fundus camera

3.2.1 Algorithm overview

The algorithm as the top priority in the whole system, the following to understand the whole process of the algorithm.

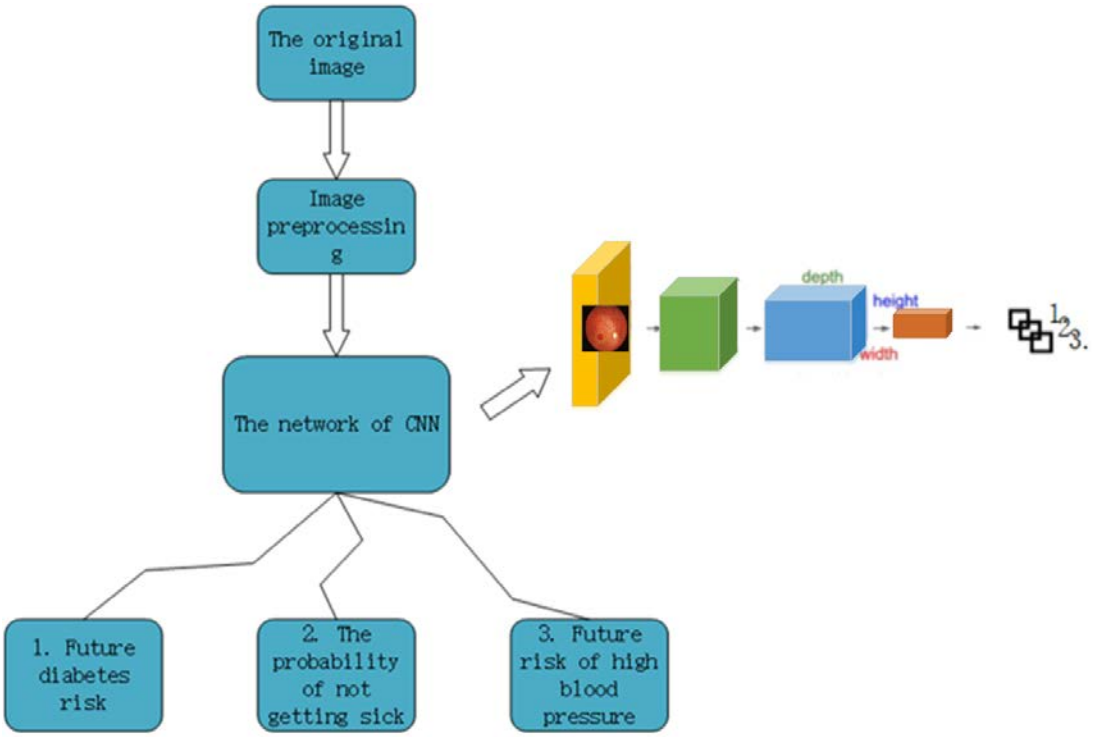

Fig. 14. Visual system diagram

First, retinal fundus image processing is for retinal image processing, so the first step should be to collect the original retinal image. In this paper, the pupil free fundus camera is used to collect the image, and the second step is to upload the image to the computer through the data line.

Then run the image processing program studied in this paper on the computer. The image processing program includes the following parts:

1) Preprocessing by opencv

(a) Make all retinal fundus images the same size (e.g. 28*28)

(b) We expand it by one dimension

(c) Cut off 10% of the image to remove border effects.

2) Train CNN network generation model

(d) Let's start with 96 cores of 4 steps 11 by 11 by 3.

(e) The second convolutional layer takes the output of the first convolutional layer as input (reaction normalization and pooling) and then filters it with 256 5 x 5 x 48 cores.

(f) The third, fourth and fifth convolutional layers are connected to each other, without pooling layer and normalization layer. The third convolutional layer has 384 3 x 3 x 256 kernels connected to the output of the second convolutional layer (normalization + pooling). The fourth convolutional layer has 384 cores of 3 * 3 * 192, and the fifth convolutional layer has 256 cores of 3 * 3 * 192. Each full-connective layer has 4,096 neurons.

(g) Save this neural network to the generated mat file

3) Load the weight and input the picture into the model weight.

4) Classify the input images

5) Put the corresponding label on the picture

6) Display display results

3.2.2 Software

```
#import necessary package
from keras.preprocessing.image import img_to_array
from keras.models import load_model
import numpy as np
import argparse
import imutils
```

```
import cv2
#load image
image = cv2.imread(“image”)
copy = image.copy()
# Operate on the image
image = cv2.resize(image, (28, 28))
image = image.astype(“float”) / 255.0
image = img_to_array(image)
image = np.expand_dims(image, axis=0)
# Load the trained neural network
Model = load_model(“model”)
# Classify the input images
(p_dm, p_hbp,p_none) = model.predict(image)[0]
# Label the image accordingly
output = imutils.resize(orig, width=400)
cv2.putText(output, label, (10, 25), cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 0), 2)
#imshow the result
cv2.imshow("Output", output)
cv2.waitKey(0)
```

4. Summary and prospect

4.1 Summary

Along with our country informationization construction and the internationalization level enhancement, the computer vision and artificial intelligence more and more take seriously.

Based on the rapid development of computer and image processing technology, today's social demand for machine vision, we design and implement a target classification system based on deep learning, the analysis study surrounding retinal fundus images, and the risk of the disease by the human eye to make use of the system preliminary estimates.

Firstly, according to the computer vision technology at home and abroad, the research significance and research direction of this subject are proposed. Secondly, it browses the existing image processing methods and proposes a technical route suitable for the research in this paper. Then consult the retinal fundus images of the disease symptoms of the relevant literature to develop the idea of risk assessment. Finally, the function of each part is realized.

The main work and results of this paper are as follows:

A simple mydriatic - free fundus camera was designed and studied

The CNN algorithm with the stronger anti-interference ability is studied and applied in retinal fundus image processing, achieving a higher accuracy rate than the traditional visual processing algorithm.

4.2 Prospect

This paper can do further research on the follow-up work.

1) The processing method in this paper is suitable for running on high-speed processors or using images between 200k-1m in size, otherwise, the processing speed will be slow.

2) The filming equipment is relatively large, which has a relatively small radiation range for the audiences who need more help in remote areas.

I will continue to study and solve the above problems in the following study.

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