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The Survey of CNN-based Cancer Diagnosis System

Mingzhe Ruan, Yongshuo Ren, Zhiqi Wu, Jianrui Wu, Shuai Wang and Xulei Yang

School of Computer Science & Software Engineering, Tianjin Polytechnic University, Tianjin, China
Email: mingzheruan@foxmail.com

Abstract. This thesis summarizes the structure and image processing methods of miniature robot from the perspectives of miniature diagnostic robot, CSF (CNN-SVM-FCN) and expert systems, in which it highlights the key technologies and the latest research progress in various aspects, analyzes the advantages and disadvantages of each method, elaborates their respective implementation processes and system framework. It also further explores ways to promote their complementary advantages and makes a prediction of the possible opportunities brought by the combination of these three methods.

1.Introduction

Medical diagnosis is a process in which doctors judge and make decisions based on their clinical experience and symptoms of a patient. Early diagnosis and treatment can significantly improve the patient's survival rate in terms of cancer and other diseases, yet wrong diagnosis may cost the price of life. This kind of decision-making mainly depends on the doctor's practical work experience, which is greatly influenced by his/her subjective experience and external interference factors. This paper discusses and studies cancer diagnosis technology and proposes a new MCSFE diagnosis method. Firstly, the body was explored using a miniature diagnostic robot, and through the use of image information obtained by the feedback, the cancerous target was identified. Finally, the information was submitted to the expert system for diagnosis and a treatment plan was obtained, which has reached the goal of accurate and rapid access to cancer treatment programs.

2.Miniature robot diagnostic system

With the development of biomedical engineering, the demand for miniaturization, portability, and economy of medical devices has become higher and higher. However, traditional insertion endoscopes and capsule endoscopes have their shortcomings and limitations. Therefore, a miniature robot diagnostic system can be studied by using mature micro-mechanics, micro-electronics, wireless communications, and wireless energy transfer technologies. The miniature diagnostic robot is mainly composed of four modules: a video camera module, a wireless communication module, a wireless energy receiving module, and a miniature linear actuator.

Miniature diagnostic robots [1-5] perform autonomous exercise after entering the human gastrointestinal tract from the anus or mouth. Doctors can wirelessly communicate with the miniature diagnostic robot through the robot controller and control the robot to move forward, backward or stop to observe the fixed-point at real-time. The miniature robot carrying the video camera device wirelessly transmits the captured image of the gastrointestinal tract to the robot controller for the doctor to save and to process, which can also obtain human body models for medical research through 3D modeling technology. [6]

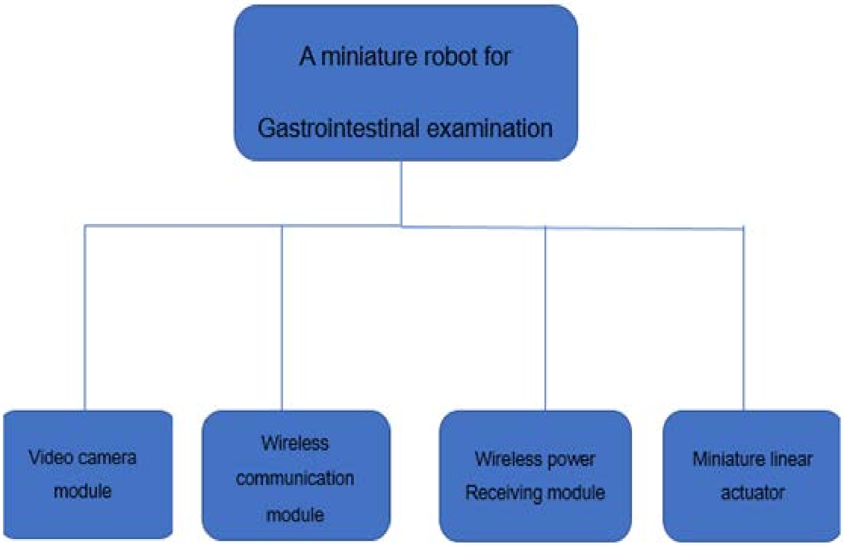

Figure 1 Miniature Robot Diagnostic System

The control system of the miniature diagnostic robot is based on the theory of subsumption architecture (SA), which refers that when building an intelligent system, the intelligence must be progressive and it has to be ensured that the system is complete in all aspects; the intelligent (sub) system on each level should have the ability to sense and respond in real-world situations, rather than being instilled knowledge directly by human beings.

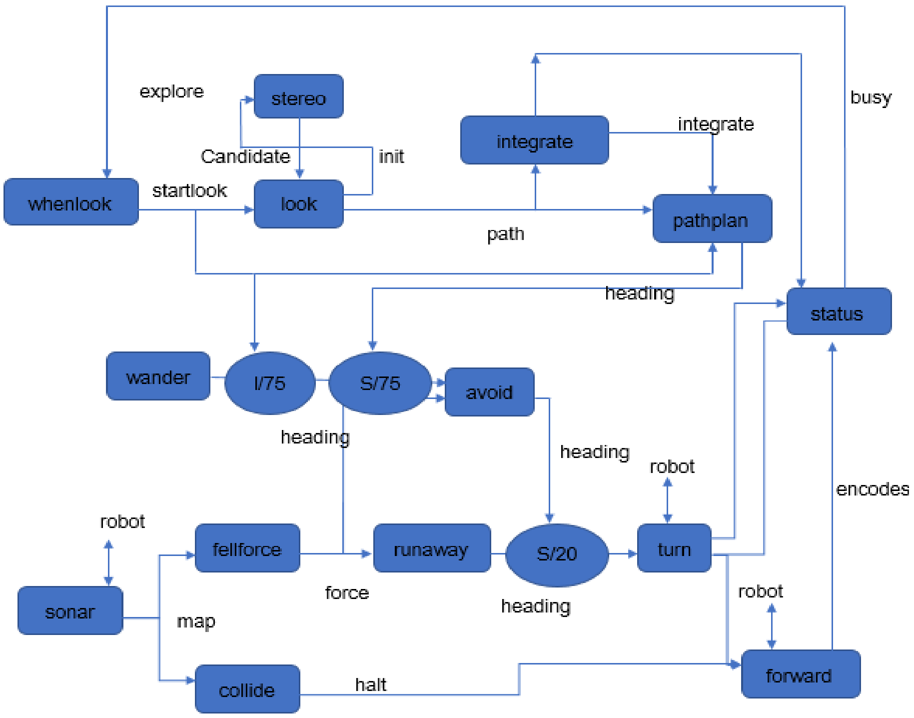

Figure 2 Robot Structure Diagram

We found a conclusion through the research on the control structure of some autonomous robots that it is very difficult to clearly represent the world model, yet it is a better solution to directly incorporate the robot into the environment. Figure X shows the control structure of the robot, which consists of three layers where the intelligence moves from the bottom to the top, and each layer can work independently. The basic unit of the structure is a finite state machine, consisting of state sets, one or two registers, as well as one or two clocks, which is capable of operations such as simple vector addition, transferring fixed-length characters asynchronously to other finite state machines, or receiving information from other finite state machines to work. Finite state machine mainly solves the conflict between different behaviors. The characteristics of this architecture are:

- The behavior is abstracted into different levels; each layer has its own topological structure.
- The underlying behavior is relatively simple and the high-level behavior is relatively complex. They are dynamically combined.
- The behavior of each layer achieves a function.
- If more functions are needed, it is only necessary to add a new level to it rather than improving the existing layer.
- Resolve conflicts and generate new global behaviors through finite state machines.
- This architecture is a bottom-up structure.

We have found that the miniature diagnostic robot constructed by this structure has a high degree of autonomy, as well as adaptability and robustness to the environment. Furthermore, it does not require precise control modeling or centralized control, has less demand for computing resources [7-8], and can learn and obtain intelligence from the environment. With the advancement of miniature diagnostic robot, we can obtain a large amount of image information, and transfer the images captured to the CSF system and use the CSF system to identify the cancer target, which is the most important part of this cancer diagnosis method.

3.CSF System

When the CFS system receives the image information from the miniature diagnostic robot, it starts to recognize the cancerous target. The CNS [9] in the CFS system is mainly composed of two types of network layers: the convolutional layer and the pooling/sampling layer. The role of the convolution layer is to extract various features of the image, while the role of the pool layer is to abstract the original feature signal, in order to greatly reduce the training parameters, and to also reduce the degree of model over-fitting. The figure below is a classic CNN structure.

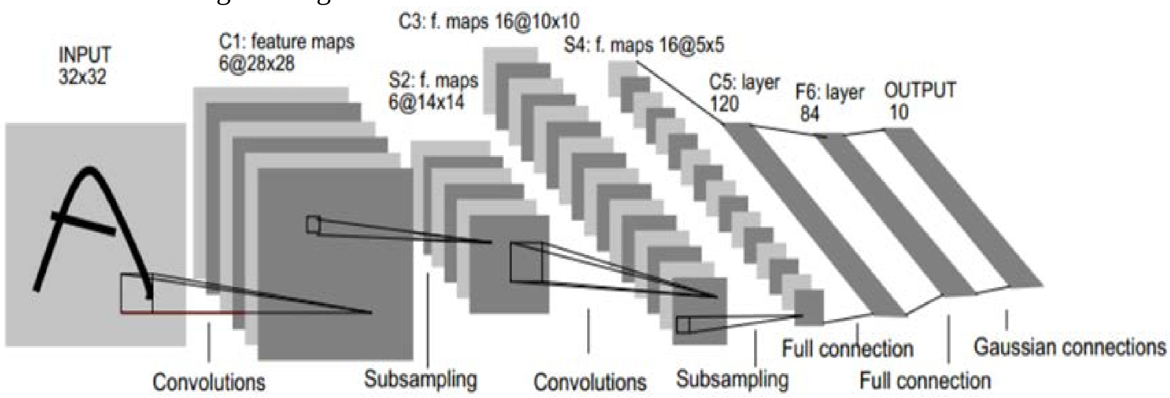

Figure 3 CNN Structure Diagram

The convolutional layer is calculated by one-by-one sliding window on the upper input layer of the convolution kernel. Each parameter in the convolution kernel is equivalent to the weight parameter in the traditional neural network and is connected to the corresponding local pixel. Convolved the various parameters of the convolution kernel with the corresponding local pixel values to obtain the result on the convolution layer

After obtaining the image features through the convolution layer, we can directly use these features to train the classifiers theoretically. However, doing so will face huge computational challenges and will easily lead to over-fitting. In order to further reduce the over-fitting of network training parameters and models, we will conduct pooling/sampling on convolutional layers.

Support Vector Machine (SVM) is a classifier with minimal structural risk. SVM was first proposed as a linear classifier, whose basic model is the largest interval linear classifier. There are several types of support vector machines from simple to complex. When the data is linearly separable, the linear classifier learned is called a linear separable support vector machine by maximizing the hard interval; When the data is approximately linearly separable, by maximizing the soft interval, the learned linear classifier is called soft interval support vector machine, also called linear support vector machine; When the data is linearly inseparable, a kernel function is introduced to map the feature vector to the high-dimensional space, and the low-dimensional linear indivisibility problem is mapped to a high-dimensional space linear separable problem. By maximizing the soft interval, the classifier learned is called nonlinear support vector machine, which is the one that we used. The process is as shown.

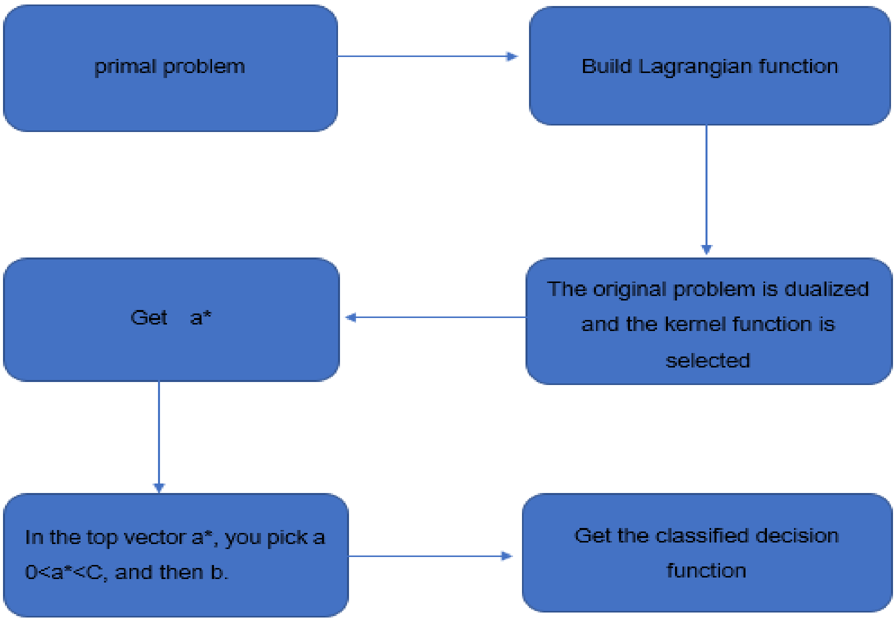

Figure 4 Nonlinear Support Vector Machine Model Diagram

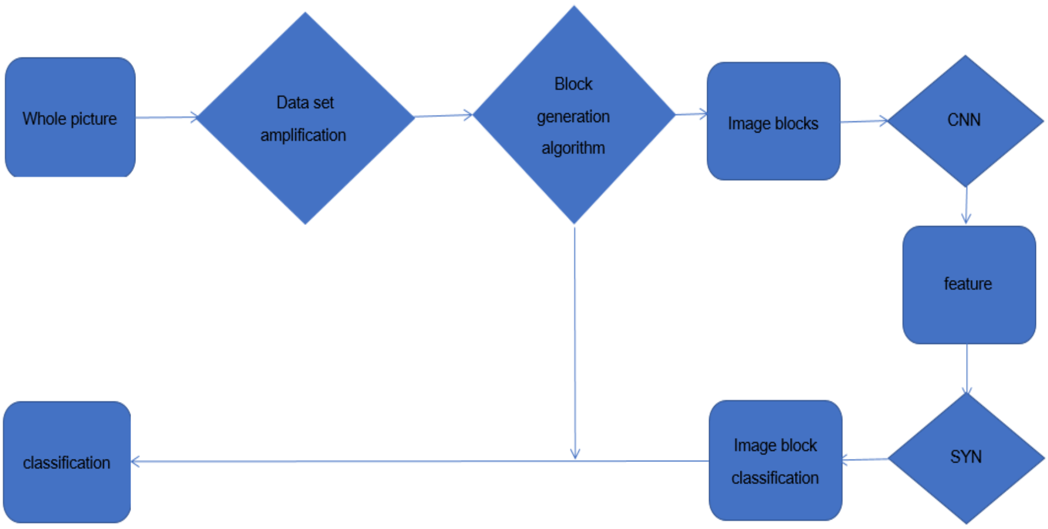

Figure 5 CNN-SVN System Flow Chart

We utilized CNN [10] for classification identification, and through the study of classical models, we adopted a lightweight CNN that applies this data set. The invariability of feature descriptions and the minimization of structural risks contribute to the generalization of the model. These ideas are CNN [10] combined with CNN to construct a method for identifying microvascular classification based on CNN-SVM. As shown in the picture.

The FCN transforms the fully connected layer in the traditional CNN into a convolutional layer. After several convolutions, the images obtained get smaller and smaller, and the resolutions get lower and lower. In order to restore the resolution from the coarse resolution image to the original one, FCN uses

Figure 6 FCN flow chart

up-sample. Up-sample is achieved through de-convolution. However, the result obtained by de-convolution is yet not accurate where some details cannot be restored. As a result, the previous layers were de-convoluted and the results were refined. The process is shown as above.

Finally, we designed the CSF system. Its structure is as follows:

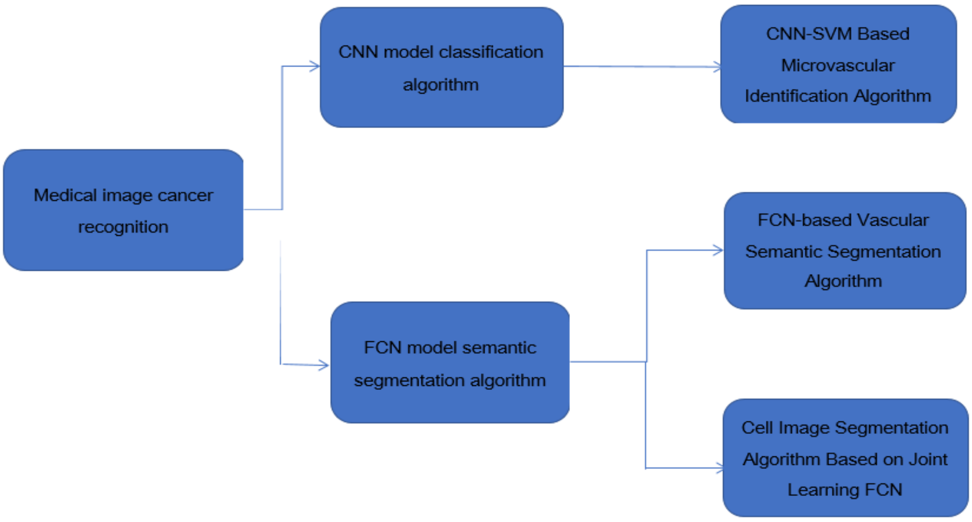

Figure 7 CSF System Structure

The CSF system is driven by data and is more suitable for complex and varied medical images than manual design features. Data amplification technology enhances the invariance of CNN features , while SVM classifiers have better generalization capabilities. CNN-SVM's new identification method has studied a series of data amplification technologies to improve the prediction invariance of the system for scaling and rotating images. In terms of classifier enhancement, the introduction of SVM has replaced the generalization ability of softmax enhancement systems. By using a CSF system, the accuracy of the model improves at the image block level. The utilization of the FCN allows the CSF system to accept any size input image, and all training images and test images do not need to have the same size, which is more efficient and avoids the problems of duplicate storage and computational convolution caused by using pixel blocks. When the cancer target is identified through the CSF system, the information can be forwarded to the expert system to obtain the optimal treatment plan.

4.Expert System

The expert system refers to the knowledge that can be learned from the expert experience, which can involve a variety of changes and forms. The expert system is the key to the superiority of the knowledge base of the expert system. Through knowledge withdrawal, the content in the knowledge base can be expanded and modified, and the automatic learning function can also be realized. The following figure shows the structure of the expert system.

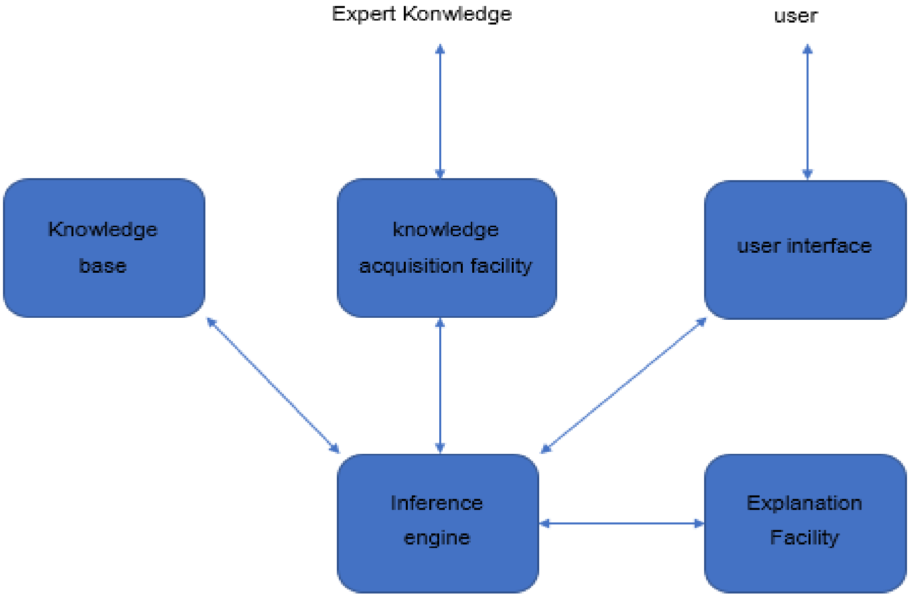

Figure 8 Rule-based Expert System

4.1.Knowledge acquisition facility

The goal of knowledge acquisition is to convert professional domain knowledge into a knowledge base or other computerized expression, of which the function is to collect the above data into a computable model, and also to analyze the knowledge provided by experts, including the integrity and consistency of knowledge.

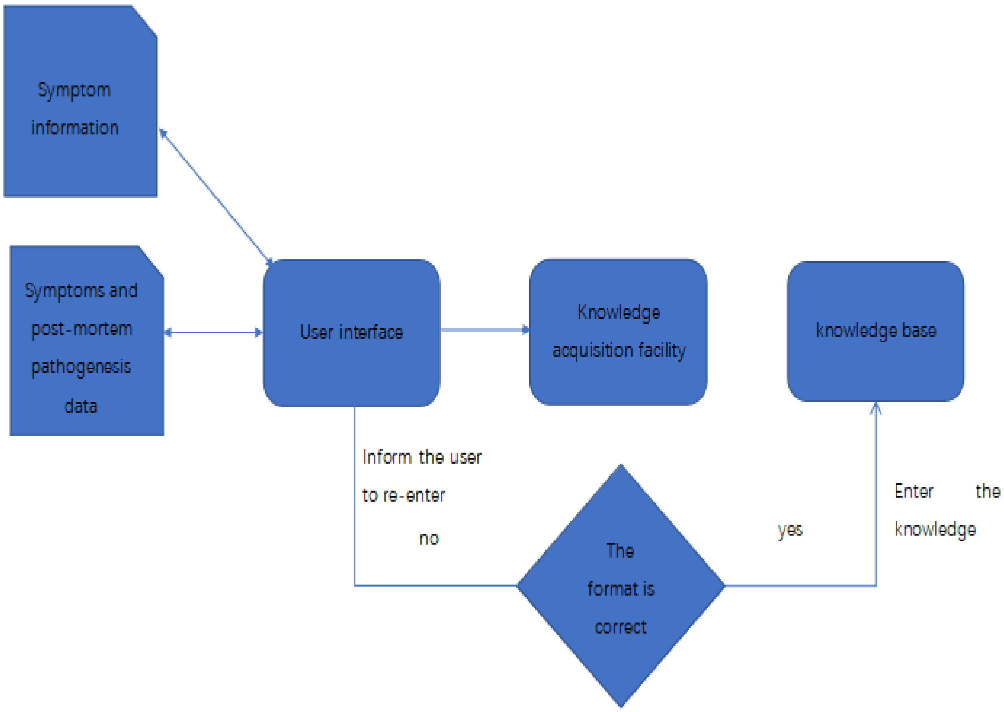

Figure 9 Knowledge Acquisition Process

4.2.Knowledge base
The knowledge base is used to store the knowledge provided by experts. The problem solving process of expert system is to simulate the expert's way of thinking through the knowledge in the knowledge base. Therefore, the knowledge base is the key to the success of the expert system, that is, the quality and quantity of knowledge in the knowledge base determine the success or failure of the expert system. The knowledge base and expert system programs in the expert system are independent from each other, where users can improve the performance of the expert system by changing and improving the knowledge content in the knowledge base.

4.3.Inference engine
The inference engine is the core of artificial intelligence, which is used to figure out the knowledge data and the relationship between the data from the knowledge base according to the conditions or known information of the current problem, and to repeatedly match the rules in the knowledge base so as to obtain new conclusions. Then it provides answers by interpreting the facility and the user interface.

4.4. Explanation facility
The function of the explanation facility is to list the logical process of reaching the result from the beginning to the end after the data is input and the result is generated, which is believed to help explain how the organs in the disease affect each other and their processes. Through system user verification and further transformation, explanation facilities can improve the knowledge, as well as perfect the system.

4.5.User interface
The user interface is the interface for users to input data and for the system to display results. Through this interface, the user inputs basic information, answers related questions raised by the system, and outputs reasoning results and related explanations, etc.

The application scope of the expert system is continuously expanding, while the ability to solve practical problems is also constantly increasing. The social benefits and economic benefits achieved in various fields are recognized by the entire world, all of which depend on its following advantages:

- The expert system works efficiently, accurately, thoughtfully, quickly and tirelessly
- The expert system is not affected by the surrounding environment when solving practical problems
- The use of the expert system is not limited by time or space and can be performed in an environment where people cannot work. It can also spread and utilize expert knowledge in an environment that lacks of experts.
- The expert system can promote the development of various fields where it summarizes and refine the expert knowledge and experience. It has the ability to disseminate expert knowledge, experience and capabilities in a broad and powerful manner.

5.Conclusion
Complex decision-making problems such as the intelligent assessment and diagnosis of cancer diseases have high requirements of the expertise and ability on doctors. To a large extent, these problems depend on the actual diagnosis experience of the doctors. It takes a long time for doctors to accumulate a wealth of medical diagnostic experience. Hence, young doctors may misdiagnose under some circumstances. On the other hand, the diagnosis process is also largely affected by the subjective awareness of doctors and external factors, etc. The diagnosis will be subject to greater deviations and lead to misdiagnosis. Once the doctor misdiagnoses, it will generate fatal outcome. The most important thing is to reduce the number of unnecessary medical examinations through intelligent assessment and diagnosis, which can greatly shorten the time the patients suffer. Therefore, the creation of a cancer diagnostic intelligence system is of great significance for scientific and objective disease assessment and diagnosis in the medical field. And we will apply relative techniques in mobile applications [11-17]. This paper presents a new MCSFE diagnostic method. Firstly, the body was

explored by a miniature diagnostic robot, and the cancerous target was identified using the CSF system with the use of feedback image information. Finally, the information was submitted to the expert system for diagnosis and a treatment plan was generated.

6.References

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