

# Research on the detection technology of Medical Diagnostic X-ray Machine based on machine vision

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## Abstract

Medical diagnostic X-ray machines (X-ray machines) is widely used in the medical field. In order to ensure that medical diagnostic X-ray machine meets the standard requirements of quality control of medical conventional diagnostic X-ray equipment, light field and irradiation field detection technique is usually used. Machine vision has the advantages of long time stable operation, wide spectral response range and non-contact measurement, so it has a good performance in the measurement field. At present, the semi-automatic detection of light field and irradiation field is affected by artificial factors, so the measurement accuracy is low and the efficiency is not high. In this study, a light field and irradiation field detection system based on machine vision is proposed to realize the automatic theoretical method of medical diagnostic X-ray machine detection and carry out several light field and irradiation field measurement experiments. The detection system has the advantages of fast detection speed and high accuracy of measurement results, which meets the standard requirements of medical diagnostic X-ray machine.

## 1 Introduction

In the medical field, medical diagnostic X-ray machine and medical treatment X-ray machine are widely used at present. X-rays of different energies can destroy or inhibit the properties of irradiated cells and tissues. Based on this characteristic, medical therapeutic X-ray machines have been developed and widely used. Some diseases can be treated by using medical X-ray machines that shine light on cells and tissues in diseased areas of the body<sup>[1]</sup>. The medical diagnostic X-ray machine was developed based on the theory that using X-rays to illuminate the body's potentially diseased organs would produce inconsistent amounts of X-rays. When a medical diagnostic X-ray machine is used to irradiate a possible pathological part of the human body, an image of whether the part is abnormal will be displayed on the fluorescent screen and film, and the disease part will be diagnosed based on the analysis of the patient's performance and condition<sup>[2]</sup>. However, due to the powerful penetrating power of X-ray, the damage to human body cannot be ignored<sup>[3]</sup>.

How to avoid this harm effectively and detect the consistency of X-ray light field and irradiation field is one of the most effective means. Therefore, how to accurately and effectively ensure that medical diagnostic X-ray machine conforms to the standard quality control requirements of medical conventional X-ray diagnostic equipment is a key technical problem to reduce the damage of X-ray to human body<sup>[4]</sup>.

At present, there are many methods for the detection of light field and irradiation field, such as film imaging method, fluorescence method, etc., but the research on the automatic detection system of light emission field of medical diagnostic X-ray machine is very few. Machine vision system can not only improve the speed but also greatly improve the accuracy of traditional vision detection, while reducing the labor required by the operation of equipment,

effectively reduce the production cost, so it is necessary to study the automatic detection system of light emission field of medical diagnostic X-ray machine<sup>[5][6]</sup>.

## 2 Overview of monitoring system

### 2.1 Design of detection system

In view of the working mode of hospital diagnostic X-ray machine and the positioning principle of machine vision, considering the detection mechanism and system performance.

The main design principles of the system include:

- (1) The detection time of the deviation of the whole light field and irradiation field should not be too long.
- (2) The whole test data transmission is effective.
- (3) Ensure that the detection device is light, portable and easy to operate.
- (4) High detection accuracy, can distinguish smaller light field and irradiation field deviation.

## 3 High efficient and reliable medical diagnostic X-ray detection technology and system structure

### 3.1 Image processing

In order to calculate the parameters of light emission field in the future, it is necessary to use CMOS camera to obtain higher quality light emission field images containing some characteristic information. Taking the field image and the measure block in pixel equivalent calibration as an example, the appropriate image processing operation is selected to obtain the image that meets the requirements of this paper. Fig.1 shows the process of image processing<sup>[7]</sup>.

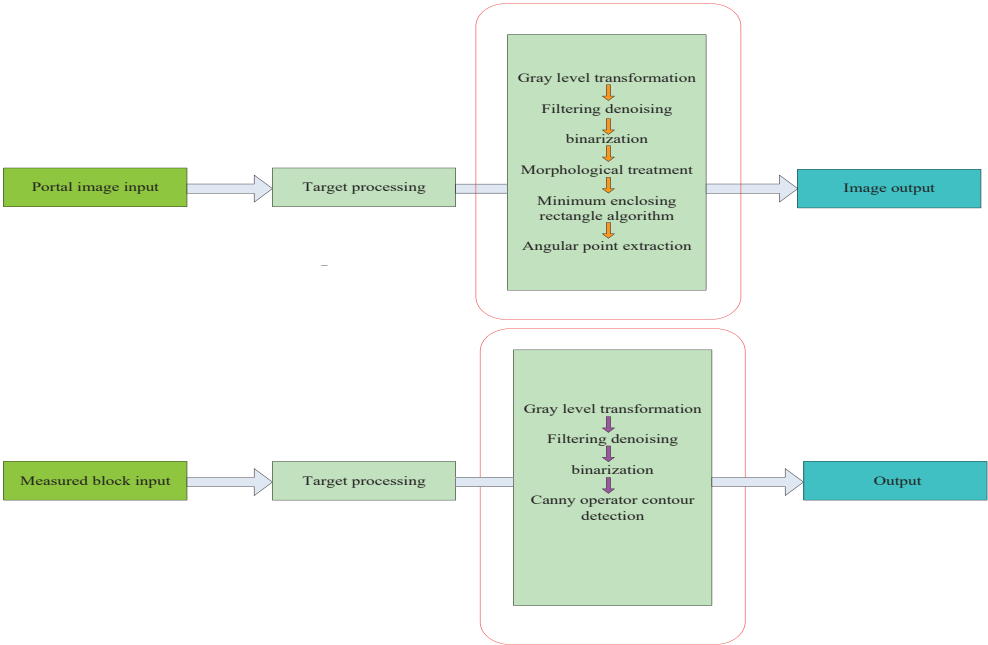


Fig.1 Image processing flow

3.2 System Architecture Overview

In this paper, the overall framework of design is a preset X-ray exposure conditions (voltage, current, exposure time), through the software validation system, detection system on the computer control CMOS camera intake X-ray image of a light beam respectively and transform it into image signal, through the USB cable to transmit image signal to the computer, Then, the detection system on the computer pre-processes the image of the light field image and the image of the radiation field, and extracts the contour<sup>[8]</sup>. Then, the mathematical calculation formula is used to obtain the deviation value of the two images. Finally, the pixel equivalent value is calculated to obtain the physical size of the deviation value. The system structure is shown in Fig2.

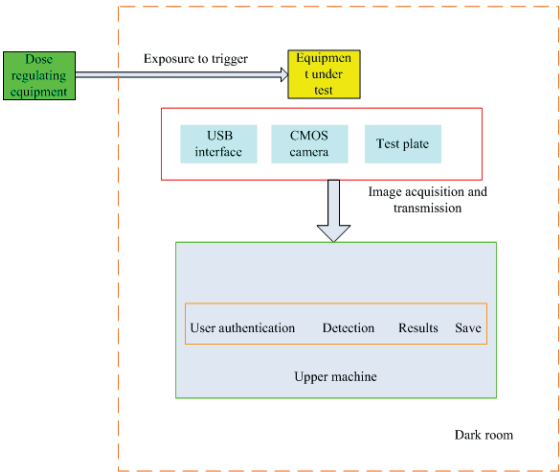


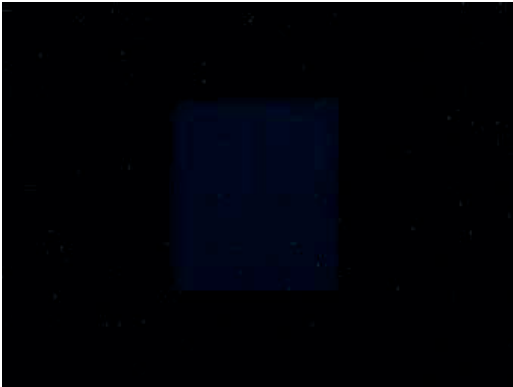
Fig.2 System chart of detection

4 Detection effect analysis

Fig.3 shows the collected images of the light field and irradiation field.



(a) diagram of one size light field



(b) The field image

Fig.3 Image of light field and irradiation field

**Table 1.** light field and irradiation field

The serial number	Aa/mm	Bb/mm	Cc/mm	Dd/mm
1	2.82	3.90	4.01	2.63
2	2.83	3.87	4.04	2.63
3	2.86	3.89	4.02	2.66
4	2.80	3.87	4.01	2.64
5	2.82	3.88	4.02	2.67
The mean	2.826	3.962	4.02	2.646

As can be seen from the data in the above table, the multiple measurement error of the deviation value on the left side of the optical emission field image is within 0.06mm, the multiple measurement error of the deviation value on the top is within 0.03mm, the multiple measurement error of the deviation value on the right side is within 0.03mm, and the multiple measurement error of the deviation value on the bottom is within 0.04mm. The error between the center of light field and the center of radiation field is less than 0.04mm, and the measured values of 5 parameters all meet the requirements of the national testing specifications.

## 5 Conclusion

(1) In this paper, the common medical diagnostic X-ray machine is taken as the measurement object to detect the light emission field. The medical diagnostic X-ray machine based on machine vision has stable data and high precision. The whole system is designed scientifically and rigorously, and the image acquisition and processing are completely automated. The monitoring system has the characteristics of automatic processing, portability, simple and convenient operation, and can effectively detect the consistency of radiation field in various X-ray equipment. The optical field and irradiation field deviation monitoring system has a good image resolution, but it also has some shortcomings, such as the influence of X-ray radiation on CMOS sensor. Combined with the quality control and detection methods of hospital diagnostic X-ray machine, such as tube voltage, wire harness, and bed/box verticality, etc., need to be further studied.

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