# Development of Banknote Detection Circuit System

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**Abstract**

Due to the continuous improvement of digital imaging technology, making counterfeit banknotes has become easier and cheaper. In order to solve the problem of counterfeit banknotes, the main purpose of this article is to develop a banknote detection system (BDS). This system will detect whether banknotes are included in the digital image during scanning or printing, reducing the use of high-resolution digital imaging products for counterfeit banknote manufacturing opportunity. The system is divided into three main steps: magnetic detection, fluorescent detection and watermark detection. In the future, this system can be implanted in image-related computer peripherals (such as scanners, printers or multi-function printers) to scan banknotes at the beginning or prevent blockages when copying banknotes.

Keywords: Counterfeit banknotes, Magnetic detection, Fluorescence detection, Watermark detection.

## 1. Introduction

Due to advances in technology, the anti-counterfeiting measures used by the central bank to issue banknotes in the past can gradually be cracked by computer corrections. At present, the police are still unable to move the anti-counterfeiting lines and watermarks of the counterfeit banknotes they have seized. However, in the counterfeit banknote groups that have been seized, counterfeit banknotes with watermarks have gradually appeared, and even hot stamping has been used. Technology to print counterfeit banknotes with a sense of security thread, making it more and more difficult for the public to identify the authenticity of banknotes. [1-2]

Although financial institutions have introduced credit cards from abroad, most oriental people are still accustomed to using banknotes for various transactions. In addition to the high liquidity of banknotes, the most important reason is that credit card security mechanisms are still not rigorous enough. In view of this, various anti-counterfeit banknotes equipment came into being, but there is still no simple and effective way to get it right.

The production of counterfeit banknotes is becoming more and more refined, and it is often difficult to distinguish the authenticity with the naked eye. In order to prevent the proliferation of counterfeit banknotes and cause the people to suffer losses, this research proposes a new method and single-machine to achieve the purpose of identifying the authenticity of banknotes. The counterfeit banknote recognition technology currently known to be used is nothing more than the use of chemical or physical properties. Roughly speaking, it can be divided into three inspection methods: money detector, ultraviolet lamp, and magnetic ink.

Because of these reasons, we choose this topic, hoping to effectively solve the above-mentioned problems, and can achieve the following goals: 1. Can check multi-national currencies 2. Can check credit cards 3. Have magnetic detection function 4. Have watermark detection function 5. Have UV light and warning function.

## 2. System Architecture

The system design is divided into three parts, namely (1) magnetic detection, (2) fluorescent detection, and (3) watermark detection, respectively. In terms of magnetic detection, the most difficult to distinguish between genuine and counterfeit banknotes is the magnetic area of the banknote. It was originally thought that the paper of the banknote was produced by magnetic ink, but this is not the case but a small magnetic area. The magnetic head can detect tiny magnetism such as banknotes. The magnetic head is the transducer that realizes the electromagnetic conversion in the tape recorder. There are three types of magnetic heads, which are arranged in the order of the degaussing head, the recording head, and the playback head along the tape direction in the tape recorder. The relative position of the head gap with the tape during operation determines the magnetic track pattern recorded on the tape.

Generally, currency detectors and currency detectors on the market have the function of fluorescent detection, which is also the easiest way to distinguish banknotes in general stores. The principle of the warning function of the currency detector is based on the fact that a counterfeit banknote is irradiated by ultraviolet light, because it will not emit strong fluorescent light, causing it to drive the detection circuit. However, the paper used for real banknotes will show invisible ink under the irradiation of ultraviolet lamps, and it can also be stronger than the development projected by counterfeit banknotes. It will pass through the filtering effect of color filters, and the light projected by it will be received by phototransistors and the received weak signal is conducted through the transistor to generate a base current, and then to drive the LED light to produce the so-called warning effect. According to this principle, a detection circuit is set up.

The watermark detection circuit is to place a fluorescent tube under a white plexiglass plate to produce a milky white incandescent lamp, and then close the watermark detection part of the banknote to the plexiglass, and finally the watermark can be clearly observed. Counterfeit banknotes are very similar to real banknotes in this respect, but counterfeit banknotes are indeed slightly wider than real banknotes in this respect. This is a common problem that most people tend to make, so normal vigilance is very important. Because banknotes are magnetic and the ink locations are not the same, traditional detection methods cannot be used to identify the authenticity of various banknotes at the same time. As shown in Figure 1, the circled part is the position where the magnetic ink for various banknotes is inspected. [3-4]

Figure 1. Magnetic ink inspection positions for different banknotes

And, the characteristics of common banknotes are also shown in Table 1.

| banknotes | characteristics |
|---|---|
| Taiwan Dollar | The three-color fluorescent fiber thread and the banknote number will turn fluorescent red, and the banknote paper itself has no fluorescent reaction. |
| Chinese Yuan | Fluorescent numbers and pinyin letters on the front |
| Hong Kong dollar | Fluorescent numbers on the coin amount, with patterns and English fluorescent fonts on both ends of the back |
| US dollar | 100 dollar on the left side of the portrait, red characters under fluorescent light |

Table 1. Common features of several banknotes

## 3. Banknote detection circuit system and results

3.1 Magnetic detection

The small magnetic area of the NT$1,000 bill is placed on the magnetic head and rubbed back and forth, so that the small magnetic area in the bill is generated by the relative movement of the magnetic dot. The AC signal is amplified by the LM324 three-stage, and finally through the three-stage amplification as shown in Fig.2. The latter signal is sent to the final follower, causing the driving LED to light up.

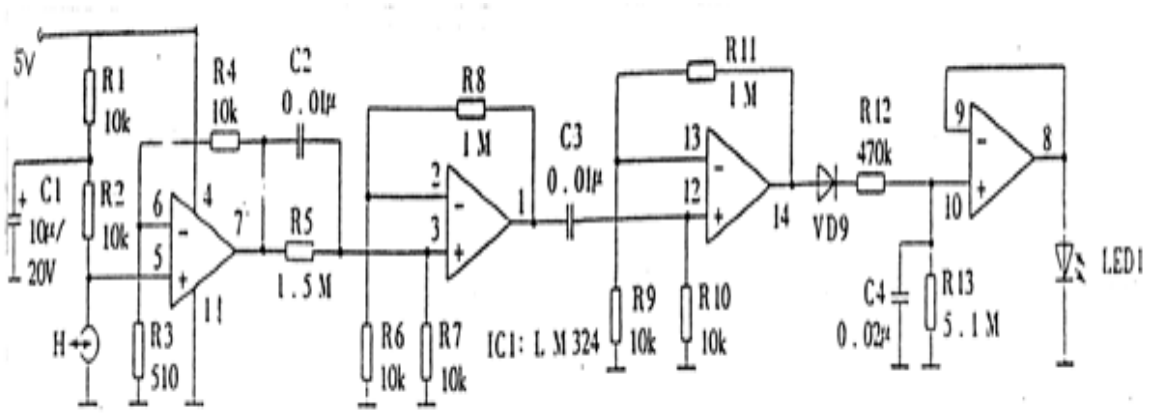


Figure 2. Magnetic detection circuit

3.2 Watermark detection

Place the banknote on a platform equipped with a milky white acrylic plate, press the K1 button to send the high-voltage power supply to the 8W white woven light tube VG1, because the white woven light tube VG1 is installed under the milky white acrylic plate, so the white woven lamp tube emits light through the milky white acrylic plate, and you can clearly see that a bunch of flowers and a watermark of 1000 yuan dollar are displayed on the banknote. The watermark detection circuit is shown in Fig.3. If the watermarks of a bunch of flowers and 1000 numbers do not appear during the watermark detection , that is a counterfeit bill.

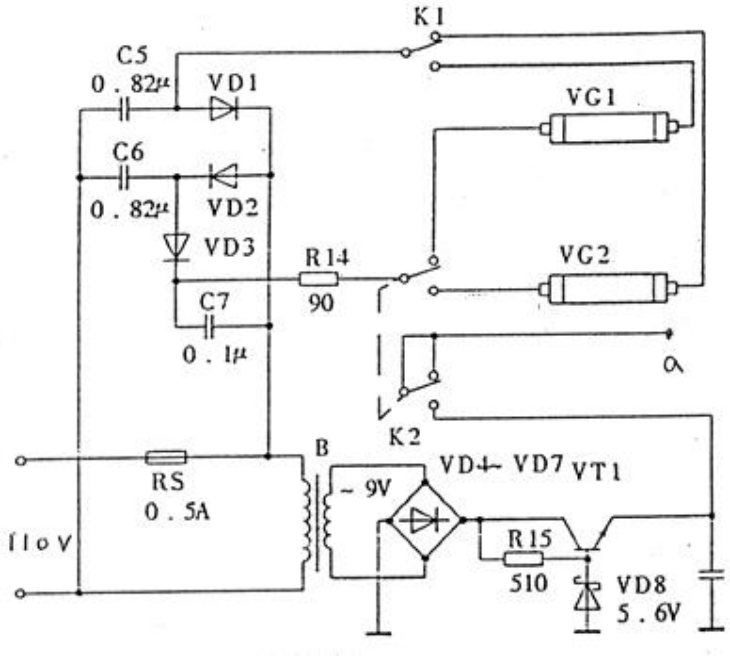


Figure 3. Watermark detection circuit

3.3 Fluorescence detection

Fluorescence detection is the most important part of a currency detector, because the fluorescent part is often the most difficult place to imitate in banknotes. The paper used in real banknotes is specially processed, so there will be no strong fluorescence when irradiated by ultraviolet light. We designed the fluorescence detection circuit based on this principle as shown in Fig.4. When the banknote is placed on the flip-type acrylic plate for fluorescence detection, when the flip is pressed down, the switch we installed will be activated, because the phototransistor is very sensitive to other light sources, which makes it easy to cause disputes. Because of the error in recognition, you must turn on the switch when the flip cover is pressed down to make the correct fluorescent detection action. After the photo transistor receives the fluorescent signal, the same direction input 11th terminal of the four comparator LM339 in the circuit gets the potential signal, and the 13th pin at the low potential rise to the high potential, and the C10 capacitor can make it at the high potential. When the time accumulates to a certain extent, the 9th leg is driven, so that the 14th leg is raised from low to high, and the intensity of the fluorescent light is fine-tuned by the W3 variable resistor.

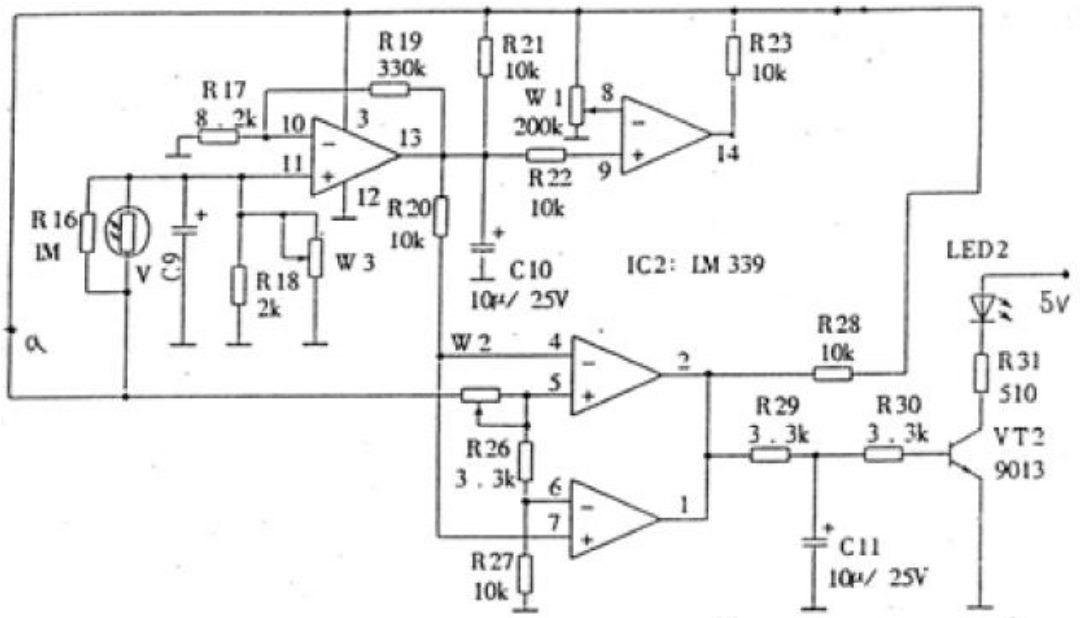


Figure 4. Fluorescence detection circuit

In fluorescent detection, the most difficult thing is how to make the paper automatic banknote recognize that this is a real banknote when the ultraviolet lamp is on. Therefore, the photoelectric crystal and color filter play an important role in the fluorescent detection circuit. In the fluorescent detection part, it was found that the photoresistor is more sensitive to the light source than the photo-transistor, so we added a so-called "multi-layer color filter" to the photo-resistor, which is specifically designed for the collection of light from the ultraviolet lamp when it passes through the banknotes. Fluorescence, the received signal can be amplified by the comparator to turn off the originally lighted LED2, which is the main function of fluorescence detection. [5-7]

## 4. Conclusion

To solve the counterfeit problem, the objective of this research was to develop a banknote detection system (BDS) that could be used to detect digital images and to determine if the image includes a banknote. Circuit system was designed using magnetic test, followed by fluorescent test and watermark test. In summary, our system could be potentially embedded in image related peripherals (e.g., scanners, printers, or multi-function peripherals) to prevent counterfeit from being printing or scanning. After various a series of tests, the expected performance was achieved and met the design requirements.

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