Development of Detection Algorithm for Influenza A and Influenza B Immunofluorescence Rapid Test

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Abstract

Influenza abbreviated as Flu, refers to an acute respiratory illness caused by the influenza virus, characterized by its high contagiousness, and in severe cases, it can lead to fatalities. Accurate detection of influenza rapid test is crucial. Therefore, this study proposes an algorithm to detect the results of A and B type influenza rapid test. The image processing method is written in the Python programming language. The method is to first convert the image into a grayscale image matrix, and then segment the Region of Interest (ROI). Use the numerical distribution of ROI to infer the detection results and concentration. In order to increase the accuracy, the concentration estimation is based on the relative relationship between the environment and the C line and the T line. The experiment was conducted in an optical detection dark box environment, using 365 nm UV-LED to illuminate type A and type B influenza rapid tests, and using a USB camera for detection. From the experimental results, it is shown that the standard deviation of type A influenza between the concentration of 25 ng/ml to 500 ng/ml is less than 0.1 and the maximum variation is 4.79%. The standard deviation of type B influenza between the concentration of 100 ng/ml to 500 ng/ml is less than 0.01 and the maximum variation is 8.84%.

Materials and methods

In this study, the fluorescence chromatography influenza antibody rapid reagent was used as the detection target, and USB camera and UV-LED with a wavelength of 365nm were used for detection. The program in this study was written using the Python programming language. During the image processing process, the image captured by the USB camera is first used to grayscale the captured image. The original image and the grayscale image are shown in Figure 1. Extract a fixed range of Region of interest from the grayscale image. The ROI and its numerical distribution are shown in Figure 2. Use the Full width at half maximum (FWHM) in the figure to find the C and T lines. The fitting line of the background value within the range is used to eliminate the error caused by the background value, and then find the maximum peak value of the C and T lines within the range and calculate the amplitude value of the C and T lines (peak value versus background value). After obtaining the amplitude values of the C and T lines, multiply the values by 0.5 to get the half amplitudes of the C and T lines respectively. After calculating the half amplitudes, collect the peak values of the C and T lines that are greater than the half amplitude value, which is the half peak. That is, the reading range of C and T lines. These values are integrated and averaged. Finally, the difference between the gray scale value of C and T lines and the background value is calculated to obtain the relative gray scale value, and the relative gray scale value is used to determine the concentration range.
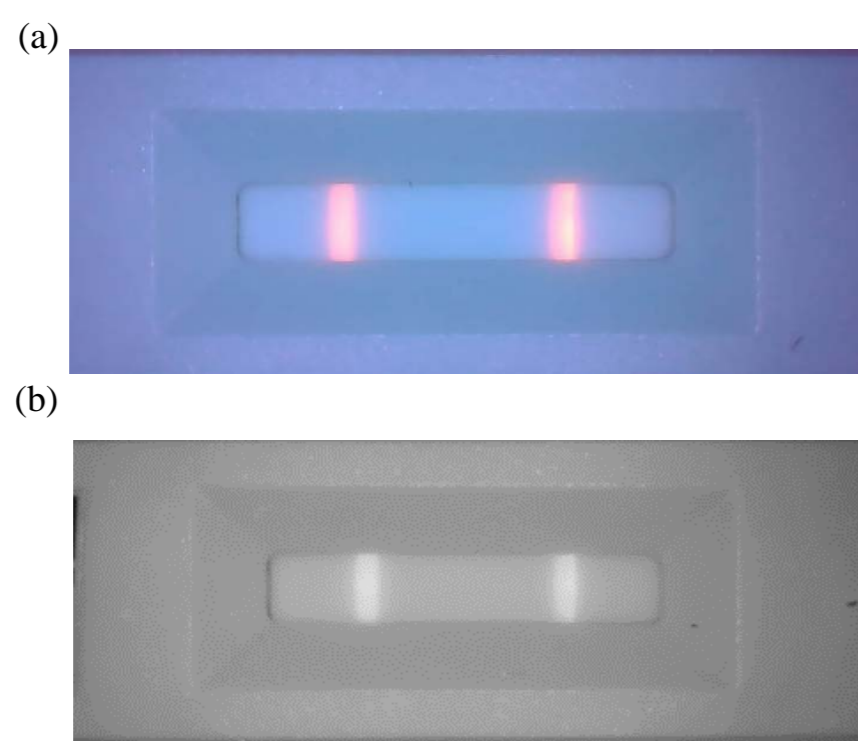

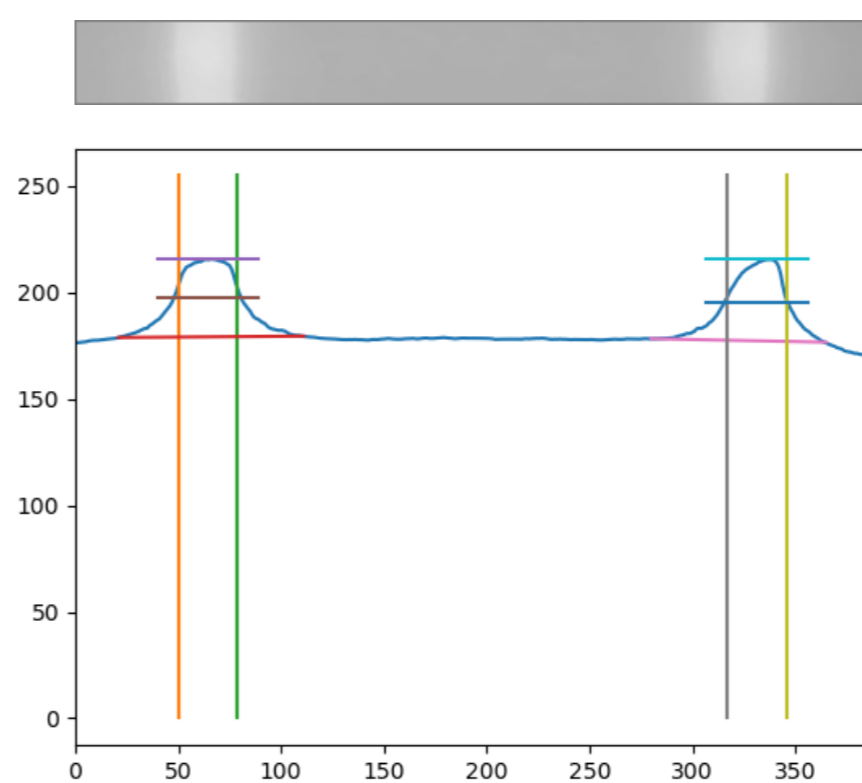Figure 1. (a) Original Image and (b) Gray-scaled image

Figure 2. The ROI Image and its numerical distribution

Results and discussion

In this study, samples of various concentrations of influenza A (H1N1) and influenza B (Yamagata) were tested. From the experimental results, we know that the standard deviation of each concentration of H1NA influenza detection is less than 0.1, the R square value is 0.8542, which means that the interpretation system has good stability in the detection readings in this concentration range. The results of type A influenza are compiled and shown in Figure 3.The standard deviation of the concentration of each dilution ratio of Yamagata is less than 0.01, and the R square value is 0.9603. It can be seen that the algorithm has good linearity and stability for detecting Yamagata. Figure 4 is obtained after sorting the detection results of various concentrations of Yamagata.
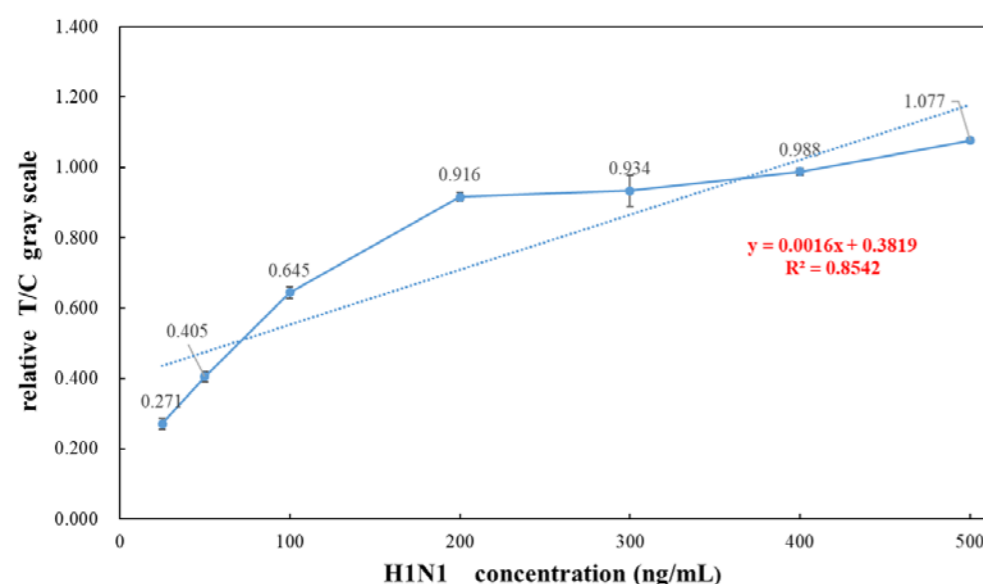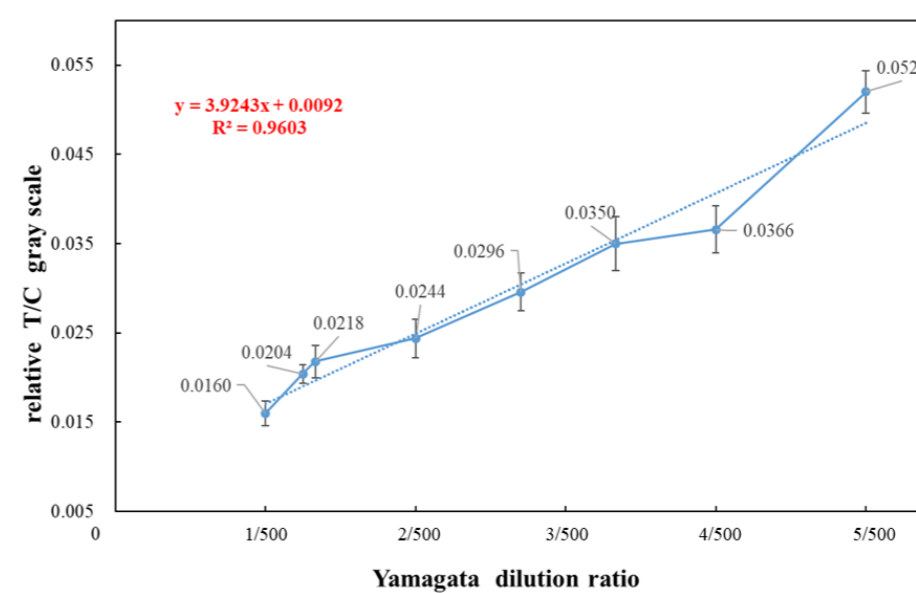

Figure 3. Result of H1N1 experiment

Figure 4. Result of Yamagata experiment

Conclusion

In this paper, the purpose is to detect the result of fluorescence chromatography influenza antibody rapid reagent and detect the concentration of result. It can be seen from the experiment result the purpose algorithm has great linearity and stability for detecting H1N1 and Yamagata.

In addition, the method proposed in this study uses FWHM and background values to draw up a line to estimate the concentration, which also reduces the impact of boundary effects and allows the readings to have good linearity.