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Development of quantitative interpretation equipment for fluorescent type A and B influenza rapid test reagent

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Abstract

This paper has developed a UV-fluorescence immunoassay rapid test reagent analysis equipment. It is mainly used for the interpretation of fluorescent immunoassay rapid test reagents. It uses a light source in the ultraviolet band to illuminate the color area of the rapid test reagent and detect the brightness. The brightness of the area is used to obtain the concentration of the analyte, and the interpretation result is displayed on the touch screen of the device. The detection equipment architecture includes Raspberry Pi development board, universal serial bus camera, light source control circuit board, ultraviolet light-emitting diode light source circuit board, cooling fan, touch display, real-time clock module and optical dark box. In this paper, commercially available standard samples of fluorescent influenza A (H1N1) and influenza B (Yamagata) were used for verification. From the verified detection values, the R square value of influenza A was 0.97, and the R square of influenza B was 0.96. And both have excellent linearity and stability (coefficient of variation less than 10%). The equipment developed by this paper institute is characterized by small size, easy portability, quantitative detection, high linearity and stability. And because the ultraviolet band light source has special operating conditions, general inspection personnel cannot directly use the naked eye for interpretation. So it is necessary to have such related equipment to assist in detection.

Materials and methods

The hardware components of the UV-fluorescence analyzer used in this paper were designed using SolidWorks. The analyzer includes the assembly structure of the shell, optical detection module, heat dissipation module, electronic circuit module, display and other parts, as shown in Figures 1 and 2. The overall structure dimensions are 230 mm × 110 mm × 95 mm. The light source in the detection module uses ultraviolet light-emitting diodes (UV LED), and the illumination value of the ultraviolet light can be controlled through a self-designed light source control module. The optical detection dark box uses SONY's 8 million USB camera, and the designed replaceable cassette can be replaced with different styles of rapid test reagent products, which can increase the diversified applications of the analyzer, detecting ultraviolet light and fluorescence Relevant products.

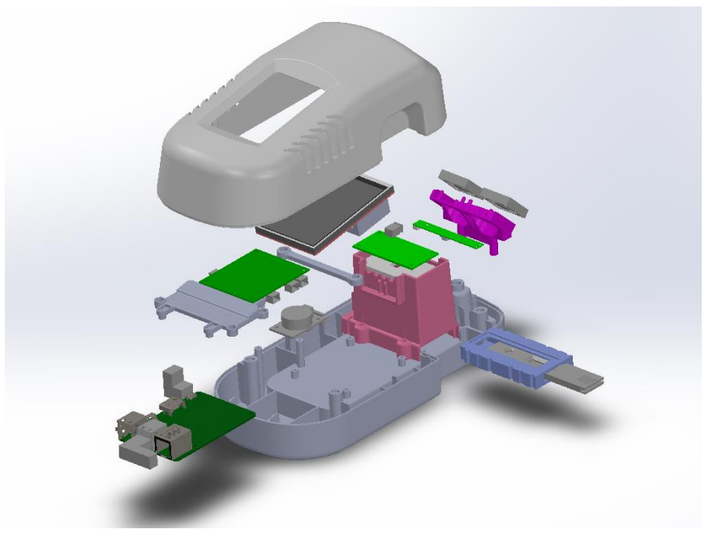

Figure 1. Exploded view of UV-fluorescence analyzer design.

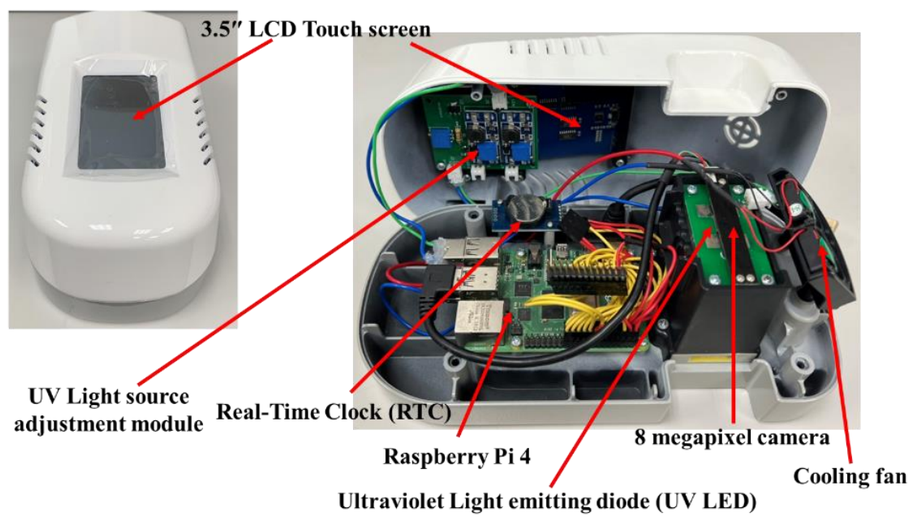

Figure 2. Internal physical diagram of UV-fluorescence analyzer.

The internal program of the analyzer is written in Python and includes: light source detection, image processing, region of interest (ROI) cropping, control line (C line) and result line (T line) algorithms, grayscale and concentration conversion. Finally, the obtained data are analyzed and compared with the actual AB influenza rapid test reagent concentration to establish a fitting curve for AB influenza. In addition, this study also established the human-machine interface of the overall system, which integrates analyzer-related setting functions on the touch screen.

Results and discussion

After integrating the hardware and software, we have completed a UV-fluorescent analyzer device that can be used for quantitative detection and analysis of rapid test reagents. As can be seen from Figure 3, the X-axis is the designed influenza A (H1N1) concentration, and the Y-axis is the T/C grayscale data (T line data/C line data) calculated by the analyzer. It can be seen that when the concentration is below 2 ng/mL, the concentration can still be determined by the analyzer, and the coefficient of determination (R^2) reaches 0.9925. The design concentration and T/C gray scale data of influenza type B (Yamagata lineages) are shown in Figure 4. It can be seen that the concentration can still be interpreted using the analyzer after being diluted 500 times, and the coefficient of determination (R^2) reaches 0.96. In addition, since the actual concentration of type B influenza only has a multiple relationship and does not have an actual concentration value, it is impossible to verify the concentration fitting curve. The fitting curve data between the T/C grayscale data and the actual concentration of influenza A (H1N1) is shown in Figure 5. It can be seen that the analyzer can use the calculated T/C grayscale data to back-calculate the corresponding concentration.

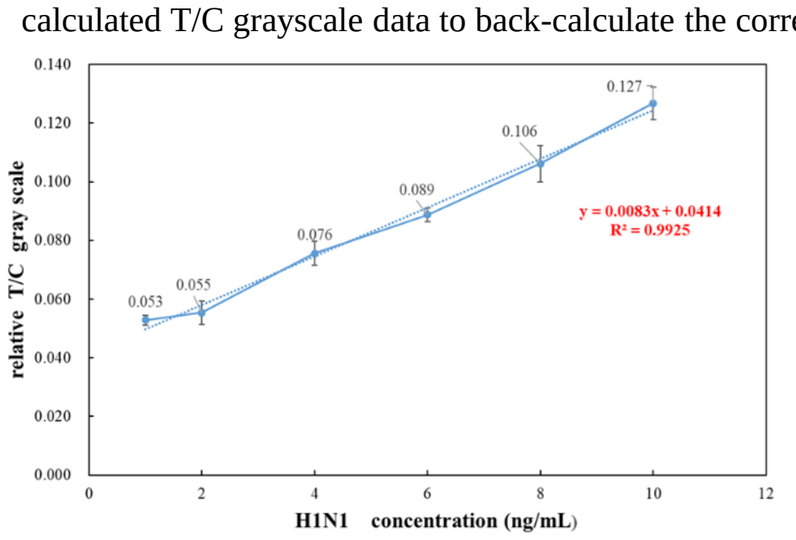

Figure 3. Relationship between influenza A (H1N1) concentration and gray scale.

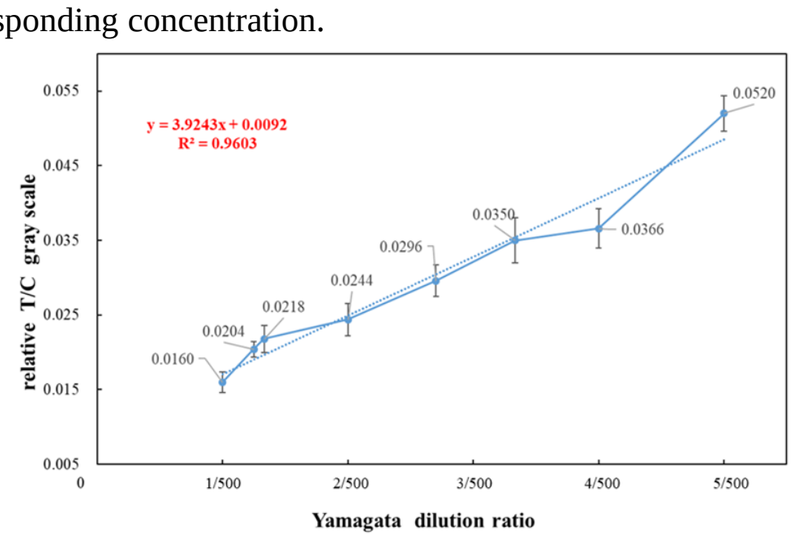

Figure 4. Relationship between influenza type B (Yamagata lineages) concentration and gray scale.

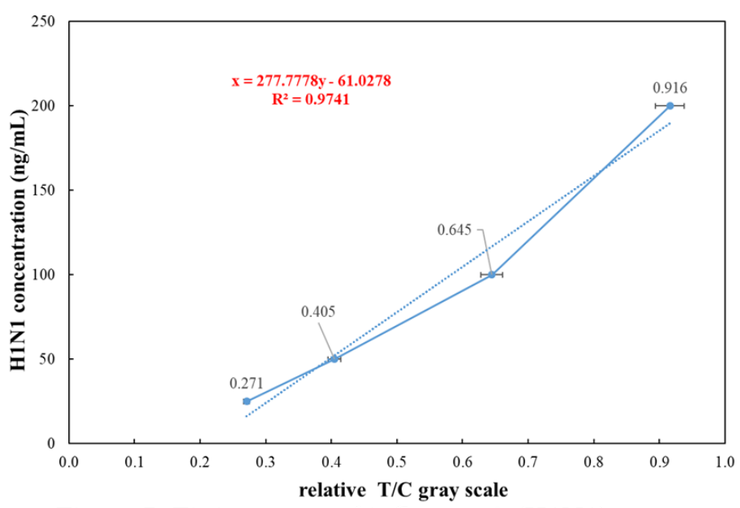

Figure 5. Fitting curve of influenza A (H1N1) concentration and gray scale (from 25 ng/mL to 200 ng/mL).

Conclusion

In this paper, an analyzer that can be applied to the detection of fluorescent rapid test reagents was successfully established. Including hardware design and production, software writing, system integration, human-machine interface development, etc. In the early stage, fluorescent AB influenza was used for data verification, and good data detection results were obtained. The advantages of the analyzer developed by our institute are small size, rapid detection, and easy operation. In the future, we hope to test more fluorescent items to increase the diversity of the analyzer.

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