Research on Electronic Devices Suitable for Epidemic Prevention and Control

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Abstract. Facing the normalization of epidemic situation in COVID-19 at present, how to effectively prevent and control the epidemic situation is very important. The traditional face recognition method is short in recognition distance and can't recognize whether to wear a mask, so it is not suitable for today's environment of epidemic prevention. In this paper, MLX90614 high precision infrared probe is used. According to the principle that the infrared energy is focused on the photodetector and converted into corresponding electrical signals, using gradient calibration and linear data acquisition method to program, the function of high-precision long-distance contactless body temperature measurement is realized. The face recognition function uses the camera to scan a number of key attributes in the face, uses advanced mathematics to carry out three-dimensional modeling, establishes the curvature, gradient, curl, angle and distance data corresponding to the feature points, and iteratively compares them with the feature values to realize the recognition of the face and whether to wear a mask or not. Finally, K210 intelligent chip is used as the main controller to connect with each part to realize its function, and the actual verification test is carried out, and good results are achieved.

1. Introduction

With the resumption of work and production across the country, how to prevent and control the epidemic in a timely and effective manner is very important. The design of an integrated device for face recognition and body temperature detection that can quickly, accurately and remotely perform face recognition and body temperature monitoring and determine whether to wear a mask during the epidemic is of great significance in the prevention and control of the epidemic.

At present, in the field of face recognition and deep learning, most of them are two-dimensional models, using RGB values for pixel points and comparison to achieve recognition functions, such as the widely used and classic Viola-Jones detection algorithm [1]. Because this type of detection algorithm is more sensitive to changes in factors such as light, angle, and expression, and the same person’s photos are very different at the pixel level, it cannot be accurately identified when the appearance is similar or the surrounding environment is not good, and the algorithm cannot judge whether a person is wearing a mask. In terms of body temperature measurement, there are mercury thermometers and thermometers in the market, but they have the problem of slow measurement speed or inaccurate measurement, none of them meet the current epidemic prevention and control requirements. Therefore, this paper designs an integrated device for face recognition and body temperature monitoring.
2. Materials and Methods

2.1. General idea
In this paper, K210 intelligent chip is used as the main controller, and python language is used for programming, using field theory analysis algorithm in advanced mathematics, a three-dimensional vector analysis model is established. The data of curvature, gradient, curl, angle and distance of each feature point of face and wearing mask are scanned as feature values, and iterative comparison is carried out. If the index value is consistent within a certain threshold range, the comparison is deemed to be successful. MLX90614 infrared high-precision temperature measurement module is used for body temperature detection, and gradient calibration method is used \[2\]. Realize the function of high-precision contactless temperature measurement and fever alarm within one meter. The general idea is shown in Figure 1.

![Figure 1. Whole-body thought diagram](image-url)

2.2. Research on contactless body temperature measurement
Non-contact body temperature measurement uses a high-precision infrared probe MLX90614 with a maximum measuring distance of 2 meters. The module uses the principle that infrared energy is focused on the photodetector and converted into corresponding electrical signals, and the signals are converted into the temperature value of the measured target after being corrected by the algorithm and target emissivity in the instrument through an amplifier and a signal processing circuit, and the discrimination accuracy can reach 0.02°C. The internal principle is shown in Figure 2.

![Figure 2. Internal schematic diagram](image-url)
According to its principle, the program is written, and the program flow chart is shown in Figure 3.

![Program Flow Chart](image)

Figure 3. Program flow chart

The infrared module can measure the temperature range from 0°C to 125°C, and capture the PWM pulse sequence output from different temperature ranges according to the electrical test technology. The pulse diagram is shown in Figure 4.

![PWM Capture Diagram](image)

Figure 4. PWM capture diagram

The signal received during capture is affected by self-radiation and environmental reflection radiation, which correspond to the sensor's own temperature and object temperature respectively, and is also affected by distance. The calculation formula is.
\[ L = \frac{1}{\sigma} \ln \frac{x}{k(T_1 + T_0)} \]  

(1)

In which \( \sigma \) is atmospheric extinction coefficient, \( x \) is radiation contrast, \( T_1 \) is absolute temperature of object, \( T_0 \) is absolute temperature of sensor chip, and \( k \) is adjustment coefficient.

In addition, in order to ensure that the measurement accuracy reaches \( \pm 0.2^\circ C \), it is necessary to select the reference temperature correctly. At present, there are commonly used contact thermometers such as glass mercury thermometer and electronic thermometer in the market, but glass mercury thermometer is the most accurate [3]. Therefore, although the debugging process is slow in the study, in order to achieve higher accuracy, glass mercury thermometer is chosen[4].

The electrical characteristics of infrared temperature measuring module are shown in Figure 5.

![Figure 5 - Electrical characteristic diagram of infrared temperature measuring module](image)

Figure 5. Electrical characteristic diagram of infrared temperature measuring module

It can be seen that there is a linear relationship near \( \frac{3}{8}T \), so in the process of calibration and debugging accuracy, this interval is selected to establish the body temperature measurement function, and the result is the most accurate. Gradient test is carried out in this interval, different gradients are selected for calibration, the temperature is divided into different intervals, multiple measurement calibrations are carried out in each interval, and the coefficient of temperature calculation formula is adjusted to achieve higher accuracy.

2.3. Research on Face Recognition Algorithm

Use the camera to scan the face attributes of the face including multiple feature points such as eyes, mouth, nose. Then, the identified pictures are processed to intelligently identify the three-dimensional contour of the face and process its color, so as to avoid the influence of color and light and other factors. Use advanced mathematics midfield theory modeling algorithm to carry out three-dimensional vector analysis, establish the curvature, gradient, rotation, distance and angle corresponding to the feature points, and put the data into the database, and use the program to search in the library and perform Iterative comparison, if the index value meets within a certain threshold range, the comparison is determined to be successful, that is, it is detected that the face and the stored photo are the same person [5]. The monitoring results are shown in Figure 6.
This paper is based on the PCA algorithm to realize the extraction of the feature value of the face image. Firstly, the collected images are preprocessed to form a face information database, and then the collected image feature values are extracted through algorithms and compared, and finally the required recognition results are obtained [6]. The processing procedure is as follows.

1. Enter N existing face image sets \( A = [a_1, a_2, \ldots, a_n] \)

2. Preprocess the face image set and convert it into a gray-scale matrix \( Y = [a_1, a_2, \ldots, a_n] \)

3. Centralized processing of all images \( a_{j(i)} = a_{j(i)} - \frac{1}{n} \sum_{i=1}^{n} a_{j(i)} \)

4. Calculate the covariance matrix of the image set \( D = A \cdot A^T \).

5. Use the singular value decomposition method to solve the eigenvalues of the covariance matrix D in (3) \( \lambda = [\lambda_1, \lambda_2, \ldots, \lambda_n] \) and Feature vector \( V = [v_1, v_2, \ldots, v_n] \).

6. The eigenvector \( V = [v_1, v_2, \ldots, v_m] \) composed of the first m eigenvalues sorted in descending order is used as the dimensionality reduction subspace set.

7. Output dimensionality reduction feature matrix.

Using this method can effectively improve the recognition speed and accuracy, so as to obtain the required eigenvalues.

In addition, because the mouth and nose are covered when wearing a mask, the mask recognition model further processes the scanned face data on the basis of the above-mentioned face recognition. By entering the mask model data that meets the epidemic prevention requirements in the market, the final determination is whether it meets the requirements for epidemic prevention and control. The actual test is shown in Figure 7.
3. Results & Discussion
Using this device for actual testing, taking 100 person-times as monitoring samples, after final statistics, 83 out of 100 people wore masks, 3 people had a fever, and the rest of the samples all met the epidemic prevention requirements. The final face recognition success rate was 99%, which is a requirement for epidemic prevention. The judgement success rate is 100%, the error of non-conforming body temperature monitoring accounted for 5 in the range of 0.2 °C, and the body temperature measurement success rate was 95%. As shown in Figure 8.

![Error scatter diagram of samples](image)

Figure 8. Error scatter diagram of samples

4. Conclusions
In order to quickly and accurately identify a person’s body temperature, identity, and compliance with the epidemic prevention and control requirements during the normalized epidemic prevention and control period, this paper designs a face recognition and remote body temperature monitoring device suitable for epidemic prevention and control, which uses high precision The infrared probe and high-definition camera realize the collection of human body temperature and face data. The collected electrical signals and image data are processed and analyzed through the main control chip, and the resulting processing results are finally output. The device designed in this paper can accurately and quickly realize body temperature measurement and identity recognition, and finally achieved good results, making a great contribution to reducing the pressure on epidemic prevention and control.

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