Design and Research of Non-contact Temperature Measurement and Identity Recognition System

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Abstract. With the rapid spread of the new crown epidemic, prevention of the epidemic has become an important task in daily life. As of now, the cumulative number of confirmed cases in the world has exceeded 150 million, and the epidemic prevention situation is very serious. In the face of the spread of the epidemic, effective temperature measurement, mask recognition, and face recognition are necessary for mobile personnel. Traditional methods such as the deployment of Raspberry Pi, windows platform, etc. can better meet the above requirements, but there are disadvantages such as low number of recognition frames, low accuracy, and bulky equipment. Due to the large market demand, the cost of the chip has also risen. If the above-mentioned functions are deployed according to the traditional method, the cost is relatively high, which increases the economic pressure on small and medium-sized enterprises. The main work of this research is to solve related functions through a processor Kendryte K210 based on the open source instruction set RISC-V. So as to realize a portable and low-cost non-contact temperature measuring device. The paper introduces a low-cost solution based on K210 on the basis of comprehensive discussion of multi-party implementation methods. Based on this processor, the face recognition and mask recognition functions based on YOLOv2 training are deployed through its machine vision and machine hearing capabilities. The temperature is measured by an external MLX90614 sensor; the serial port screen and the voice module JQ8400 are used for user interaction, which meets the guidance of users to the greatest extent. In the design of the hardware circuit, a lithium battery charging and boosting mobile power board based on MH-CD42 is designed. The user can supply power through an external lithium battery to realize the portability of the system.

Keywords: portable and low cost; machine vision; mask recognition; Kendryte K210.

1. Introduction

1.1. Design research background and research significance
Due to the spread of the new crown epidemic, our lives have been severely affected. The ensuing epidemic control has become a major problem. In recent years, various technologies have developed rapidly, and many technologies have also been used to prevent epidemics. Among them, the most eye-
catching has to be the recent Ai+LOT technology. Combining machine vision and the Internet of Things technology can meet many daily application scenarios, such as face recognition check-in machines, temperature measurement gates, etc. These technologies have facilitated our lives and helped prevent and control the epidemic. The face recognition temperature measuring gate is shown in Figure 1.

![Figure 1. Temperature measuring gate](image1)

Traditional face recognition technology mostly uses PC as the recognition hardware platform. With the development of technology, this platform has been greatly restricted. In recent years, some new chips have targeted the blank market left by the lack of PC platforms. Kendryte K210 is a newly launched embedded chip with AI capabilities by the domestic Kanzhi Company, which can realize machine vision and machine hearing capabilities by running a convolutional neural network training model [1]. It uses an ultra-low power 28 nanometer process and has a 64-bit dual core processor has improved stability and reliability while having better power consumption performance. Kendryte K210 is positioned as a system-level chip in the AI and IoT markets, and has the functions of a traditional MCU, which is very convenient for developers to use. The difference between K210 and traditional embedded processors is that it has a convolution hardware accelerator KPU, which can perform some convolution operations quickly, so it can run some lightweight convolutional neural network training models [2]. This enables development to easily use the K210 to deploy a training model using a lightweight architecture within the shortest timeliness, giving the product artificial intelligence while reducing the cost of development. The K210 processor module is shown in Figure 2.

![Figure 2. K210 processor module](image2)
1.2. Current research status at home and abroad

In recent years, deep learning technology has shined in image classification and object detection tasks, so deep learning has also been widely used in the direction of face detection and face recognition. Some neural network training models with superior performance include R-CNN (Region-based-convolutional Neural Network) model and YOLO convolutional neural network model (You Only Look Once). Among them, the more widely used network model YOLOv2 with better performance. Generally speaking, the YOLOv2 network is based on a sequential structure and consists of a convolutional layer and a pooling layer. Compared with the YOLOv3 network, it has the characteristics of easier implementation and training. Based on this, South Korea’s Firs Company launched the Vision Gate face recognition system with a recognition success rate of 99.8%, which can have access control, attendance and other functions [3].

2. Scheme selection and theoretical analysis

2.1. Scheme selection

K210 is a 64-bit dual-core processor based on the RISC-V instruction set. It has a 600Mhz clock speed, a rich peripheral interface, and a neural network processor KPU. It supports fixed-point training by mainstream training frameworks according to specific restrictions. The model supports both 1x1 and 3x3 convolution kernels, which is very suitable for running training models, and the unit price is only 20 RMB [4]. The core module that integrates the K210 only costs 70 yuan, which is less than the size of an IC card. According to the above analysis, considering the portability and economy of this design, this design uses the K210 processor that supports the operation of the neural network model. Figure 2-2 shows the core board equipped with the K210 processor [5].

In this system, the temperature measurement sensor is also an important component. According to the requirements of the design, the selected sensor needs to be able to perform rapid measurement with considerable accuracy, can directly return the temperature data of the subject, adapt to changes in the environment, and have a small amount of data calculation. Commonly used temperature measurement sensors are MLX90640 and MLX90614. The former is a 32*32 pixel thermal infrared array widely used in infrared thermal imaging, which contains 768 FIR pixels, is small in size, high in accuracy, and can output data at 1 time per second. Users can use the communication protocol interface to read the value of the register is solved. MLX90614 is a non-contact measuring sensor that calculates temperature through reflected infrared rays. It is small in size and uses a TO-39 package. It integrates an infrared thermopile sensor and a customized high-precision 17-bit ADC as well as powerful functions. The digital signal processing chip can support -20°C-120°C temperature measurement, and the price is relatively cheap, about 50 yuan. Combining these two temperature sensors, the MLX90640 needs to calculate a 32*32 dimension data, which greatly occupies the resources of the microcontroller. When the solution data takes too long, it will greatly reduce the running speed of the neural network model and reduce the frame rate of the camera to obtain the image, and the price of the sensor is more expensive than MLX90614. For the purpose of economy and effectiveness, we choose MLX90614 sensor [6].

3. Overall system hardware design

3.1. The overall structure and design of the system

The hardware part of the entire non-contact measurement recognition device is composed of the main control part and the expansion part. The main control part is based on the K210 development platform, and is composed of a camera, LCD screen, and serial communication sub-modules according to the overall block diagram of the system design. The expansion board is composed of a power management circuit, a step-down circuit, and a power indicator circuit. Next, this article will give a detailed description of the function configuration corresponding to each selected module.

(1) Main control module: This module is the core processing module of the entire system, which collects and processes images in real time, and can display the collected images in real time on the LCD.
(2) Expansion module: This module is mainly used to connect peripherals and provide power. The integrated lithium battery charge and discharge management chip MH-CD42 and the low dropout linear voltage regulator circuit AMS1117-3.3 and AMS1117-1.8 are onboard.

(3) Peripheral module: The external MLX90614 temperature sensor, HMI serial screen and JQ8400 voice module used in this system.

The main control part is the selected SPIEEED MAIX GO development platform with K210 core. The platform integrates 2.4-inch TFT capacitive touch screen, OV7725 camera, power management, etc., which greatly meets the needs of AI embedded device development. Because there is 8M RAM inside the chip, the system will develop software by transplanting Micro Python. Micro python is a reduced version based on Python3, has most of the Python syntax, and is adapted to embedded chips with limited memory and performance, and can be packaged into an interface through the production of Python libraries. It greatly facilitates our use and rapid development.

3.2. Analysis of the hardware design of the main control part
The main control part is the selected M1W module with K210 core. The module uses a stamp hole packaging method to lead out all the core IOs. Compared with the traditional embedded chip GPIO (General Purpose Input Output) such as STM32, the internal functions are basically bound to the IO. The user realizes the function through the initialization and multiplexing of the pins, and each time the user adds a new peripheral When you need to read the manual of the chip carefully, the main control chip K210 of this system supports FPIOA (Field Programmable Input and Output Array), which can be registered through pins, and any function can be mapped to IO, which greatly facilitates the development of users. Because there is 8M RAM inside the chip, the system will develop software by transplanting Micro Python [7]. Micro python is a reduced version based on Python3, has most of the Python syntax, and is adapted to embedded chips with limited memory and performance, and can be packaged into an interface through the production of Python libraries. It greatly facilitates our use and rapid development.

4. Software design of non-contact measuring device
4.1. The overall system software design composition block diagram
The software part of this design consists of five parts: face recognition, mask recognition, Internet of Things communication, sensor reading and user interaction. Functionally, offline face recognition and mask recognition are realized [8]. In terms of user interaction, a display interface is made by writing a serial screen interface, which can guide the administrator user to choose the mode, and set the learning mode management password to ensure that the administrator writes and reads the face data Permission to take. At the same time, the voice broadcast module is also used for user interaction. When mask recognition is performed, the recognition result will be broadcast by voice. When the identified target is not wearing a mask, the voice broadcast module will issue an alarm to remind people to wear a mask.

4.2. Part of the software design of face recognition
In this system, the face recognition part uses the method of extracting the key points of the face. Face recognition is performed by running the face detection model based on the MobileNet v2 network, the five-point key point detection model of the face, and the 196-dimensional feature value model of the face. The face detection model can detect whether there is a face in the current image, if there is a face, then five-point key point detection is performed, and the recognized face is cropped and sent to the five-point key point detection model [9]. In the face five-point key point detection model, the key point coordinates are detected. The five key points of the face are detected, which are the coordinates of the left eye, right eye, nose, and left and right corners of the mouth. According to the obtained 5-point coordinates and the standard face coordinates the affine transformation matrix is obtained. The affine transformation refers to linearly changing the face feature vector to the positive face feature vector space. The front face image is obtained by affine transformation, and the feature value in the front face image is calculated. The feature value is a set of 64-dimensional arrays. Use the written face_compare function
to calculate the currently acquired feature value and compare it with the stored feature value stored in
the local face database. When the feature value similarity is greater than 85, it can be determined that
the face image is similar to the image in the feature database. Match. When entering the learning mode,
the face name is obtained by receiving the data sent from the serial screen and decoding it, and the face
name and face feature value are saved in the memory card in a certain format. At the next power-on,
the program first reads the text file in the memory card, and adds the obtained face name and face feature
value to the current recognition list, thus realizing the establishment of an offline database of face data.

5. Conclusion and Outlook
In the era of big data, more and more attention is paid to data security, and the leakage of face data has
become a concern for people. The increasing number of online recognition APIs makes people's face
data precarious. Recently, Alipay launched face recognition payment, claiming to have the face data of
300 million people. The security of face data has gradually entered the public's attention. Therefore, this
article is dedicated to realizing offline face recognition through low-cost embedded devices to ensure
the security of the user's face data. The K210-based non-contact temperature measurement and
identification device proposed in this paper is based on the open source instruction set RISC-V
architecture, which is an open source architecture. In the context of the current Sino-US trade war, high-
performance chips using the ARM architecture may be sanctioned, resulting in many domestic
manufacturers without cores. Therefore, tap the emerging open source instruction architecture processor,
built its open source ecosystem, and use backup solutions in a timely manner after foreign sanctions on
us. All compilers and development environments used in this system are adapted by domestic
manufacturers, which have high controllability and safety.

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