Deep Guard Dog - AI-Based Night Intrusion Detection Mobile Phone Software

Keming Chen*, Jiaxin Wang
Tianjin University of Science and Technology, Tianjin, China
*E-mail: * 18336462861@163.com*

Abstract

This article introduces an Android mobile app called "Super Electronic Watchdog", which aims to solve the problem of home security. The application utilizes Android Studio, NCNN framework and Opt2Ada night vision algorithm to realize humanoid object detection and night image enhancement. Users can switch the camera, select the humanoid detection model and CPU/GPU operation mode, and activate night vision through the app. The application has vibration and voice alarm functions to alert the user that someone has entered the monitored area. The software is divided into Native layer and Java layer, using C++ and Java development, the overall design structure is clear, efficient and practical.

Keywords: home security, Android Studio, humanoid object detection,voice alarm functions

1. Introduction

In today's society, with the improvement of people's living standards and the enhancement of safety awareness, home security[1] has become the focus of increasing attention. From whether the doors and Windows of the house are illegally broken into, to whether the incapacitated people such as children and the elderly stray into dangerous areas such as kitchens and balconies, these potential security risks threaten our daily life. Especially for people who rent houses, travel or travel on business, security cameras cannot be installed for various reasons, and home security problems are more prominent.

To address these challenges, an AI mobile app called "Deep Guard Dog" has been developed. It is developed using Android Studio, Tencent's deep learning reasoning framework NCNN, and our self-developed night vision algorithm Opt2Ada. Through the built-in artificial intelligence algorithm, this app can recognize the humanoid target in the coverage area of the mobile phone camera in real time, and has the function of enhancing the brightness of the mobile phone camera image, even at night can realize the clear recognition of the image.

When the app detects a humanoid object, it will immediately trigger a voice announcement and vibration notification to alert the user that someone is present in the target area. This function is not only suitable for daily home monitoring, but also plays an alarm role for illegal intrusion when the user is sleeping or busy with other things. Compared with the traditional pet dog guard method, "super electronic guard dog" is not only more intelligent and efficient, but also not limited by time, space and other factors, providing a more comprehensive and reliable guarantee for home security.

The rest of this article is organized as follows. The second part is the description of the software. The third part introduces the overall design of the software. The fourth part introduces the related modules of the software, including image acquisition module, night vision enhancement module, human object detection module, voice vibration alarm module, and the fifth part summarizes the main content of this paper.

2. Software description

The camera is used to collect video information, the night image is enhanced by the night vision algorithm deployed in the software, the humanoid target is detected by the depth model, and the mobile phone vibration or voice broadcast is performed according to the detection results. The running interface of the app is shown in the following Fig.1.

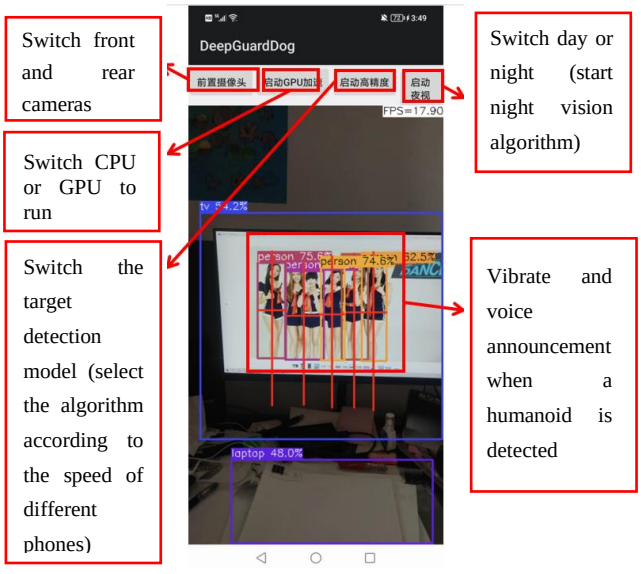


Fig.1 The running interface

2.1. Camera switch (front/rear)

The front/rear camera used to switch the mobile phone can be flexibly placed in the area that needs to be

monitored when combined with the mobile phone bracket.

2.2. Humanoid detection model switch

Multiple artificial intelligence algorithms that can be used for humanoid target detection are deployed in the software. On the same phone, different algorithm models require different floating-point arithmetic (FLOPs), that is, the running speed and detection distance are different. Therefore, users can choose the optimal model according to their own mobile phone configuration and actual application scenarios.

2.3. CPU\GPU switch

Users can switch between using the CPU or GPU of the phone to run the software according to their mobile phone configuration. For some high-configuration mobile phones, the software runs faster on the GPU than the CPU.

2.4. Day \ night switch

Images taken by mobile phone cameras at night are too low in illumination to distinguish humanoid targets. To solve this problem, when using the software at night, you can choose to start the night vision algorithm[2], which can improve the illumination of the night image to a certain extent, so as to improve the detection rate and accuracy of humanoid target detection. The night vision function diagram is shown in Fig.2. In Fig.2,the night algorithm is not enabled on the left, while the night vision algorithm is enabled on the right. It can be seen that after the night vision algorithm is turned on, it can effectively detect previously undetected humanoid targets.

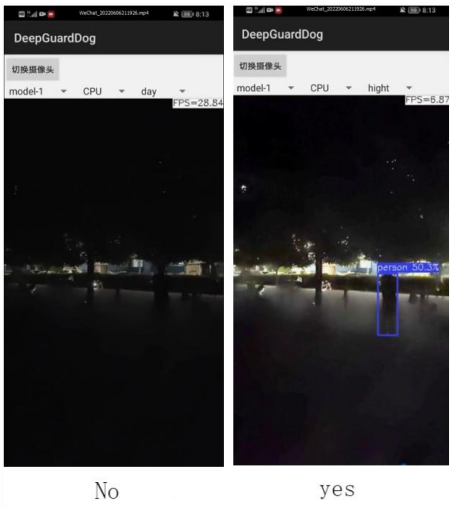


Fig.2 Schematic diagram of night vision function

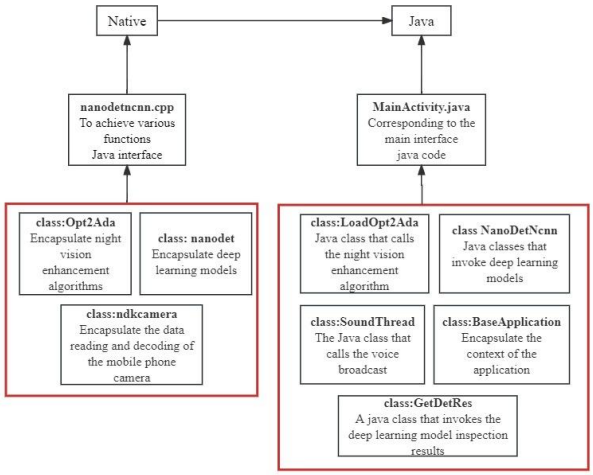
Based on the above design and implementation of the electronic watchdog function that can be realized by this app, it can identify and alarm personnel intrusion in the monitoring area.

3. Overall design

3.1. Design method

This app is developed using Android Studio. The structure of the software is divided into Native layer and Java layer. The Native layer first implements the call and reading of the mobile phone camera, and deploys deep learning algorithm and night vision algorithm, and uses cmake to manage and compile the code. The Native layer is developed using C++, in which the object detection algorithm is deployed using Tencent's open-source deep learning reasoning framework NCNN, and the night vision algorithm is implemented and deployed using C++. When compiled, the Native layer generates a shared library for the Java layer to call. In the Java layer, the deep learning algorithm and night vision algorithm in the Native layer are called, and the interface rendering and voice broadcasting functions of the app are realized. The design structure of the overall software is shown in Fig.3.

Fig.3 Schematic diagram of software overall code design



3.2. Overall structure

The overall structure of the software is to process the data of the mobile phone camera as a linear data stream. First, the software decodes the video captured by the mobile phone camera to obtain the RGB map. If the operating environment of the software is really daytime, it is not necessary to turn on the night vision algorithm, if the software is running at night or in a poor light environment, it is necessary to turn on the night vision algorithm. After the RGB image decoded by the camera is enhanced by the night vision algorithm, the next step is processed by the deep learning object detection algorithm to detect whether there is a humanoid target. According to the results of detection, the relevant vibration alarm and voice broadcast are carried out. The following describes the structure and flow of each processing module.

4. Correlation module

4.1. Image acquisition module

The schematic diagram of image acquisition module is shown in Fig.4. Here, the software uses the methods in the NCNN library to decode the image and convert the color space. This module directly reads the video stream collected by the camera of the mobile phone and outputs the image in RGB format.

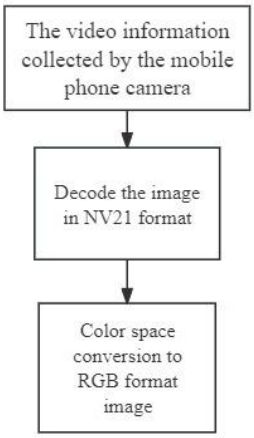


Fig.4 Structure diagram of image acquisition module

4.2. Night vision enhancement module

The night vision enhancement module is shown in Fig.5. The input of this module is the RGB format image output by the previous module, and the output image of this module is the image after illuminance enhancement and is used as the input image of the next module.

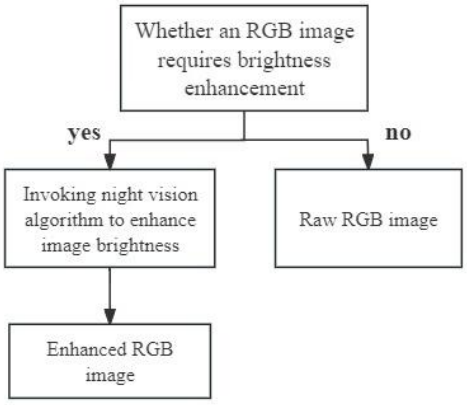


Fig.5Night vision enhancement module structure diagram

4.3. Humanoid target detection module

The humanoid target detection module[3] is shown in Fig.6. The input of this module is the RGB format image output of the previous module, and the output of this module is the detection result of the image. In this module, the NCNN library deployed the deep learning models NanoDet-RepVGG (input resolution 416*416) and NanoDet-EfficientLite (input resolution 512*512) for object detection. Users can choose which model to use according to the actual application scenario and phone configuration. Compared with traditional image processing algorithms, deep learning models can accurately identify humanoid objects from complex backgrounds, so they are suitable for home environments.

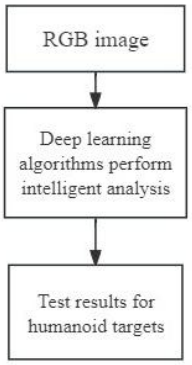


Fig.6 Humanoid object detection module

4.4. voice & vibration alarm module

The voice & vibration alarm module diagram is shown in Fig.7. This module is deployed in the Java layer and runs in a separate thread. The input of this module is the detection result of the deep learning model, and the detection result in the Native layer is retrieved through the data interface of the Java layer. If the result contains a humanoid target, the voice broadcast and mobile phone vibration alarm will be carried out. The voice broadcast content is: "Someone has entered", and the broadcast frequency is once every 2 seconds.

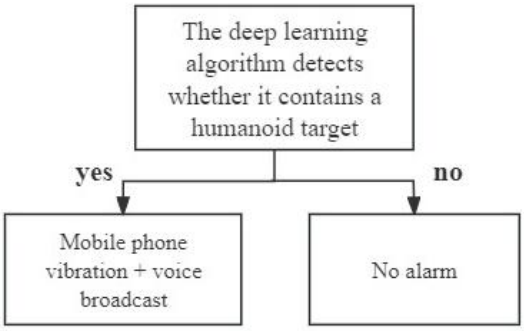


Fig.7 voice & vibration alarm module

5. Conclusion

"Deep Guard Dog" application uses smart phone technology and deep learning algorithms to achieve efficient and intelligent home security monitoring, solving the problem of illegal entry and incapacitated people into dangerous areas, more comprehensive and reliable than the traditional way, and will continue to optimize and improve user experience and identification accuracy in the future.

References

1. Yang Piao. Design and Implementation of Intelligent Video surveillance System in Security Field based on Deep Learning. *Materials for Information Records*, 2024, 25 (11):177-179.
2. Zou Peng, Chen Yuzhang, Chen Longbiao, et al. Light distribution prediction algorithm for night vision restoration based on neural networks. *Computer Science*, 2019, 46 (S2): 329-333+340. (in Chinese)
3. Lin Zhi-Bin, HUANG Zhi-Quan, YAN Lin-Ming. Research on Face detection based on Android platform. *Electronic Quality*, 2021, (11): 40-45.

Authors Introduction

Mr. Keming Chen

He is currently an undergraduate in Tianjin University of Science and Technology. He is majoring in automation. His research focuses on deep learning.He specializes in developing mobile phone software using C++ and Java.

Ms. Jiaxin Wang

She is currently an undergraduate in Tianjin University of Science and Technology. He is majoring in Robot engineering. Her research focuses on deep learning.She specializes in developing mobile phone software using C++ and Java.