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Embedded Implementation of YOLO Nano Algorithm for On-site Recognition of Relay Pressure Board Status

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Abstract

For the relay platen state identification problem, whether it is a camera or a designated track driving robot inspection, will be affected by the glass door reflection, foreign object obstruction, angle blind area and other platen can not be correctly identified, manual inspection is inevitable. In addition, the current platen image recognition requires a huge background structure, and the inspectors cannot immediately obtain the verification information at the operation site, which greatly affects the work efficiency. In this paper, in response to the above problems, an embedded-based handheld terminal solution is proposed, which uses a miniature intelligent HD camera to achieve multi-angle photography of the pressure plate screen cabinet, effectively solving the problem of obstructing photography due to glass door reflection, foreign object obstruction, angle, etc. In addition, this paper proposes a relay platen status field identification method based on embedded and YOLO Nano algorithm, and selects a high-performance computing core and a special vision recognition module as the hardware platform to avoid a huge background architecture and realize the operation field identification and verification. The test results show that the system has a 100% accuracy rate of relay platen status identification, which effectively solves the operation site identification problem of relay platen status and has strong practicality and applicability.

1. The Research Idea of this Paper

In order to realize the on-site identification and verification of the relay platen throw-out operation, the overall design scheme of the proposed method includes two parts: the hardware platform of the handheld terminal and the firmware program software. Embedded hardware platform core for image recognition embedded unit consists of image acquisition module, graphics processing module, AI computing module and display module. The operation site platen recognition check flow, as shown in figure 1.

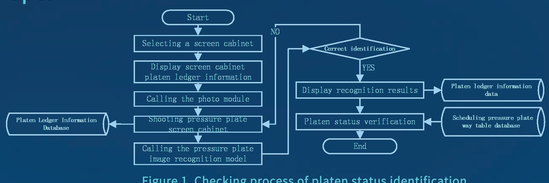

Figure 1. Checking process of platen status identification

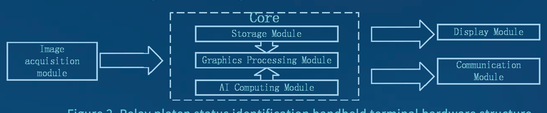

Figure 2. Relay platen status identification handheld terminal hardware structure

The core of the embedded handheld terminal for the status of the relay platen is an image recognition embedded unit consisting of an image acquisition module, a graphics processing module, an AI calculation module and a display module, as shown in figure 2.

2. Embedded Software Design for in Situ Identification and Verification of Platen Status

The system firmware program proposed in this paper includes two parts: the operating system and the pressure plate state identification software. The operating system firmware includes display driver, WiFi driver, Bluetooth driver, USB driver and operating system porting module.

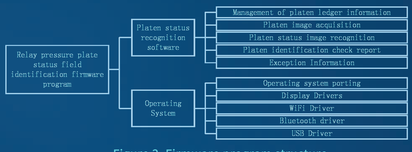

Figure 3. Firmware program structure

The platen status identification software includes platen ledger information management, platen image acquisition, platen status image identification, platen identification verification report and exception information module. The firmware program structure, as shown in figure 3.

3. YOLO Nano Algorithm for Relay Platen Status Field Identification

Due to the limitation of computing resources of embedded devices, in order to maximize the effectiveness of image recognition algorithms. The algorithms deployed on embedded devices are required to have high accuracy, good real-time performance, low development difficulty, small network model, and low memory occupation. The existing target detection networks, such as SSD and Mask-RCNN, are unable to perform their applications on embedded devices due to the limitations of computation and memory of embedded devices.

The YOLO Nano network is a highly customized network for embedded devices and is created in two steps: 1. create a prototype network based on the YOLO family of networks; 2. obtain the final network based on the prototype network through a machine-driven exploration strategy. The network is a highly customized network for embedded devices.

4. System Implementation

RK3399 of Rexchip Micro is used as the core module with ARM-based Linux operating system to design and develop a handheld terminal for relay platen status identification. The size of the hardware core version of the handheld terminal is 124x93mm, which meets the design requirement of portable embedded handheld terminal, as shown in figure 4.

The platen state recognition software is built and developed based on Java platform. The YOLO Nano network for embedded devices is built in the host computer using the TensorRT framework, and the network is trained with the labeled data set to obtain the prediction model and parameters, which are embedded in the recognition software.

Figure 4. RK3399 Core Motherboard and Implementation of Embedded Handheld Terminal

The model and parameters are embedded in the recognition software. The software is installed and deployed in the embedded handheld terminal, and the algorithm model is invoked to recognize the platen image during the usage. Some of the software functions are implemented as shown in figure 5.

Figure 5. Platen status recognition software implementation

In the main control room of a 220kV substation, the system proposed in this paper was used to conduct relay pressure plate image identification and verification tests at the operation site, and the test results are shown in table below.

5. Analysis of Test Results

From the analysis of the experimental results, it can be obtained that the accuracy of platen recognition is 100% when the YOLO Nano algorithm is used in the embedded handheld terminal for photo recognition of platen status.

Num	Number of plates	Number of correct	Correct recognition rate
1	200	200	100%
2	400	400	100%
3	600	600	100%

6. Conclusion

The present relay platen verification has the problems of perceived large influencing factors, difficulty in promoting the verification system and low accuracy of image recognition. In this paper, the identification and verification of the field relay platen status is realized by developing an embedded handheld terminal and curing the YOLO Nano network model in the handheld terminal.(1) The embedded handheld terminal was developed to solve the problem of the convenience of verifying the status of the platen on site. (2) It solves the problem that the current substation image identification application must use the background server to identify, and the site verifier can obtain the pressure plate identification and verification results in time by using the handheld terminal to take pictures of the pressure plate screen cabinet.(3) Innovative use of an embedded device with neural network acceleration function to solidify the YOLO Nano model and apply it to relay pressure plate status verification in the field.(4) After the application of the experimental summary of the proposed method for relay platen status identification accuracy of more than 100%, can effectively solve the problem of low efficiency of manual verification platen status, with strong practical and promotional value.