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Intelligent Judgment Method of Superimposed Label Recognition Technology Based on a Deep Learning Target Detection Algorithm for Detecting Wiring Errors in Current Transformer Tests

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Abstract. This paper presents a novel method of intelligent detection of transformer wiring tests. It combines a new deep learning-based object detection algorithm with a tag code identification technique. Complex wiring in the current transformer error test scenarios implies a need for frequent human testing and judgment by digitizing the equipment terminals and the connected wires in the test. The automatic identification of the test connection lines is realized, relying on learning from the standard wiring and logically binding the standard wiring relationship. The proposed method is instrumental in greatly saving labor costs, reducing the possibility of human error, improving work efficiency, and developing a new concept of current transformer error test training for new employees.

Keywords. multi-target detection algorithm, current transformer, wiring judgment, deep learning.

1. Introduction

The error test of the current transformer is a relatively important work in the 24 field operations of the power marketing and measurement category, which is directly related to the fairness and feasibility of the electric power trade settlement. It is also a must-have skill for new employees of the State Grid Corporation of China. It is one of the electrical test training programs. During the training process, the trainer needs to check permanently whether their wiring is correct or not. Due to a large amount of training, trainers will inevitably experience fatigue during the inspection process, deteriorating the test efficiency and leading to various, which brings a more significant safety hazard to the training process. For this reason, this study proposes an automatic judgment method for the error test of current transformers based on the YOLO algorithm,

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significantly improving the wiring inspection efficiency. Besides, the workload is reduced, the possibility of misjudgment is diminished, and the safety of the training process is ensured.

2. Current transformer error test method

The comparison method is adopted in the error test of the current transformer. To measure the error of the current transformer under test, the standard current transformer with a high accuracy level should be compared with the test product, and the error of the current transformer under the rated load and the lower limit load should be measured. Consider the specific wiring in Figure 1.

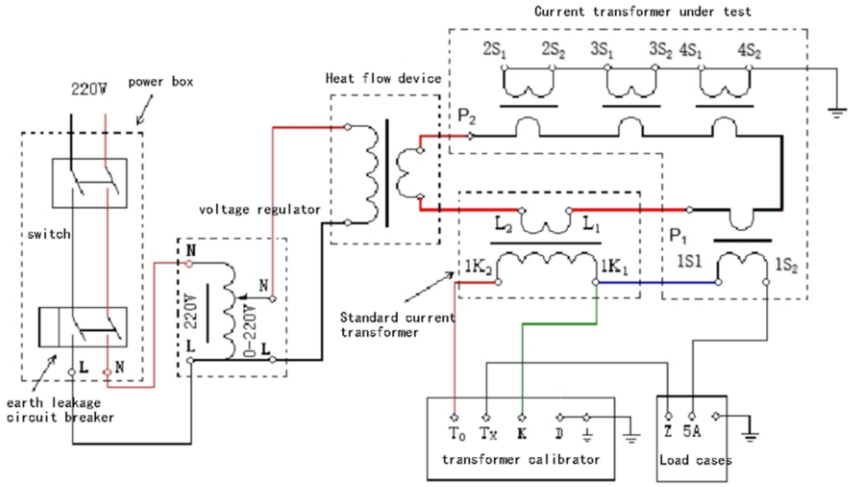

Fig. 1 Wiring diagram of the current transformer error test

Figure 1 comprises seven devices: the power box, voltage regulator, current lifter, standard current transformer, current transformer under test, load box, and transformer calibrator. A total of 16 wires are used, including twelve secondary wires, three ground wires, and one high-current wire. There are 16 pairs of terminals, among which wires 1K1-1S1 and 1K1-K share terminal 1K1.

3. Design ideas

Based on YOLOv4 target detection [1], intelligent barcode recognition [2], and data intelligent verification technology [3], an intelligent judgment system for the misconnection of the current transformer field error test is developed.

3.1. Digital preprocessing

(1) Digitization of test equipment

All the test equipment participating in the test undergoes pasting of the equipment asset code, entering the equipment information and barcode into the system through the data acquisition terminal that supports the camera function (hereafter referred to as the acquisition terminal).

(2) Terminal digitalization

One should digitize the terminals of the test equipment, adopt the recording method of pasting a two-dimensional code, and enter the system through the acquisition terminal (hereinafter referred to as the terminal code), and the terminal code is bound to the test equipment code, as shown in Figures 2 and 3.

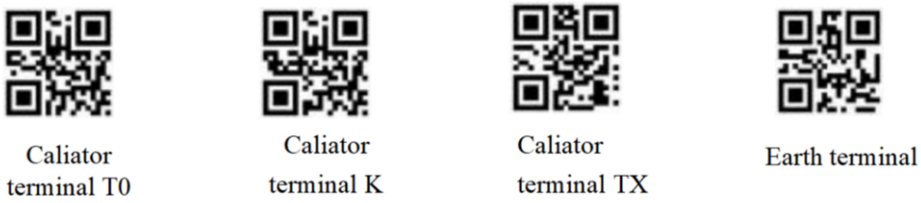

Fig. 2 Terminal code

Fig. 3 Device terminal code digitization

(3) Digitization of the tested product

The wiring terminal of the test transformer is digitized by recording the acquisition terminal into the system, and the transformer terminal code is bound with the transformer device code.

(4) Digitization of test lines

The two terminals of the test line are coded in rings, used in pairs, and entered into the system through the acquisition terminal. Test line labeling digitization in Figure 4.

Fig. 4 Test line labeling digitization

3.2. Terminal Wiring Detection

Using the target detection method of YOLO v4[4], the terminal and wiring are set as the target identification area, multiple bar codes are collected in each identification box, and the barcode images are processed through the image processing function of the acquisition terminal. The computer reads the picture in the image file format and then identifies it through image preprocessing, binds the interconnected terminal codes and line codes, identifies the terminal codes and single or multiple line codes in the area, and records it in the temporary database. The detection and identification results are illustrated in Figure 5.

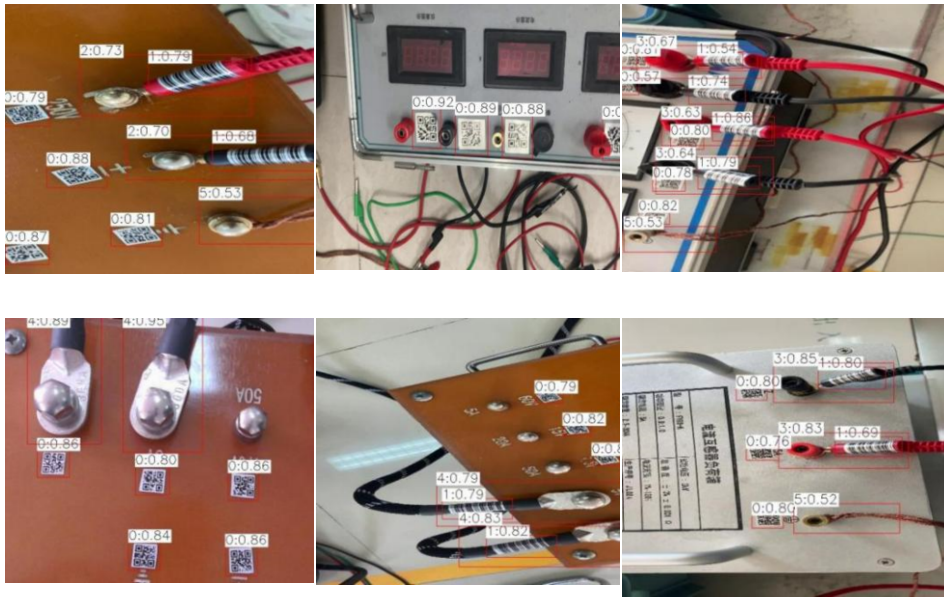

Fig. 5 Detection and identification results

The total training results achieved 90% correct recognition detection at IOU at 0.5.

By this method, all the terminals were photographed and identified successively. All the terminal codes and the corresponding lines of the terminals were identified successively and recorded in the alignment library. The YOLOv4 intelligence was required to distinguish the mutual binding relationship between terminals and line codes.

4. Intelligent judgment system of transformer wiring

This paper aims to realize the wiring intelligent judgment system of the transformer. First, the image (video) acquisition equipment, combined with the YOLOv4 target detection algorithm, sets the target identification area and collects all equipment, terminals, and wiring barcodes. Then, the computer is used, the relevant information is obtained and recorded to the temporary database for relationship binding, and the wiring connection rules are determined. After sending the pictures to be tested by the system for a series of analysis operations, and the actual connection relationship is compared with the information in the database, one can judge whether the connection is correct or not, and the intelligent judgment operation of the connection can be completed.

Specific function implementation involved the following components:

(1) Data acquisition function: with microcomputer Nvidia NANO camera as a video picture acquisition terminal, using LINUX system, the OpenCV environment, implanted YOLOv4, barcode recognition, and information comparison algorithm [5].

(2) Barcode information binding: computer implanted barcode recognition algorithm, for local data analysis, bar code analysis, corresponding relationship binding record to the temporary database.

(3) Data detection function: the YOLOv4 algorithm is used to train the model, detect the pictures that need to be judged, interpret the bar code, compare the interpreted information with the database, and obtain the results.YOLO v4 algorithm was used for model training, as shown in Figure 6.[1]

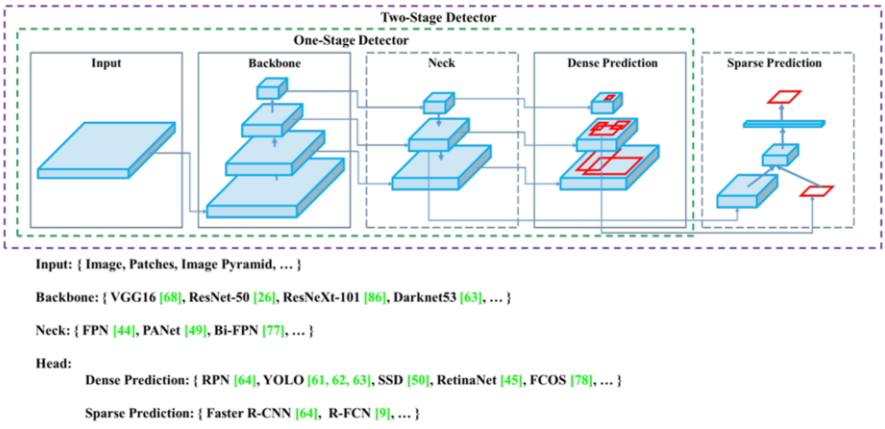

Fig. 6 The YOLOv4 algorithm usage to train the model[1]

5. Application of intelligent wiring judgment

5.1 Standard wiring mode learning

In the standard wiring mode, the teacher holds the acquisition terminal, identifies and scans the code of the standard terminal code and the line marking code, obtains the corresponding relationship between the wiring ports, and saves the name as the standard wiring mode.

5.2 Wiring judgment and testing

The wiring detection procedure envisages that the trainees should watch the operation training video before connecting. After the trainees have completed the wiring, they should hold the acquisition terminal to perform target detection and identification on all the test instruments and transformers, in turn, automatically capture the equipment terminal code and line code, and detect the unscanned data. The missing terminals should be prompted until all scanning and verification are completed, the corresponding relationship between each port will be obtained, and it will be automatically compared with the standard wiring method of the test item. If it is not correct, it will display "wrong wiring" and display the name of the wrongly connected terminal, and the system will not be powered. This item is changed from manual inspection by on-site teachers to intelligent inspection by the software system.

6. Conclusion

This paper proposes a two-stage procedure to implement the intelligent judgment method of superimposed label recognition technology based on a deep learning target detection algorithm for detecting wiring errors in current transformer tests. The first stage envisages data collection through the acquisition terminal and binding the corresponding relationship. The second stage uses the YOLOv4 algorithm model, the recognition algorithm of bar code, and the intelligent data calibration algorithm to detect the terminal wiring. Bar code size, model parameters, and database size settings are combined with the actual scene and adjusted to the appropriate value. The method provides accurate target detection identification and timely recording of equipment information through intelligent detection system wiring inspection, improving detection efficiency and reducing misjudgment rate. Since it can reduce labor intensity and misjudgment rate, while enhancing the labor efficiency of users, the proposed method can also be extended to other kinds of electrical test wiring automatic determination, especially those involving training projects.

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