Intelligent Judgment of Wrong Wiring Method in Large-Scale Training of Electrical Testing

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Abstract: In the paper, in view of the complex wiring in the large-scale training process of electrical testing, the trainer needs to frequently judge the wiring right and wrong status quo, and proposes an intelligent judgment method based on the YOLO algorithm, through the logical binding of the digitized equipment terminals and the connected wire relationship in the test, relying on the learning of standard wiring, the automatic identification of the test connection line is realized, which greatly saves labor costs, reduces the possibility of human error, and improves work efficiency. New ideas have been developed for the training of new employees to conduct large-scale voltage transformer error tests.

1 INTRODUCTION

Electrical test is an important means for the power grid company to judge the status of electrical equipment, good or bad, but also a new employee must master a class of important skills, in the training process, the trainer needs to constantly check whether their wiring is correct or not, due to the large amount of training, the trainer in the inspection process will inevitably appear paralyzed, visual fatigue, resulting in low efficiency, there is such or that error, which brings greater safety risks to the training process, for this reason, The author proposes an automatic determination method for electrical test wiring based on YOLO algorithm, which greatly improves the labor efficiency of wiring inspection, reduces the possibility of false positive, and thus ensures the safety of the training process. Below we take the field test of current transformer as an example to illustrate the application of this method.

2 TEST METHOD FOR ERROR OF CURRENT TRANSFORMER

The current transformer error test is using the comparative method, in order to measure the error of the current transformer under test, it is necessary to use a standard current transformer with a high accuracy level, compared with the test product, in the rated load and the lower limit load of the two cases, respectively, the error of the current transformer under test is measured, and the specific wiring is shown in Figure 1.

3 DESIGN IDEAS

Based on YOLO V4 target detection, intelligent barcode recognition, and data intelligent verification technology, an intelligent judgment system for misconnection of current transformer field error test is developed.

3.1 Digital Preprocessing

3.1.1 Digitization of Test Equipment

All the test equipment participating in the test, paste the equipment asset code, and enter the equipment information and barcode into the system through the data acquisition terminal that supports the camera function (hereinafter referred to as the acquisition terminal).

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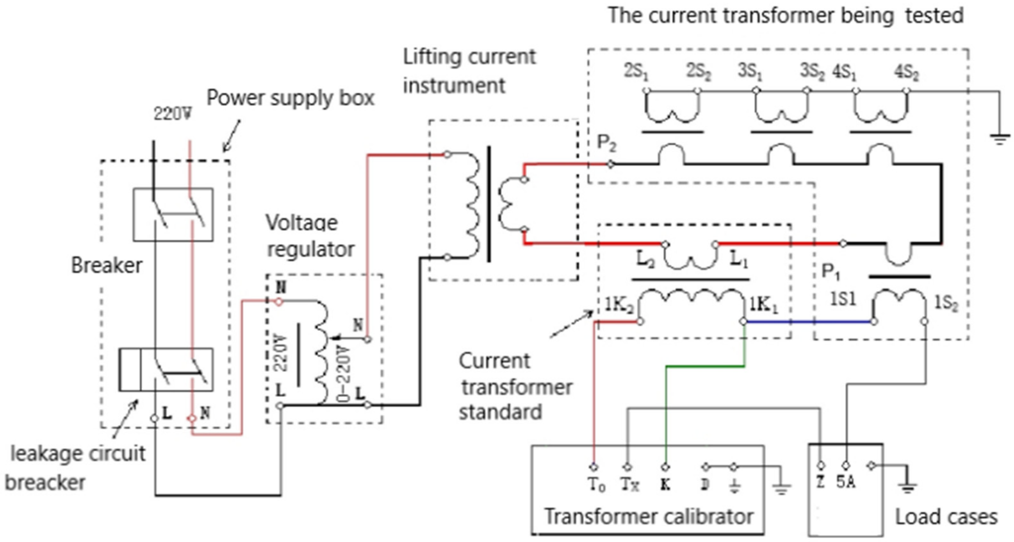

Figure 1: Wiring diagram of current transformer error test.

Seven devices are used in Figure 1, namely power supply box, voltage regulator, lifting current instrument, standard current transformer, current transformer tested, load cases and transformer calibrators, using a total of 16 wires, including 12 secondary wires, 3 grounding wires, and 1 high-current wire. A total of 16 pairs of terminals are involved, of which wire 1K1-1S1 and wire 1K1-K share a terminal 1K1.

3.1.2 Digitization of Test Equipment Terminals

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 Figure 2 and Figure 3.

Caliator terminal T_0 | Caliator terminal K

Caliator terminal Tx | earth terminal

Figure 2: Terminal code.

Figure 3: Device terminal code digitization.

3.1.3 Digitization of the Terminals of the Device Tested

The terminals of the tested transformers are digitized, and the recording method of sticking codes is adopted. The terminal codes of the transformers are bound to the equipment codes of the transformers and are entered into the system through the acquisition terminal, as shown in Figure 4 and Figure 5.

Figure 4: Device primary terminal code digitization.

Figure 5: Device secondary terminal code digitization.

3.1.4 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, as shown in Figure 6, Figure 7 and Figure 8.

100A001

Current line logo 1

10A 002

Current line logo 2

5A 003

Current line logo 3

Grounding wire 001

Grounding wire logo 1

Figure 6: Test line labeling digitization.

Figure 7: Digitization of the primary line.

Figure 8: Secondary line digitization.

3.2 Terminal Wiring Detection

The target detection method of YOLO v4 is adopted, the terminal and wiring are set as the target recognition area, multiple barcodes in each recognition frame are collected, and the barcode image is processed by the image processing function of the collection terminal, and the computer reads the image in the image file format, and then identify them after image preprocessing (Redmon 2016, Bochkovskiy 2020), bind the interconnected terminal codes and line labels, identify the terminal codes and single or multiple line labels in the area, and record them in the temporary database.

In this way, all terminals are photographed and identified in turn, and all terminal codes and the corresponding wire labels of the terminals are identified in turn, and recorded in the comparison library. Here, YOLOv4 is required to intelligently distinguish the mutual binding relationship between different terminals and line labels (Yu 2019).

3.3 Architecture of the Algorithm

For a target detection algorithm, it can usually be divided into 4 general modules. The YOLOv4 model includes the input end. CSPDarknet53 is used as the benchmark network BackBone, SPP is used as the additional module of Neck, PANet is used as the feature fusion module of Neck, and YOLOv3 is used as the Head. The network structure analysis diagram is shown in Figure 9.

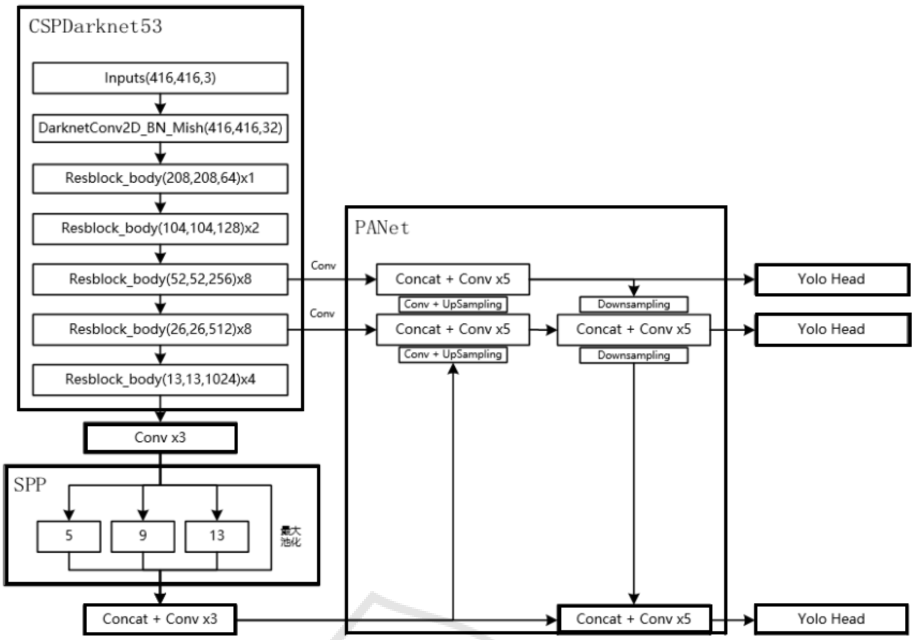

Figure 9: Analysis of YOLOv4 network structure.

The input side refers to the picture representing the input. This stage usually includes an image preprocessing stage, that is, scaling the input image to the input size of the network, and performing operations such as normalization. In the network training stage, YOLOv4 uses Mosaic data enhancement operations to improve the training speed of the model and the accuracy of the network; it uses cmBN and SAT self-adversarial training to improve the generalization performance of the network;

The benchmark network is usually a network of classifiers with excellent performance, which is used to extract some general feature representations. YOLOv4 uses CSPDarknet53 as the benchmark network. On the one hand, Concat is used instead of Add to extract richer features. After the Concat operation, the size of the feature map will remain unchanged, and the depth will increase, while the size and depth will not change after the Add operation. In this sense, using Concat instead of Add can extract richer features. On the other hand, the transition layer (1 * 1conv + 2 * 2pooling) is introduced to extract features, reduce the amount of calculation, and improve the speed. Another point is to fuse the Base layer into two parts to extract richer features. Divide the Base layer into two parts, and perform the Concat operation on one part of the output obtained through a similar residual network and the other part, and pass the result of the operation through the Transition Layer.

In fact, CSPNet is based on the idea of Densnet, copying the feature map of the base layer, and sending a copy to the next stage through the dense block, thereby separating the feature map of the base layer. This can effectively alleviate the gradient vanishing problem (it is difficult to reverse the lost signal through a very deep network), support feature propagation, and encourage the network to reuse features, thereby reducing the number of network parameters.

The Mish activation function is used to replace the original RELU activation function; a Dropblock block is added to this module to further improve the generalization ability of the model.

The Neck network is usually located in the middle of the benchmark network and the head network, and it can be used to further improve the diversity and robustness of features. YOLOv4 uses the SPP module to fuse feature maps of different scales. The full name of SPP is Spatial Pyramid Pooling, that is, spatial pyramid pooling. The purpose of using in YOLOv4 is to increase the receptive field of the network; using the top-down FPN feature pyramid and self- The bottom-up PAN feature pyramid is used to improve the feature extraction capability of the network. PANet (Path Aggregation Network) is used instead of FPN for parameter aggregation to be suitable for target detection at different levels. The method used in the PANet paper is Addition, and the YOLOv4 algorithm will The fusion method was changed from addition to Concatenation.

Head output - Head is used to complete the output of target detection results. For the detection head part, YOLOv4 continues to use the detection head of the YOLOv3 algorithm (Cao 2021). For different detection algorithms, the number of branches at the output end varies, usually including a classification branch and a regression branch. YOLOv4 uses CIOU_Loss to replace the Smooth L1 Loss function, and uses DIOU_nms to replace the traditional NMS operation, thereby further improving the detection accuracy of the algorithm.

All equipment, terminals, and connecting wires are made with QR codes or barcode digital labels. OPENCV is combined with cameras to collect the target area, interpret the QR code information on the collected photos, and bind the information accordingly. Log into a temporary database.

The data detection function interprets the photos detected by YOLOv4 that need to be judged by the QR code interpretation algorithm, and compares the interpreted information with the binding relationship in the previous database to determine whether the wiring is wrong.

4 DESIGN OF INTELLIGENT JUDGMENT SYSTEM FOR TRANSFORMER WIRING

The core of this paper is to realize the intelligent judgment system of transformer wiring. First, through the image (video) acquisition equipment, combined with the YOLOv4 target detection algorithm, set the target recognition area, and collect the barcodes of all equipment, terminals and wiring (Gao 2021); then use the computer to check the barcodes. Perform identification and analysis to obtain relevant information and record it in a temporary database for relational binding to determine wiring connection rules. After the picture to be detected is sent to the system for a series of analysis operations, the actual wiring relationship is compared with the information in the database to judge whether the wiring is correct and complete the intelligent judgment of wiring.

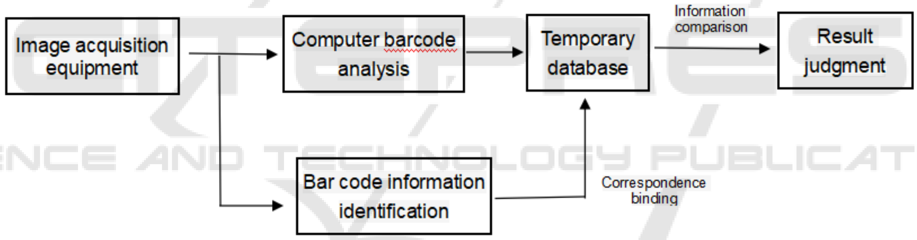

Figure 10: Flow chart of design of intelligent judgment system for transformer wiring.

Specific function realization:(1) Data acquisition function: use microcomputer Raspberry Pi with camera as video picture acquisition terminal, use LINUX system, install OPENCV environment, implant YOLOv4, barcode recognition, information comparison and other algorithms. (2) barcode Information binding: The barcode recognition algorithm is implanted in the computer, the data is locally analyzed and processed, the barcode is parsed, and the corresponding relationship is bound and recorded in the temporary database. (3) Data detection function: use YOLOv4 to detect the pictures that need to be judged, interpret the barcodes in them, compare the interpreted information with the database, and get the results (Wang 2021). The process is shown in Figure 10.

The system uses a PC host as the management platform host, which is used for information comparison and equipment management of multiple acquisition terminals. The test platform software includes management platform software and acquisition terminal. The function of the management platform is to set up and manage multiple collection terminals, and manage the comparison data in a unified manner. The acquisition terminal is embedded with a variety of artificial intelligence target detection algorithms, barcode recognition algorithms, and data intelligent verification algorithms. It has the function of automatically outputting assessment results, error prompting, built-in camera and display screen, which is convenient for handheld detection and bracket fixed detection. The secondary development interface is convenient for users to expand functions.

5 WIRING INTELLIGENT JUDGMENT APPLICATION

5.1 Learning About Standard Wiring

Standard wiring: The teacher holds the collection terminal, identifies and scans the standard wiring terminal code and line label code, obtains the corresponding relationship between each wiring port, and saves the name as the standard wiring method (Liu 2022).

5.2 Wiring Judgment Detection

Wiring detection: Before the students connect, they should watch the operation training video. After the students have completed the wiring, they will 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 will be prompted until all scanning and verification are completed, and 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 correct, it will display "wrong wiring", and display the name of the wrongly connected terminal, and the system will not be powered on. This item is changed from manual inspection by on-site teachers to intelligent inspection by software system, the specific test circuit diagram is shown in Figure 11, through the experiment, the efficiency of the trainer to check the wiring is improved, and the time is shortened.

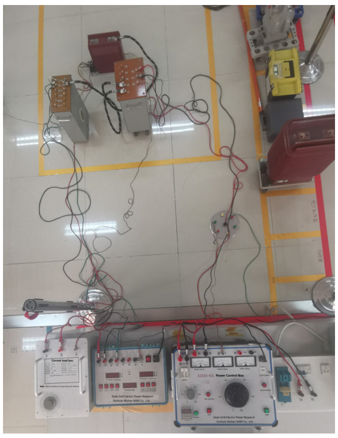

Figure 11: Digital verification of the error test terminal of the current transformer.

6 CONCLUSION

This project is mainly divided into two stages. The first stage is to collect data through the acquisition terminal and bind the corresponding relationship; Wiring is checked. The barcode size, model parameters, database size and other settings are combined with the actual scene, adjusted to appropriate values, accurately detect and identify the target, record equipment information in time, and conduct wiring inspection through an intelligent detection system to improve detection efficiency and reduce errors. The method proposed in this paper is suitable for the automatic determination of wiring of various electrical tests. especially when it comes to training projects, which can greatly reduce labor intensity and misjudgment rate, and improve the labor efficiency of users.

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