Research on AI Image Recognition of Inspection Robots in a Secondary Substation

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1. Research Background

This project aims to expand the functions of inspection robots to meet the needs of future practical applications and improve the quality and effectiveness of inspections. Visible light images are used to perform AI image recognition to achieve the purpose of real-time inspection of the operating status of equipment. At present, inspection robots can perform pre-defined path inspections, infrared thermal imaging camera temperature detection, temperature and humidity detection, and fault alerts to improve the efficiency and mobility of daily inspections and maintenance tests to ensure a stable power supply. When an abnormal notification occurs, the central control center will be notified immediately, and the information data uploaded before and after the identification may be used for comprehensive analysis to provide managers with a basis for preliminary assessment of equipment, lines, or environmental impact estimates.

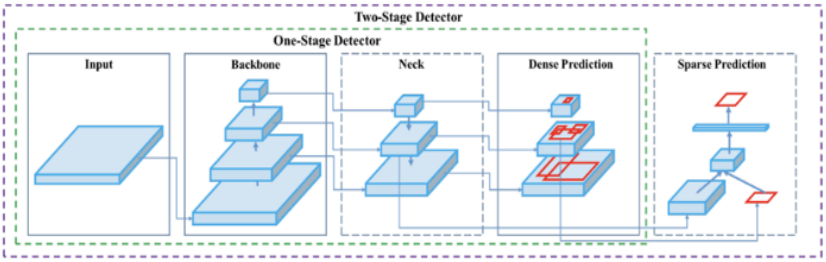
2. Research results

In this study, the recognition model of the object detection part uses Scaled YOLOv4. Its architecture is shown in Figure 1. The model can be mainly divided into four parts, namely: 1. Image input (Input) 2. Extraction input Image features (Backbone) 3. Integrate the feature maps of each layer of Backbone (Neck) 4. Send the features integrated by Neck into the head, which is used to predict the outline (bounding box) of the object to be identified in the picture.

This research project establishes an AI instrument identification model by reading the numerical range of the curve nameplate, reading the values of the thermometer and oil level gauge in the oil storage tank, identifying the instrument pointer value and the respirator color as shown in Figure 2, determining the indicator angle of the ABS circuit breaker as shown in Figure 3, and determining the temperature status of the SC fuse capacitor as shown in Figure 4. The AI instrument identification model proactively identifies whether it is abnormal and sends it back to the meter head AI identification dashboard user operation interface. The AI instrument identification model is divided into three parts: the main transformer instrument, ABS circuit breaker, and SC fuse capacitor, according to their area, and the identification method for research and development. To ensure the stability of the power supply, when an abnormal

notification occurs, it will immediately notify the central control center and provide data for a system to analyze.

This research demonstrates the potential of AI image recognition for enhancing inspection robots in secondary substations. Currently, the data source is limited to an inspection robot, which limits data collection and AI effectiveness verification. Moreover, due to the high complexity of the on-site environment, ABS automatic image recognition is still highly challenging.



Source: [1]

Figure 1 Architecture diagram of Scaled YOLOv4

Source: This study

Figure 2 Instrument values of oil level gauge and winding thermometer

Source: This study

Figure 3 The indicator angle of the ABS circuit breaker

Source: This study

Figure 4 The temperature status of the SC fuse capacitor

3. References

[1] A. Bockovskiy, C. Y. Wang, and H. Y. M. Liao, “Yolov4: Optimal Speed and Accuracy of Object Detection,” arXiv:2004.10934v1 [cs.CV], 2020