Research on Diagnostic Method of Hydrophobicity of Antifouling Flash Coating based on UAV Technology

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Abstract

The product of this project consists of UAV, camera device, water spray device and embedded artificial intelligence algorithm module. It adopts split design, the camera device, water spray device, embedded artificial intelligence algorithm microcomputer module can be disassembled, so that the maintenance and replacement of the device is very convenient. The camera device can take images of the drone's front field of vision, the water spray device can adjust the density of water droplets and the length of water spray gun, and the embedded artificial intelligence algorithm module can perform image recognition and classification. Uavs fly a camera device and water spray device for measurement of composite insulator, composite insulator hydrophobic test line in accordance with the standard required by water spray device to spray the composite insulator, composite insulator and then taken by cameras spray after photos, pictures is input into the artificial intelligence algorithm embedded in the module for processing, Then the aging degree results of composite insulators diagnosed by hydrophobicity test pictures are output.

Keywords

Unmanned Aerial Vehicle Technology; Composite Insulator; Flashing.

1. Introduction

Uavs fly a camera device and water spray device for measurement of composite insulator, composite insulator hydrophobic test line in accordance with the standard required by water spray device to spray the composite insulator, composite insulator and then taken by cameras spray after photos, pictures input to the depth of the embedded learning algorithm module for processing, Then the aging degree results of composite insulators diagnosed by hydrophobicity test pictures are output.

1.1. Water Spray Grading Method

Water-spraying classification method divides insulator surface hydrophobicity into HC1-HC7 seven levels, HC1 level corresponds to hydrophobicity state, and HC7 corresponds to fully hydrophilic surface. HC value The state of water droplets on the insulator surface.

Grade HC1: only separated water droplets, and the state, size and distribution of most water droplets should be basically consistent with the standard grade HC1 hydrophobicity image; HC2: only separated water droplets, the state, size and distribution of most water droplets should be basically consistent with the standard grade HC2 hydrophobicity image; HC3: Only separated water droplets, water droplets are generally no longer round, and the state, size and distribution of most water droplets should be basically consistent with the standard grade HC3 hydrophobicity image. HC4: at the same time there are separated water beads and water belt, completely wet water belt area is less than 2cm2, the total area of the water belt is less than 90% of the measured area; HC5: some completely wet belt area is greater than 2cm2, the total area of the belt is less than 90% of the measured area; HC6: completely wet total area is more than

90%, there are still a few dry areas (or spots, zones); HC7: The whole area under test forms a continuous film of water.

1.2. Positioning of Composite Insulator Skirt based on YoloV3-TINY

The positioning detection algorithm based on YoloV3-TINY is an important means and method for intelligent sensing to detect composite insulator skirt. The detection accuracy of the object detection framework based on deep learning on each object detection dataset keeps improving, but the detection speed is far from meeting the real-time requirements. The YOLO(You Only Look Once) model is proposed to solve the real-time problem of the existing object detection framework based on deep learning. For each candidate region, the target detection model of RCNN series needs to go through a subnetwork of classification and coordinate regression to predict the category and coordinate of the candidate region. This is obviously very time consuming when there are many candidate regions. YOLO gives up the RCNN series, which uses two separate sub-networks to do classification and coordinate regression respectively, and directly uses the network to perform regression on the category and coordinate position of the target. It is not necessary to candidate regions on the image and classify each region, so as to realize the prediction of the possible position of every object.

Compared with the target detection framework based on region extraction and classifier, YOLO describes the task of target detection as a regression problem of the position and size of the target rectangular box. In this way, the results can be predicted directly by only one forward propagation of the network. Compared with the method based on region extraction, the training and testing process is simple, and the real-time effect can be achieved. Yolov3-tiny algorithm is a lightweight target detection network based on YOLOv3 algorithm. There are 24 network layers and 2 YOLO layers, respectively YOLO16 (size 13×13) and YOLO23 (size 26×26). It has fewer network layers and fewer parameters, and can guarantee real-time operation on common embedded platforms. Figure 3-4 shows the process of YOLO target detection.

For an input image, YOLO divides it into an S×S grid, and if the center of an object falls into the grid, the grid is responsible for predicting the object. Each grid predicts B rectangles and their corresponding confidence levels. These confidence levels reflect the likelihood that there is an object inside the rectangle. If no object falls in the grid, then the confidence of the rectangle predicted by the grid should be equal to zero. For a grid with objects falling into it, the model expects the confidence of the rectangular box predicted by the grid to be equal to the intersection over union (IoU) between the predicted rectangular box and the real target box.

Each rectangle actually contains five predictors: and confidence. The (x,y) coordinate represents the offset of the center of the rectangle box from the upper left corner of the grid where it is located, and (w,h) represents the predicted size of the rectangle box. Confidence represents the IoU between the predicted rectangular box and the actual rectangular box.

Each rectangle also predicts K conditional probability distributions, which are based on the conditional probability that the target exists in the current prediction rectangle. To test, you simply multiply the confidence of the rectangle by the conditional probability distribution to find the predicted probability of each category of objects in the rectangle.

YOLO's feedforward model is modified from GoogleNet. After extracting the local features of the image through the previous convolution operation, the global information of the image is finally obtained through the full convolution layer, and these global information is input into the prediction layer to obtain the final prediction result.

In the above figure, for an input test image, on the one hand, the network outputs the predicted rectangular box and its confidence, in which the rectangle box with higher confidence has thicker lines in the figure, and on the other hand, it predicts the conditional probability distribution corresponding to each grid. Finally, the final prediction result is obtained by combining the two.

1.3. Convolutional Neural Network

Deep learning methods are adopted to learn more useful features by building machine learning models with many hidden layers and massive training data, so as to ultimately improve the accuracy of classification or prediction. Therefore, the key of deep learning is the construction of network topology structure. Network topology structure is a multi-layer network composed of input layer, hidden layer (multi-layer) and output layer. Only nodes of neighboring layers are connected, and nodes of the same layer and cross-layer are not connected. Deep learning combines low-level features to form more abstract high-level representation attribute categories or features to discover the distributed feature representation of data. Therefore, network topology directly affects feature dimension and feature learning ability.

In essence, convolutional neural network can be understood as a black-box mapping between input and output, which can establish a relatively accurate mapping relationship by learning a large number of data samples, without the need for manual determination of feature parameters in traditional pattern recognition. In the initialization stage of convolutional neural network training, all the connection weights need to be randomly initialized, so as to ensure that in the training process, the model training will not fail because the weight in the network is too large. In the process of model training, the convolutional neural network is trained by the backpropagation algorithm used to train the feedforward network. The backpropagation algorithm mainly includes forward calculation and backward update.

Since the feature extraction and pattern classification of deep learning are carried out at the same time and generated in training, images with different hydrophobicity levels are input to the network as training sets to complete the feature extraction and classification of images. The hydrophobicity level image to be identified is input into the trained network topology, and the hydrophobicity diagnosis of composite insulator and RTV antifouling flash coating based on deep learning can be realized.

2. Key Points and Difficulties

2.1. Development of Automatic Water Spray Device for UAV

It is necessary to design water sprinklers of reasonable weight and size, so that they can be carried by UAVs and accomplish the task of spraying water.

2.2. Automatic Identification and Positioning of Composite Insulator Skirt under Complex Background

The difficulty in target detection, recognition and positioning of composite insulator umbrella skirt under complex background is the adaptive segmentation of target and background, which is embodied in the following aspects: it is difficult to segment the photographed visible light pictures due to the different objects detected in the visible light images and the inconsistent parameters of different shooting angles and distances. In addition, the color and brightness of the equipment itself are not static (aging, light factor), which also causes the difficulty of optical image segmentation.

2.3. Hydrophobicity Diagnosis of Composite Insulator and RTV Antifouling Flash Coatings based on Deep Learning

1) Collection of HC1-HC7 hydrophobicity samples: It requires professional experience and complicated work to obtain sample data through reasonable laboratory aging experiment methods and collect sample data that have been out of operation in the field;

2) Selection of deep learning algorithms and model optimization: The deep learning method system includes a variety of algorithm models, including target classification, target recognition, predictive regression and other application scenarios. For this project, in-depth research is

needed on how to select a reasonable deep learning method model and optimize it, and how to further optimize the deep learning method model.

3. Conclusion

This project mainly studies the live detection technology and practical application of composite insulator and RTV antifouling flash coating hydrophobicity based on UAV technology. Automatic sprinkler systems using uavs to water transmission line composite insulators, adopt the method of deep learning to classification of water droplets form on the insulator, establishes a set of transmission line composite insulators hydrophobic charged testing implementation and judgment method, can greatly reduce the inspection personnel's workload and reduce leakage inspection by mistake. Deep learning model combines feature extraction and classifier to form a framework, and uses a large amount of data to learn features, so as to better represent the features of data, freeing the link of manual feature design. At the same time, the deep learning algorithm has strong robustness and can effectively solve the problems of complex aerial photography background of transmission lines, which is of great significance to improve the inspection efficiency of transmission lines and improve the intelligence of power system.

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