

Competition Title: Competition on meter recognition algorithm with power inspection robot
Industrial Applications ■Intelligent Manufacturing □Intelligent Driving □Intelligent Life □Smart
Medicine □Smart City

Background description

[overall background]

The development of science and technology brings about the change of people's life style and the unceasing promotion of demand, which also stimulates the progress of science and technology in reverse direction. In recent years, in order to adapt to the various needs of human life and work, the robot industry has gradually stepped onto the stage of the world. Because of its accuracy and reliability in the work, high efficiency, so that people can be liberated from heavy work, so it has been widely recognized and promoted. Although China's robotics industry started late, it is booming and has already taken the lead in the world. The current classification of robots can be divided into special service robots and industrial robots. Industrial robots are used for heavy and dangerous production, and the general name of the robot used for non manufacturing services by special service robots can be further divided into two types of civil and military services. Civil robots are used in families, hospitals and industrial services. Military robots are mainly used to replace people with high risk factors, such as demining, bomb dismantling and so on.

Inspection robot is one of the civil special service robots, which can be automatically inspecting, and can realize the functions of equipment status detection, state evaluation, fault warning and operation maintenance in the monitoring area, instead of artificial completion of environment information, equipment state information collection, security linkage and call platform. In the substation, the converter station, the cable tunnel and the overhead transmission lines, and other aspects of the outstanding performance of surpassing human inspection, can save human resources, while the risk is smaller.

[Business background]

The substation inspection robot is mainly used in the automatic inspection of the substation. There are many kinds of instruments in the substation. There are many kinds of instruments in the substation. The manual detection is time-consuming and laborious. The inspection robot can achieve the goal of unattended. It can automatically collect the picture of the instrument in the scene and read the data of each instrument, carry out intelligent evaluation, and transmit the data to the background for comprehensive treatment. Therefore, it is important to improve the operation and maintenance ability of the substation, change the way of operation and maintenance, establish the information environment of multi-sensor fusion based on the intelligent operation and maintenance robot, and quantify the operating environment, which is important to improve the information degree and management ability of the integrated operation and maintenance system.

Project description

[Problem description]

One of the main tasks of the substation inspection robot is to accurately identify the status of each device in the substation. The main problems facing the identification can be divided into two, location and recognition. Location is to locate the device accurately from the captured image, and the recognition is to read the status information of the device that is located. According to the type

of equipment, it can be divided into pointer type, OCR type, oil level type, knife gate type, indicating type, respirator type and so on. This item focuses on the reading recognition of the pointer type and OCR type equipment in the table meter recognition, and provides a data set for the participants' research and development algorithms and the judges to adopt in evaluating the performance of the algorithm.

Since the location of each device in the substation is fixed, in practical inspection, taking pictures (shooting) is usually done at fixed points, with fixed shooting angles, magnification and exposure parameters. These are the best shooting parameters selected by manual intervention during the first modeling. The pictures obtained are clear and the device is located in the middle of the picture. Although the robot in the following inspection process is still photographed according to these fixed parameters, it is difficult to avoid a small error during the operation of the robot, and the device may be displaced in the photos taken. And because of weather and other natural reasons, there is a certain degree of photographic effect, such as the lack of exposure or excessive exposure to the change of light conditions at the same time, and the blurred visibility caused by rain and snow and heavy fog.

The dataset provided by the item is the photos taken by a robot in such an environment, including a training set, a calibration set, a validation set, and a test set. And the next three data sets are directly related to the final algorithm test competition.

Training set: it provide the image data which have been classified and annotated, including more than 20 thousand images in different angles of view of more than 20 types of equipment, for the participants to design algorithm and train.

Calibration set: it contains 100 devices (the same type of different angle scale also as an independent device), each device includes 1 picture. They are clear images captured by manual intervention when the robot is built, and the device is located in the center of the picture. According to the invariable scale of the device, the set allows participants to label the necessary prior knowledge of these images, and enhance the reliability of the algorithm. For example, for pointer type equipment, the position, pointer and scale of the picture are calibrated, and the pointer can be read directly after the pointer is identified.

Validation set: the set is the same as the calibration set. It is the picture of each device that the robot has taken during a period of time when the robot is built, and each device includes 4 pictures to evaluate the performance of the algorithm. Compared with the calibration set, there may be slight deviations due to factors such as weather and machine operation errors. This is closer to the data in practical application, so that the algorithm has better generalization ability.

Test set: the set of devices is the same as the shooting mode and the validation set, but the time and the natural conditions of the weather are different, which means that there are some differences between the pictures and the verifying images, and the readings are mostly changed. Each device contains 3 images, which are used to evaluate the algorithm performance of each team when competing.

The training set, calibration set and validation set are open to the participants and can be downloaded at the specified address. The test set is not open to the participants, and is used only by the judges to evaluate the performance of the algorithm submitted by the participants.

[User expectations]

It can stabilized recognize the images captured in various weather conditions and accurately

recognize the readings of target devices in the images.

[Expected economic effect]

Because the inspection robot's outstanding performance in automatic inspection in substation, tunnel engineering and other scenes has been widely recognized and used. It has also been gradually extended to more applications, and market demand is gradually increasing.

[Technical path]

The main algorithm of this problem is the target location and target recognition, in which the target location is to locate the device based on the pictures taken, and the target recognition is to read the device status on the basis of the successful positioning. The target position uses a given calibration set as a template to determine the location of the target in the picture and select its frame to prepare for target recognition. Target recognition is carried out on the basis of location. The equipment status in the area is identified according to the equipment area obtained by the target location. For different types of equipment, the identification methods are not necessarily the same. It is advisable to design appropriate recognition algorithms combined with the characteristics of each device. Of course, the above is only for reference.

[Technical indicators]

For each type of instrument, the algorithm requires the following:

Pointer type instrument: the input is the picture of various instruments with the pointer, which requires the algorithm to identify the pointer accurately and read the dial according to the dial scale, and finally output the correct reading of the instrument. Different instruments, such as pressure gauges, oil level meters, hydraulic meters and so on, are also different in shape and pointers, as shown in Figure 1 on the right. And the different manufacturers will also cause different aspects of the shape of the instrument, the algorithm should have a strong generalization ability, adapt to different types of pointer instrument, and can ensure the accuracy. The output sample is shown in Figure 1 left. The blue rectangle is the result of the dial of the dial, the pink is the position of the marked pointer, the reading is the final reading result.



Figure 1 Example diagram of pointer type equipment

OCR type instrument: the input is all kinds of digital display device pictures, which require the algorithm to locate the digital area and accurately identify the digital information (including the decimal point). As shown in Figure 2, some figures in the right picture show that the area is on the pointer instrument, so it is necessary to find the digital display area accurately and then identify it. For LED and other display equipment, because it is in the open environment, the light conditions are greatly affected, the stronger the light will be more difficult

to distinguish the content of the display, the more difficult to identify, how to identify the situation, it is a problem to be considered. After locating the display area, each digit can be segmented and classified as a single sample by classification algorithm. The final output sample is shown in Figure 2 in the left figure.



Figure 2 Example diagram of OCR type equipment

[Submission standard]

The data set consists of 100 different devices, which are taken from the initial station (calibration set) or the actual operation of the robot (validation set and test set). It includes 90 pointer devices and 10 OCR devices. The demarcation set and validation set (example program containing the output and recognition rate of the result) can be downloaded here: (link <https://pan.baidu.com/s/1mxvV4xOle8FPRudxBHMQg> password: ZHmf). Based on these data, participants design procedures and optimization algorithms, and submit executable programs and related configuration information and model data at the time of entry. The data set can be downloaded from the Internet today. If you have any questions, please contact the topic person (13062501626).

The date of the competition is arranged according to the Organizing Committee of the competition (13062501626), and the contestants will take their own procedures to compete.

The running environment of the program is WIN10, the mainstream desktop configuration. The input of the program is the file directory of the test set data (the structure of the internal directory and the naming of the file are the same as the training set). The program is required to be identified by one by one device and output sample output (string form) and result image (string form) for each device reference technical index (string form) for results verification. The program is required to identify the equipment by one by one, and the output sample output (string form) and the result image (for the result verification and the statistical recognition rate) are output for each device reference technical index, in which the reading results are output to a text file line by line, and the result is output to a certain directory (Case program).

The competition ranking is judged by the ranking of the rate of recognition. The result of recognition is based on the text file that holds the result. The reading accuracy of the pointer meter is required to be within the 5% range of the correct reading, otherwise the error can be identified; the reading of the OCR instrument needs a few words (including the decimal point), otherwise the error can be identified. The total processing time does not exceed 5 minutes (a total of 100 devices x 3 = 300 sheets), giving 2 percentage points of Efficiency Award. Therefore, the final recognition

rate = correctly identify the number of images / total number of images (300) - Efficiency Award.

[Task list]

Read this document carefully and download the data set.

Design procedures and algorithms and participate in competition tests on time.

Reference information

[Reference tool]

OpenCV, Visual Studio

[Reference] Digital image processing, by Gonzales.

[Data interface]

Recognition algorithm reference interface:

Std:: String recognize (const char *img_path, const char *cfg_path, const char *out_prefix)

The participant is required to implement this interface, in which img_path is the input path of the picture to be identified; the cfg_path is the folder path of the prior knowledge that is required to identify the template and the like; the out_prefix is stored in the output sample of the result picture; the return value is a string of recognition results.