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A Robust and Automatic Recognition System of Analog Instruments in Power System by Using Computer Vision

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***Abstract*—It is a puzzling issue found in the field of Supervisory Control and Data Acquisition (SCADA) to read automatically the indication of analog measuring instruments, which collects many states of power system equipment. To address this problem, a lot of approaches based on computer vision have been proposed for the automatic reading of the analog measuring instruments indication. However, most the proposed systems are sensitive to brightness. Moreover, since the camera angle must be vertical, the robustness of the approaches cannot meet application requirements. In this paper, the proposed recognition system uses a novel automatic reading approach, which can automatically read the indication of analog measuring instruments at various brightness levels and camera angles. It is an integrated application of Multi-Scale Retinex with color restoration at different brightness levels, Perspective Transform to get the front view of image taken from arbitrary camera angle, and Hough Transform to determine the pointer position. The test results verify the good robustness of the recognition system to the brightness and camera angle.**

***Keywords*—Analog instrument, automatic recognition system, computer vision, Multi-Scale Retinex with color restoration, Perspective Transform, Hough Transform.**

I. INTRODUCTION

Data acquisition is one of the most important technologies of big data, and the database of Supervisory Control and Data Acquisition(SCADA) need to store various data, including structured data and unstructured data. Up to now, however, there is almost no data of analog measuring instruments in most SCADA databases, because it is unable to read the indication of analog measuring instruments automatically. However, some data of analog measuring instruments (for example oil-pressure meter of transformer) are essential index for power system operation. Today, the indication of analog measuring instrument is usually artificially read and input to the database, which is obviously inconvenient, time-consuming and inefficient. Especially, due to unexpected weather condition, some power system equipment has great potential to be disturbed. Therefore, it is urgent to collect the data of power system equipment state. However, the indication of the analog instrument without digital interface, which is about power system equipment health state, is artificially read. Because of the terrible weather, system operators cannot acquire the data of power system equipment health state on time. So the reliability of power system equipment cannot be known, the reliability of the power system also cannot be ensured.

Computer vision technology plays a very important role in many fields, for example in the field of calibration of measuring instruments nowadays. It is an accurate, repeatable and time-saving way [1–3]. Without doubt, these computer vision technologies can also be used in power system. For example, in order to achieve the goal of operating an unattended substation, the substation inspection robot uses computer vision technologies as a functioning part of its brain to recognize the reading of analog measuring instruments automatically.

In the past few years, many researchers have proposed some automatic recognition system based on computer vision techniques. Mostly, the automatic recognition systems are used to calibrate analog measuring instruments [1-5].

Belan et al. developed segmentation-free approaches of computer vision to automatically calibrate analog measuring instruments, which do not have digital built-in communication interface. Radial projections and Bresenham algorithm are used to recognize the pointer position of analog measuring instruments, so that the reading of analog instruments can be determined automatically [1].

Algeria et al. developed an automatic calibration system, and it can automatically read the indication of analog measuring instruments, which do not have built-in digital communication interface. The method on image process and analysis algorithm and computer vision algorithm were used to automatically read the indication of analog measuring instruments [2-3].

Hemming et al. proposed equipment based on computer vision technology to calibrate dial indicators, which is developed at the Center for Metrology and Accreditation in Finland. This equipment focuses on the calculation of measurement uncertainty [4]. They also proposed an updating of developed equipment to calibrate micrometers [5].

Yang et al. developed an automatic recognition method of