

Automation in Testing Process of Control Panels

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Abstract: The paper proposes the testing method of control panels which automates the tedious manual checking method of panels. It gives implementation of testing system for control panel of medium voltage switchgear using MATLAB and PIC. The system checks 'Normally closed' and 'Normally open' status of pin pairs of control panel mentioned in the wiring diagram. The input to MATLAB is wiring or ladder diagram which is in the jpeg format. This jpeg image of ladder diagram is used for getting the information, like which pin pairs are 'NO' which are 'NC' and the components connected between those pins. After finding such information from the jpeg image, it can be saved in text file for further reference. The external hardware is needed for actual connection to socket of control panel and it is also used to sense the status of pins. The necessary information is transferred to external hardware by serial communication which is controlled by MATLAB. This external hardware can be any microcontroller. Here we have preferred PIC family. The PIC shows the result on LCD display connected to it.

Keywords—checking, control panel, MATLAB, PIC controller, NO-NC status, socket.

I. INTRODUCTION

A substation is a part of an electrical generation, transmission, and distribution system. Each and every electrical sub-station has got switchgear and one of the basic functions of switchgear is protection, which is interruption of short-circuit and overload fault currents while maintaining service to unaffected circuits. Switchgear also provides isolation of circuits from power supplies. The controlling system of switchgear is nothing but control panel. Thus switchgear and its control panel are very important part of the electricity transfer and distribution system, and the control cabinet is actually low voltage system and takes different supply voltage from another feeder or Battery. This supply voltage is called as auxiliary supply voltages while the connector which gives this supply is called as auxiliary connector. The control panel has mechanism which supports opening of breaker when any faults occurred like short circuit current, over voltage or over current. It includes different limit switches, different relay coils, tripping coil, closing coil, motor also different contacts which are interrelated to support proper functioning. The internal functions and additional facility (which includes different safety indicator and additional safety mechanism) changes from switchgear to switchgear. So we have control panel whose internal structural component varies along with different pin socket, different supply voltage along with separate wiring diagram. Testing of the system is the one of the important task in the manufacturing of any electronics and electrical system. Testing checks manufacturing defects at early stages and assures us proper functioning of the system and which also gives more reliable and safe product to end user. The each and every electrical system made by us should be properly check and test before giving to the user. The whole functional test should perform in order to give maximum accuracy, which also assures safety and proper functioning. Manual checking has number of drawbacks like increase in time for delivery of product, decrease in efficiency; also it results in higher cost of the system. At the same time, the manual checking of any electrical system is quite difficult task if checking is to be done number of times, then it also increases the chances of wrong checking, which can be hazardous. Additionally it is not feasible to employ people to act as full time checker for the electrical system.

At last when person has to check control cabinet, in first step he has to observe wiring diagram, it includes pin number and also has to check contact details like whether it is 'NO' or 'NC'. And then he will perform continuity test to check its NO & NC contacts. Along with this he has to check whether motor is short or not, in the control cabinet. The manual checking of this control box increases human efforts and takes more than enough time to connect continuity tester to pair of pin. Human also takes time to decode the wiring diagram. This ultimately increases delivery time and also reduces overall efficiency of the manufacturing plant. Control panel uses various sockets. There are two types of sockets - Standard socket and Non standard socket. We use two softwares to test these sockets. LabVIEW and MATLAB software are used to test non standard socket and only LabVIEW is used to test standard socket. The proposed testing system consists of hardware PIC, LCD along with PC installed with above mentioned softwares. The central controlling element is LabVIEW because it has very good user interface and it can call MATLAB active server by MATLAB script

which is necessary to scan wiring diagram in case of non standard socket. The non standard socket varies in various terms like its pin number, control voltage, component placement and so on. This variation in the control panel requires decoding of wiring diagram, which is done by using image processing toolbox of MATLAB. LabVIEW gives path of input file to MATLAB active server for scanning purpose. During scanning process of wiring diagram, MATLAB detects various components and connection between different pin pairs from equivalent symbols mentioned in wiring diagram. Later necessary information like pin number is transferred to PIC via serial communication by MATLAB. The PIC then checks actual status of control panel and displays output on LCD display.

The standard socket on control panel is tested using LabVIEW and DAQ hardware. The standard socket is 64 pins socket with universal wiring diagram irrespective of its manufacturer. The 5V DC signal is written on the group of channels which are connected to pins of standard socket. Then signals are obtained from predefined channels. In case of normally closed contact testing, if there is well connected normally closed contact, system will get 5V DC signal and in faulty case no such signal will be available. Exactly opposite case occurs for normally open contact testing.

II. ALGORITHM

The MATLAB processing algorithm is divided in to nine steps as follows and which may be implemented in MATLAB2010a.

1.1 Image conversion

The first step is transfer of image to MATLAB root directory. If image is RGB image it is converted first to gray scale image, which is further converted to binary image based on threshold calculated from gray scale image. Then image is resized to fixed dimension.

1.2 Crop image

The wiring diagram which is in jpeg (RGB) format contains fixed outer box which contains customer name , designer name and other design number which is to be separated from main image. The rectangular outer image part is extracted in this step, and its dimension find out by image histogram. The higher three lines in histogram gives area of outer box. [1][2]

1.3 Segmentation

The binary image is now segmented into different regions. This segmentation is done on the basis of histogram calculated; also lines in the image are detected. Both parameter lines and histogram are used for segmentation. The central area which has connection lines and contact representation is separated from image, hence forth it is called as connection area. [1][3]

1.4 Character localization

Characters and number are then separated from segmented regions which are then transferred to OCR (optical character recognition) one by one. [4][3]

1.5 Line Detection

Lines are detected in the image by hough transform, the longest line is found out by from that group of lines,[1] which are very necessary to detect which switch are responsible for operation of pin pair e.g. Test / service indicator switch and motor cut off switch.

1.6 Optical character recognition (OCR)

There are many methods for character recognition. The most commonly used methods are [1][5]

1. Character recognition by using neural network

2. Optical character recognition

The OCR technique is used in order to recognize different digits. This approach is based on pattern recognition principles. The system of OCR engine is based on the template matching algorithm. The shapes identified as possible characters in the previous steps of the process are binaries and scaled to match the size of the templates in database. Each shape is compared with all the characters in the database by template matching and best match among them is selected. The commonly used techniques for the optical character recognition are

1) Distance measurement

2) Template matching using correlation

3) Template using inner product correlation [1][5]. Here we are using OCR by template matching using correlation technique. Figure 1 shows algorithm in detail.

1.7 Symbol Detection

The symbol detection is an important step .It detects pin pair in which special components like motor, tripping and closing coil are connected. This are detected from the binary image based on peculiar properties of their symbols. For motor's symbol roundness of each closed symbol is found out and later it is compared with threshold value given to it. This pin pairs are only checked for short circuit.

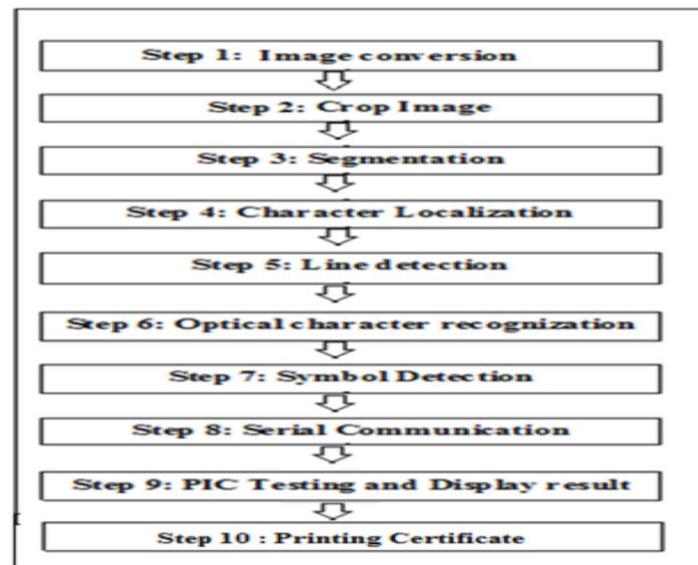


Figure 1: Algorithm

1.8 Serial Communication

The serial communication is used to pass string containing pin numbers and their status to the PIC by MATLAB. The pause of 2 seconds is inserted between two ASCII characters transferred by MATLAB so that PIC can easily store that file into its EPROM. The string has two pin number first one is left side input pin number and second one is right side output pin of the connection area. This two values are separated by ‘;’.

1.9 Checking by PIC

The PIC then reads all characters from the EPROM memory. The two bytes of the string are considered input pins and on that pin write operation is performed by PIC, at the same time read operation is performed on pin number specified by third and fourth byte, if it is read ‘1’ it means both pins are short and opposite to it, if it reads ‘0’ it means both pins are open. This results i.e. ‘NO’ and ‘NC’ is displayed on LCD. These results are also

transferred to MATLAB by same serial communication.

1.10 Printing of Tested/OK certificate

Finally information from scanned image is compared with information obtained from PIC, (i.e. whether actual pin pair is showing desired contact status or not is checked by MATLAB) if both are same Tested/ OK certificate is printed by MATLAB.

III. CONCLUSIONS

In this paper, the checking system for control panel using MATLAB program and PIC family is presented. The MATLAB program uses series of image processing techniques for identifying pin number, NO -NC status and other necessary details from the wiring diagram. The system is implemented in MATLAB and its performance is tested on images of wiring diagram consisting different pin numbers. The results shows that the system robustly detects and recognizes the pin contacts and can be implemented in the manufacturing plant and automate the tedious work to increase efficiency of plant. Time required for testing control panels is reduced much and saves labour and may decrease time to market. Automating testing process avoids human interference reducing the possibility of occurrence of any accident due to wrong wiring.

REFERENCES

- [1] V. Kasmat, and S. Ganesan, “An efficient implementation of the Hough transform for detecting vehicle license plates using DSP’s,” *IEEE International Conference on Real-Time Technology and Application Symposium, Chicago, USA, pp. 58-59, 2005.*
- [2] Y. Zheng, H. Li, D. Doermann, “Machine printed text and handwriting identification in noisy document Images,” *IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 26(3), 2004, pp. 337-353.*
- [3] R. Kandan, Nirup Kumar Reddy, K. R. Arvind, and A. G. Ramakrishnan, “A robust two level classification algorithm for text localization in documents,” *Proc. 3rd International Conference on Advances in Visual Computing (ISVC’07), Vol. 2. Springer-Verlag, Berlin, Heidelberg, 2007, pp. 96-105*
- [4] *Character Recognition Systems, A Guide for Students and Practitioners*, John Wiley & Sons Inc., Hoboken, New Jersey, 2007
- [5] Muhammad Tahir Qadri, Muhammad Asif “Automatic number plate recognition system for vehicle identification using optical character recognition”, *International Conference on Education Technology and Computer, pp. 335-338, 2009.*