Automation of Surface Resistivity Measurement for 2m X 2m RPC Electrodes and Further improvements

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Introduction

India Based **N**eutrino **O**bservatory (INO) is planning to use ~30,000 Resistive Plate Chamber (RPC) detectors of size 2m × 2m. Each resistive plate chamber consists of two charge pickup strip panels. Both glass electrodes of the detector have one outer side thin and uniform coating of custom made paint of Nerolac Co. having very low conductance value. To provide the uniform electric field throughout these electrodes surface by applying high voltage, it is necessary that the surface resistivity must be uniform [1]. Therefore, it is required to measure the uniformity in resistivity of these RPC electrodes. But it will be very difficult to measure the resistivity manually with accuracy. For this purpose it required an automated scheme which can measure the resistivity of whole surface (2×2 m^2), fast and accurately of about 60000 such plates. We have developed an automated device of size 50×50 cm as shown in Fig. 1. In this prototype automation unit three double binding DC motors are used and controlled by two personal computers. This prototype works satisfactorily. Working and design of this unit has been described in detail in Ref. [1]. Now we are scaling up this unit of the dimension 2.25×2.25m^2 to cover 2x2m electrodes comfortably as shown in Fig. 2.

Design and Limitations

Scaling up of the initial prototype automation unit up to full scale has been done. Same motors and other components are used except aluminum frame and belts. This assembly is still using three DC motors for each axis. But due to long length of x-axis one motor at one end is not enough to move the aluminum beam parallel to the fixed edge of same axis. Otherwise rest performance is satisfactory. Currently used motor's RPM is low that's why the unit is taking long time to complete the measurement of an electrode.

Experimental Details

1) Surface Resistivity Measurement

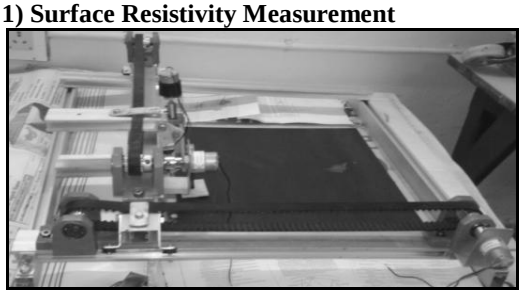

Fig. 1: Prototype of automatic system for Surface resistivity and calibration measurements of 50×50cm^2 RPC detector and its electrodes.

The surface resistivity is measured using multimeter CHY 48R multi-logger, which has capability to store data and send it to computer. The jig moves on aluminum frame of 2×2 m. The jig freely moves along desired axis with the help of DC Motor controller kit provided by Motor Bee PC control Ltd. The single kit can operate two motors in bi-direction and four motors in single direction. Since our work is to operate all four motors in bidirectional way. Therefore it not possible from single computer to operate all four motors. Initially two computers are used to operate all motors. But currently Motor Bee Company has provided "**B**eehive **M**ulti-**B**oard **C**ontrol **S**ystems using a **PC**" through which one can operate all motors with single PC. This Beehive allows any number of same Motor Bee kit and mixtures of different Kits to be connected to same PC at same time.

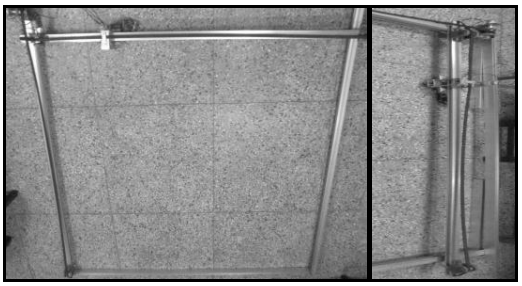

Fig. 2: Prototype of automatic system for Surface resistivity and calibration measurements of 2.25×2.25m^2 RPC detector and its electrodes.

The company has provided DLL (**D**ynamic **L**ink **L**ibrary) along with its kit, so that it is easy to write our own programs to control every step of motors and then it will run according to the written instructions. It will measure the surface resistivity of the complete glass electrode plates.

Movement of the motors

There is one motor named as M-1 which moves along X-axis, with the help of belt. Second motor named as M-2 moves along Z-axis and remaining two motors named as M-3 & M-4 move the aluminium frame with the help of belt along Y-axis. M-1 & M-2 cannot move simultaneously but M-3 & M-4 move simultaneously. Initially taking the help of motors M-1, M-3 &M-4, jig is kept at an appropriate place from where conductive coating starts on RPC electrode; second motor M-2 goes down in Z-axis direction, touches the plate and stops there for a few second. Multimeter takes that reading and saves it in memory. This motor will return back to its original position. Then motor M-1 goes one step further, (of the size jig) along the X-axis. Continuously following the above procedure step by step it reaches the last position along X-axis. The remaining two motors M-3&M-4 attached at two corners of one side do the small increment in length of Y-axis. Since the length of the rod is more than two meters it requires two motors for the increment in Y-axis. Otherwise it will tilt at one end. In this way the resistivity of the whole surface is measured by following the above steps one by one.

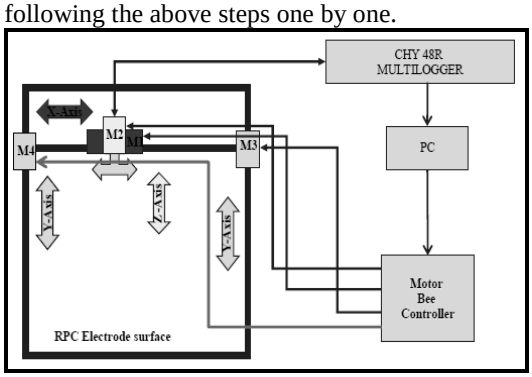

Fig. 3: Block diagram of motor control and measurement process.

Data Acquisition (DAQ) System

Figure 3 shows a CHY 48R Multi-logger which is an advance version of digital multimeter and has capability to store all the data taken during the complete measurement in it. This device displays the data on personal computer, which will be further displayed in the 2D scattered plot automatically in the computer as a final result.

2) RPC Detector Calibration

In addition, we are also planning to calibrate the detector efficiency around the detector's surface with the help of known radioactive source. Under this process, jig will be replaced by a known radioactive source such as ^{137}Cs or ^{60}Co. X-axis motor will move and stop for a minute at each X- and Y-axes crossing and at that moment radioactive source will come close to the crossing with the help of Z-axis motor and wait there for a minute. During this time period data will be taken for each crossing and for the whole surface of the RPC detector and the 2D scatter plot will be drawn to see the change in efficiency of the detector. We will take data for each crossing for a constant time period.

Summary and Outlook

This method is used for the measurement of surface resistivity of electrodes in a short span of time automatically with high accuracy. It is suitable for large scale and fast measurements. Movement of motors in present system is with the help of belts that are long and expensive. We are working on making automatic system smart and more effective as shown in Fig. 4 with the use of minimum number of motors.

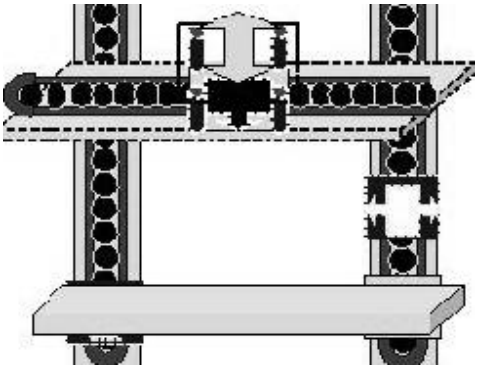

Fig. 4: Advanced Model of automatic system.

Acknowledgments

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Reference

[1] S. Shree et al., DAE NP Proc. **59**, 854 (2014); M. K. Singh et., (Oral) IWAD & 14th RD51 Collaboration Meeting, Oct. 27-31, (2014).