

Automation for Measuring the Surface Resistivity of RPC by Arduino Motor Shield

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1. Introduction

India Based Neutrino Observatory (INO) is planning to use ~30,000 Resistive Plate Chamber (RPC) detectors of size 2m x 2m. Each resistive plate chamber is made up of glass or Bakelite whose resistance is of the order $10^{12} \Omega/\text{cm}^2$, and two pick-up panels. Both glass electrodes of the detector have one side (outer) painted with thin and uniform coating of graphite paint. This provides the resistivity of range 100 - 300 k Ω per square. This range of resistivity provides distribution of voltage over the surface of glass electrodes. Uniform coating will provide uniform electric field inside the glass plate chamber and high resistivity value will help in confining the induced charge on the surface. It is one of the necessary criteria for good RPC detector that the coating of graphite paint should be uniform. Therefore it is required to measure the resistivity for the verification of uniformity. Last few years we have been focusing our efforts in this direction. In this connection, we made sequential improvement from the previous work. The present system is cost effective, automatically recording measurement in the computer, fast and accurate. Earlier MOTOR BEE ver. 5.0 microcontroller was used which was an imported and costly material. After massive search in the local market Arduino microcontroller was discovered, which controls the movement of all motors and it also saves the value of resistivity in the computer automatically.

2. Experimental Details

Arduino is a microcontroller board which is operated through embedded coding in language C on Arduino IDE software as a platform where coding has to be compiled and uploaded to the board. It required four motors for the movement of jig – a device that measure the surface resistivity per square, on the whole surface as shown in Fig. 1 (top). These motors are controlled by using motor shield that is placed over microcontroller board. Motor shield can control four bidirectional DC motors. Embedded - C

coding has been done successfully to control all these motors via motor shield to measure the resistance of RPC electrodes. The actual photograph of the automatic scanning system is shown in Fig. 1 (bottom).

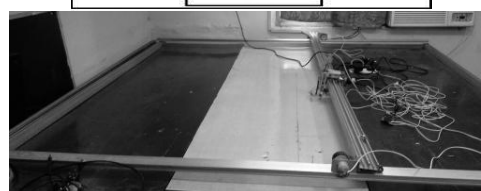
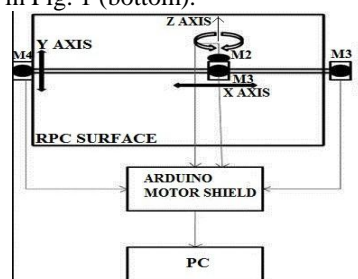


Fig. 1: (Top) Block diagram of automatic scanning system (ASS) and (Bot.) Photograph of the ASS for 2m x 2m RPC detector.

a. Controlling of Motors

All four DC motors namely M1, M2, M3 and M4 are controlled by L293D ARDUINO Motor Shield which is mounted over Arduino UNO Microcontroller. Motion of the jig i.e., up and downwards direction (along z-axis) is controlled by using motor M2. Motor M1 moves the jig along the x-axis so that jig can measure the resistance of next position of the RPC electrode. After the jig completes the one line of surface resistance measurement along the x-axis, motor M3 and M4 can move the jig along the direction of y-axis and repeat the same for next line of space, simultaneously. In this manner, it completes the measure of surface resistivity of the whole surface of the electrode. Movement i.e., step size and speed of DC motor is controlled by library named as <AFMotor.h> which is included in the beginning of the program.

b. Measurement of resistivity

Principle of voltage divider is applied for the measurement of resistivity of RPC in which voltage of 5V, supplying from ARDUINO, is divided among two resistances, one is known resistance and the other one is the resistance across the jig, which is using, for probing, the resistance value as shown in the Fig. 2. Coding has been done in order to calculate the voltage across the jig, when it is placed over RPC surface, hence the resistance value can be calculated and resistance data are stored using software named as Cool Term which transfers the data containing resistance values from ARDUINO UNO.

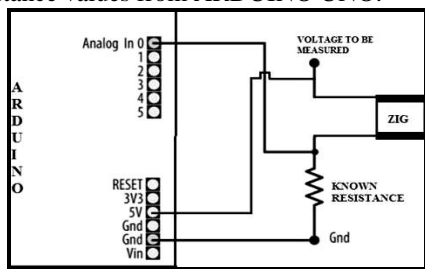


Fig. 2: Circuit diagram for measuring surface resistivity of the RPC detector's electrodes.

c. Advantages of Arduino Motor shield

Arduino Motor Shields are easily available in the local market and very cost effective. Operation of Arduino shield is completely based on embedded C language coding, therefore, coding is independent of the operating platform. Another important feature is that it can be used for a long period of time since program has been uploaded to the Arduino board. It would not get reset until a new set of command is uploaded into it.

3. Results and Discussion

To know the variation in the measurement, we performed a series of experiments. **Set 1:** We measured resistance value of known resistance (221.5kΩ) at least 1000 times using the automatic scanning system. We obtained the resistance value of 221.4±0.5kΩ as shown in Fig. 4a. In this measurement a constant amplitude current of 3 sec. interval was applied to the jig and its movement was fixed. **Set 2:** Similar procedure were applied to get the value of known resistance except the jig which touches the both terminals of resistance 1000 times as it will measure the actual surface resistivity. The obtained value is 220.5±0.4. The fitting parameters are shown in the insets of Fig. 3a & b.

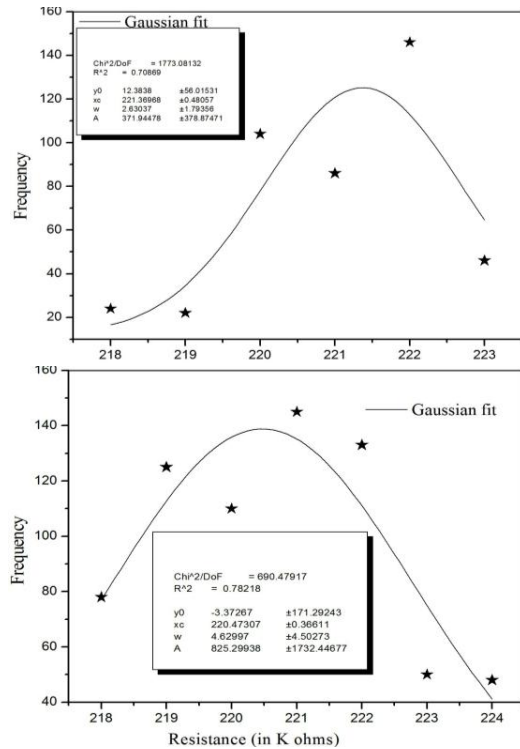


Fig. 4: The data is fitted with the Gaussian function. (a) Known resistance value is measured for the Set 1 procedure and (b) for Set 2 procedure.

4. Summary and Outlook

This method is used for measurement of surface resistivity of RPC detector's electrodes in short span of time with high accuracy. It is suitable for large area and fast measurements. Connection between Arduino motor shield and PC has been done via USB cable. We are working for a better system in which we can control the motor shield using wireless communication so that we can operate the whole setup remotely and comfortably.

Acknowledgement

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References

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