

Virtual Modeling To Calculate Magnetic Susceptibility With Computer Software

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Abstract

A simulation modeling of theory and experiment by the computer software is one of the most efficient techniques of teaching and learning. The manuscript deal with the computer modeling of physics experiment to calculate magnetic susceptibility of FeCl₃ using SCADA(Supervisory Control and Data Acquisition) software. Authors prepared a computer program in visual basic language to create a virtual model of experiment which was identical to the actual experiment. The components used to create this model have been prepared using component wizard utility of SCADA. The tabulation and calculation was placed within the experiment window for scientific performance of experiment. The virtual model of concept of magnetic susceptibility was also created by the author within the simulation program. Authors also studied effectiveness of virtual model with group of students by cunning their performance during the virtual and actual experiments. After this study it is conclude that the students who employ the virtual model can understood the concept of theory and experiments very well..

Keywords: SCADA, Modeling, Simulation, Visual Basic, Software Utility.

1. Introduction

The rapid pace of technological developments and the high cost of scientific equipment, pose different challenges to traditional modes of science education. Innovations in teaching and learning are desirable. In particular, education on practical aspects of science and personnel training can be enhanced through the use of virtual laboratories. Murphy et al (2002) described the development, set-up and application of a virtual twin heat exchanger plant using SCADA[1]. Santos-Martin et al (2012) presents the experience of a problem-based learning approach within the context of teaching wind energy conversion systems for electricity generation at an Electrical and Electronic Master's degree level[2]. Frederico Menine Schaf et al(2009) presents a proposal in

SCADA to integrate mixed-reality remote experiments into virtual learning environments (VLEs) using the concept of interchangeable components, which can represent either real or virtual devices or software in industrial automation systems and included a description of four experiments developed using the proposed environment and concepts[3]. One of the original motivations for research in qualitative physics was the development of intelligent tutoring systems and learning environments for physical domains and complex systems. Forbus et al (1999) describes CyclePad, a fully implemented articulate virtual laboratory that captures a substantial fraction of the knowledge in an introductory thermodynamics textbook and provides explanations of calculations and coaching support for students who are learning the principles of such cycles[4]. In response to the Indian Ministry of Human Resource Development (MHRD) National Mission on Education through Information and Communication Technology (NME-ICT) Initiative, the Virtual and Accessible Laboratories Universalizing Education (VALUE @ Amrita) Virtual Labs Project was initiated to provide laboratory-learning experiences to college and university students across India who may not have access to adequate laboratory facilities or equipment and Virtual Labs Project is providing virtual laboratory experiments that directly support the All India Council for Technical Education (AICTE) and the University Grants Commission (UGC) model curricula for engineering and sciences undergraduate and postgraduate programs[5-6].

2. SCADA

Supervisory control and data acquisition (SCADA) is an industrial control system which is used in several modern industries like energy, manufacturing, power, water transportation, etc. SCADA systems organize multiple

technologies that allows to process, gather and monitor data at the same time to send instructions to those points that transmit data. In today's world, almost anywhere you can observe SCADA systems, whether it's a waste water treatment plant, supermarkets, industries or even in your home. SCADA systems range from simple to large configurations. Most of the SCADA applications use human machine interface (HMI) software that permits users to interact with machines to control the devices. HMI is connected to the motors, valves and many more devices. SCADA software receives the information from programmable logic controllers (PLCs) or remote terminal units (RTUs), which in turn receive their information from the sensors or inputted values which we have given manually. SCADA in a power system is used to collect, analyze and monitor the data effectively, which will reduce the waste potentially and improve the efficiency of the entire system by saving money and time.

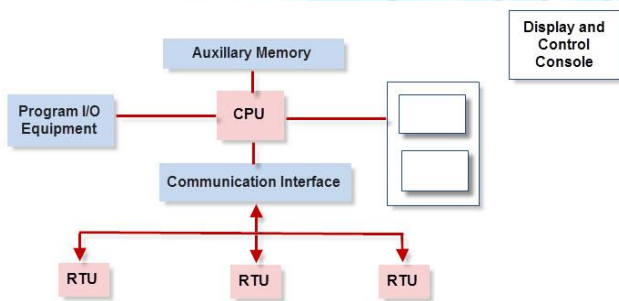


Figure – 1 Functional Units of SCADA

In this manuscript the only programming application of SCADA is used by authors. The Wonderware Intouch 9.0 (Demo version) was used to design the virtual simulation. The Visual Basic language was employed by authors to design virtual experiment. The software contains two windows for user interface. The first window named Development window is used to create virtual experiments. The components and equipments were put using wizard tools. Lots of drawing tools and text format available to create identical model of experiments. The script tool is used to make programming of all components and equipments putted using wizard tool. Lots of control mode is available to create attractive and identical model of simulation.

3. Experiment

The Quincke's method is used to determine magnetic susceptibility of diamagnetic or paramagnetic substances in the form of a liquid or an aqueous solution. When an object is placed in a magnetic field, a magnetic moment is induced in it. Magnetic susceptibility χ is the ratio of the magnetization I (magnetic moment per unit volume) to the applied magnetizing field intensity H .

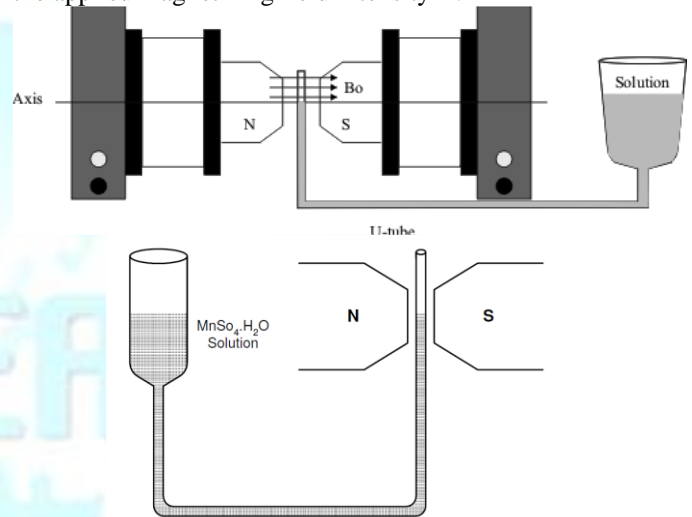


Figure 2 Quincke's experimental set-up

$$x = 2 \left[1 + \left(\frac{r}{R} \right)^2 \right] \frac{\rho g h}{H^2} \text{-----(1)}$$

$$x = 2 \left[1 + \left(\frac{r}{R} \right)^2 \right] \rho g \times \text{Slope} \text{-----(2)}$$

- χ = Magnetic Susceptibility
- r = radius of Thinner limb of Quincke's tube
- R = radius of wider limb of Quincke's tube
- ρ = Density of Solution
- H = applied magnetizing field intensity
- h = Height of solution in Thinner limb of Quincke's tube

In experiment, the reading of h (Height of solution in Thinner limb of Quincke's tube) and H (applied magnetizing field intensity) was taken and plot of h vs H^2 was find used to find slope and hence χ (Magnetic Susceptibility) can be measured of given solution

3. Virtual Model

The virtual mathematical model was created using Wonderware Intouch 9.0 (Demo version) SCADA software in window operating system. In the development window the identical components such as pair of electromagnets, Quincke's tube, Constant Current Power Supply, Digital Gauss-meter, Sensor to measure magnetic field intensity etc were placed using wizard tool of software. The table and desired buttons and switches were also placed in the development window to create simulation. Screen shot of Development window is visualized in figure – 3. The functioning of virtual model is explained in the flow path shown in figure – 4. The script was developed in Virtual Basic language and the screen shot of script window is shown in Figure – 4.

The functioning of virtual model is performed in the Runtime window of software. As per script, the model was function and the simulation can be performed by students with the help of flow path. The button is available within the software to switch over the mode of window operation. The development window with five reading is shown in figure – 5.

4. Conclusions

It is observed that the students who performed the virtual mathematical simulation model before actual experiment can easily conduct actual experiment. The video of this model can also help students to conduct their practical in the laboratory. A number of virtual models of different Physics and electronics experiment can be designed in the

interest of student's education. Different software like MULTISIM, MATLAB, Simule8, Anylogic, SLM etc can be used to design various experiment's simulation.

References

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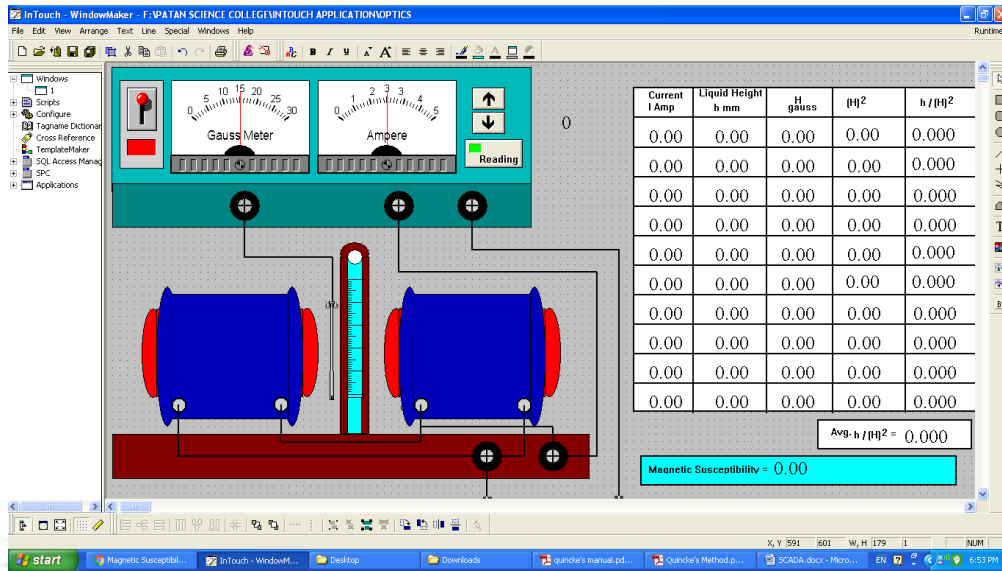


Figure – 3 Development window of SCADA

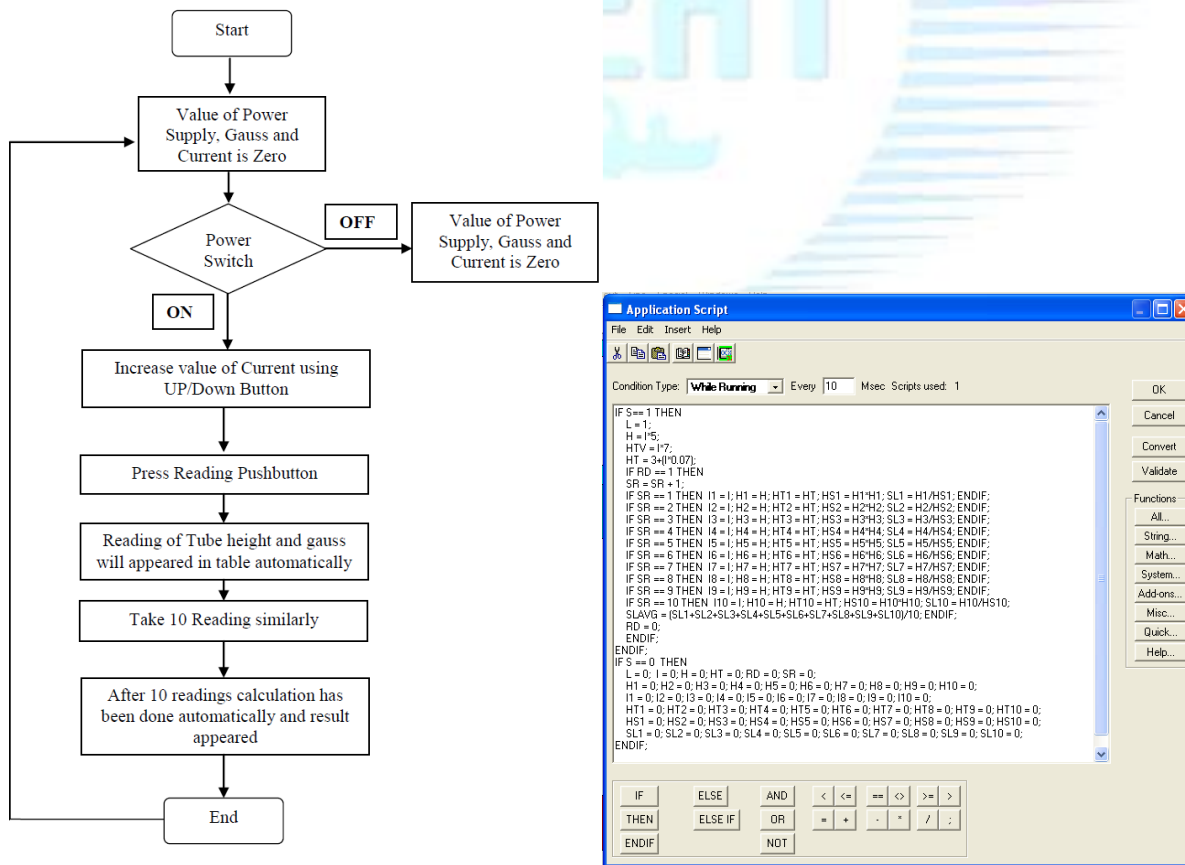


Figure – 4 Functioning Flow Path of virtual model and Script Programming window

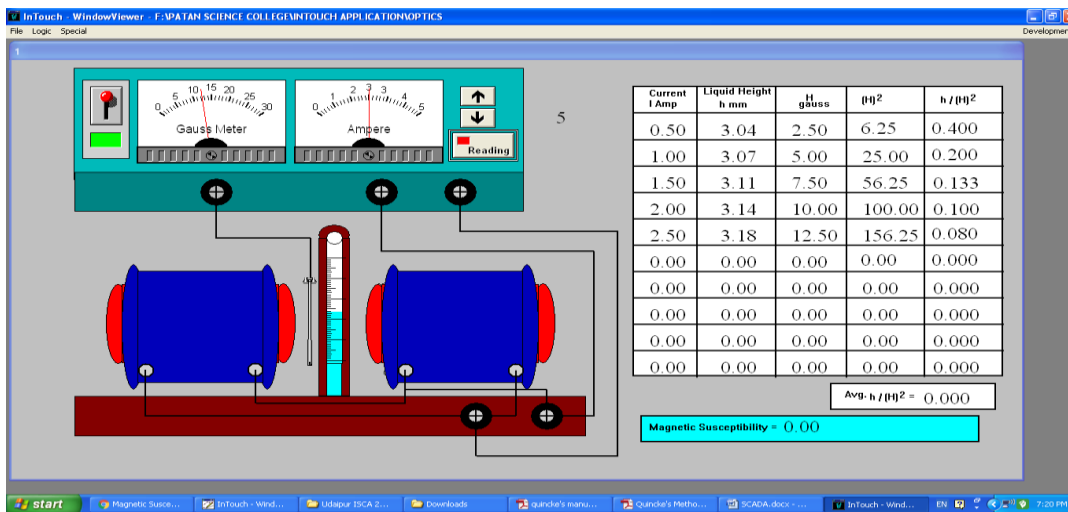


Figure – 5 Runtime window of SCADA