AC 2010-719: PROJECT BASED LEARNING

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PROJECT-BASED LEARNING (PBL)

ABSTRACT

Engineering and Technology educators in higher education use Topic-Based Learning (TBL) to present course contents. This method classically relies on numerous attributes, which include the instructor presenting facts to students, a learning structure defined by the sequence of material presented in a text book, discussion of questions or problem solving and textbook oriented labs. This conventional and often successful model of knowledge transmission centers for the most part on the teacher and what they want students to learn and accomplish from theses lectures. Another teaching approach known as Project- Based Learning (PBL) promotes critical thinking utilizing real-life problems as the starting point. Professors and students are expected to play non-conventional roles by engaging in this instructional and learning approach. In a PBL environment, learners practice higher order cognitive skills (analysis, synthesis and evaluation) and are constantly engaged in reflective thinking asking questions that are based on application of concepts from different Science, Technology, Engineering and Mathematics (STEM) disciplines. This paper draws on the lessons learned from different disciplines where PBL has been employed. The motivation behind the development and implementation of PBL in a Data Acquisition course was to help students avoid memorization, to free them from being equations driven and to assist them in learning and understanding concepts through critical thinking. Projects that provide contextual based learning and analysis are implemented in an integrated Data Acquisition Systems course. Projects provide our student opportunities to integrate Engineering Technology concepts to enhance learning. Team consisting of three students work on design of sensor based projects to model, test, and modify system for efficient performance. This paper will present student projects to illustrate the methods employed to implement PBL.

INTRODUCTION

Project-based learning (PBL) is a model that organizes learning around projects. According to the definitions found in PBL handbooks for teachers, projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work on projects over extended periods of time; and culminate in realistic products or presentations[1, 2].

Over the last decade due to the good feature of Project Based Learning (PBL) such as challenging students with real world problems and empowering students with responsibility for their own knowledge, a number of PBL research projects have been carried out worldwide[3, 4, 5, 6, 7]. In PBL, students work actively in groups and build their own knowledge to solve real-life problems. A teacher becomes an instructor who gives only guidelines or direction of the subject. In 1993, Stepein[8] developed a PBL model for mathematics, science, and social studies classes at elementary and secondary levels. It was found that PBL increased students learning skill including problem-solving skill, literature searching skill, collaboration skill, and critical thinking skill[7, 8, 9, 10]. Students also become more responsible for building up their knowledge. Compared with the traditional lecturing, PBL model enhances the quality of student learning in subject matter and foster deeper learning.

Project based learning consists of five criterions:

(1) PBL projects are central, not peripheral to the curriculum. This criterion has two corollaries. First, according to this defined feature, projects are the curriculum. In PBL, the project is the central teaching strategy; students encounter and learn the central concepts of the discipline via the project. There are instances where project work follows traditional instruction in such a way that the project serves to provide illustrations, examples, additional practice, or practical applications for material taught initially by other means. However, these "application" projects are not considered to be instances of PBL, according to this criterion. Second, the centrality criterion means that projects in which students learn things that are outside the curriculum ("enrichment" projects) are also not examples of PBL, no matter how appealing or engaging.

(2) PBL projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline. This criterion is a subtle one. The definition of the project (for students) must "be crafted in order to make a connection between activities and the underlying conceptual knowledge that one might hope to foster."

(3) Projects involve students in a constructive investigation. An investigation is a goal-directed process that involves inquiry, knowledge building, and resolution. Investigations may be design, decision-making, problem-finding, problem-solving, discovery, or model-building processes.

(4) Projects are student-driven to some significant degree. PBL projects are not, in the main, teacher-led, scripted, or packaged. Laboratory exercises and instructional booklets are not examples of PBL, even if they are problem-focused and central to the curriculum. PBL projects do not end up at a predetermined outcome or take predetermined paths. PBL projects incorporate a good deal more student autonomy, choice, unsupervised work time, and responsibility than traditional instruction and traditional projects.

(5) Projects are realistic, not school-like. Projects embody characteristics that give them a feeling of authenticity to students. These characteristics can include the topic, the tasks, the roles that students play, the context within which the work of the project is carried out, the collaborators who work with students on the project, the products that are produced, the audience for the project's products, or the criteria by which the products or performances are judged[4].

This paper presents a project-based learning (PBL) model for the teaching and learning of Data Acquisition Systems course. The model consists of three basic components including introduction of basic data acquisition concepts, deeper learning of LabVIEW through lectures, enhancement of understanding on the subject and application through working on projects and project reporting, seminar presentation and assessment. The Vernier SensorDAQ is a data-acquisition interface that offers unprecedented convenience and power to engineering students with USB connectivity and the ability to automatically detect Vernier sensors. The details of the projects conducted by the students are presented in the following sections.

Project 1 – "**Building a Virtual Thermometer**"

The objective of this lab was to introduce students to the basic concepts of LabVIEW Programming. They also learned about interfacing the temperature sensor to the SensorDAQ manufactured by Vernier Corporation in collaboration with National instruments. LabVIEW program was developed to collect data from temperature probe. Following is the front panel and the block diagram for the Virtual Thermometer.

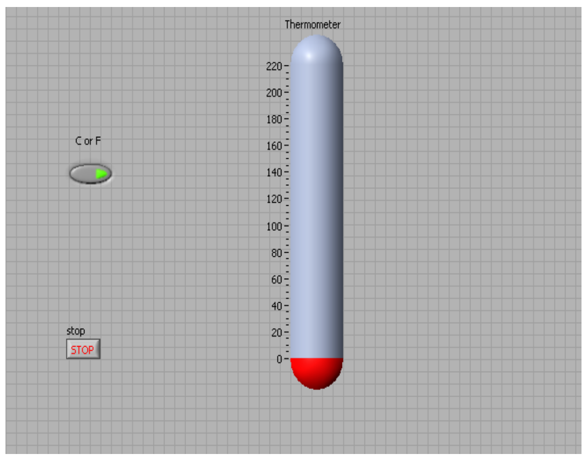

Figure 1: Front Panel of Lab "Building a

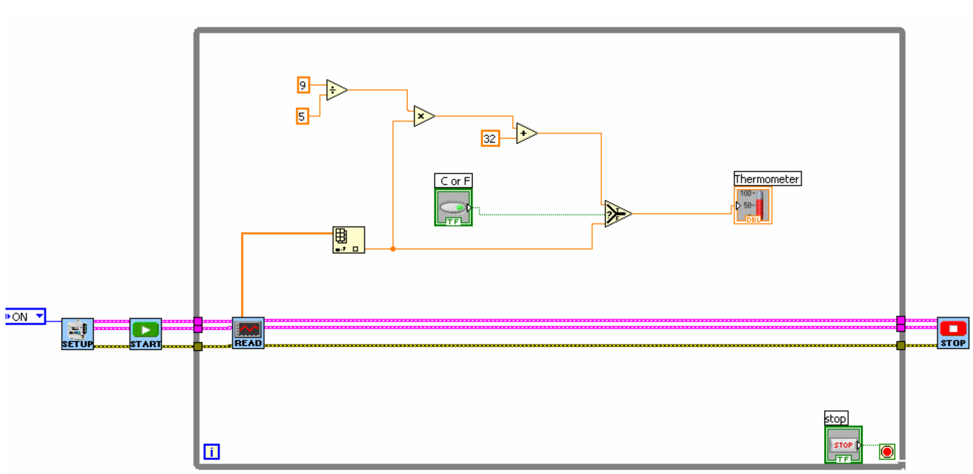

Figure 2: The Block Diagram of the Lab: "Building a Virtual Thermometer"

Project 2 – "**Light Tracker**"

In this lab project students were introduced light sensors which detected the light and displayed the sensitivity on the front panel. Students wrote a LabVIEW program that was designed to read the signal of two light sensors connected to Ch1 and Ch2 of the Sensor DAQ. The program first compared the difference between the readings to a threshold value set by the user. If the difference in readings is below the threshold, this means that the light source is providing equal light to both sensors and must be located between the two light sensors. In this case no DCU lines will be turned on. If the difference in readings is above the threshold, it means the light source is providing a brighter light to one of the two sensors. The program then compared Ch. 1 Ch. 2 light reading. DCU line 1 will be activated if Ch. 1 is greater, DCU line 2 will be activated if Ch. 2 is greater. Following is the front panel and the block diagram for the Light Tracker project.

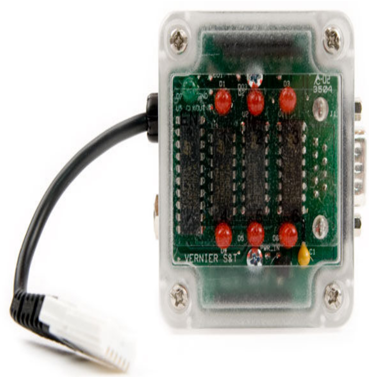

Figure 3: Digital Control Unit

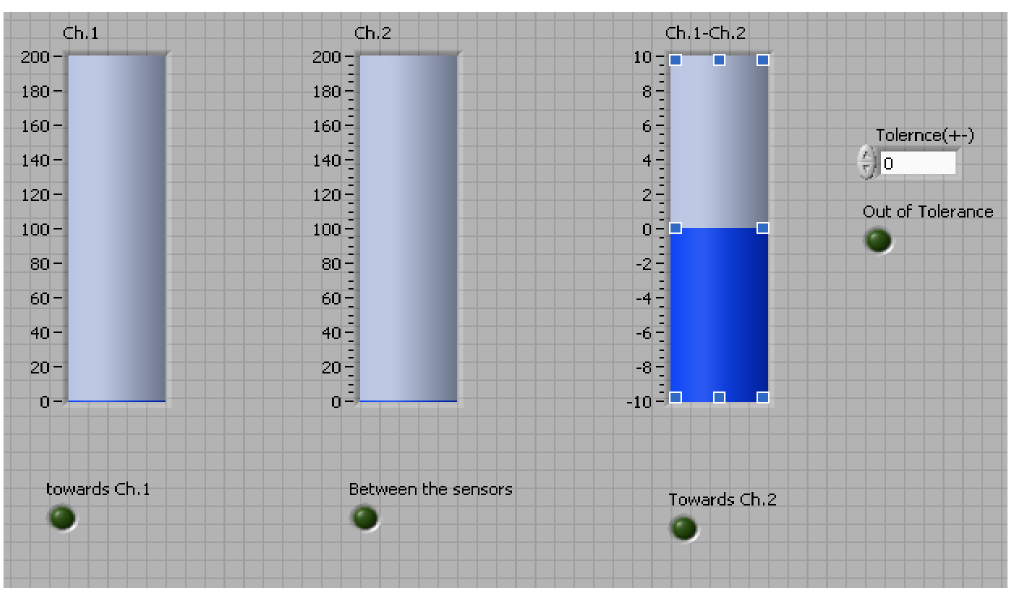

Figure 4: The front panel of the "Light Tracker"

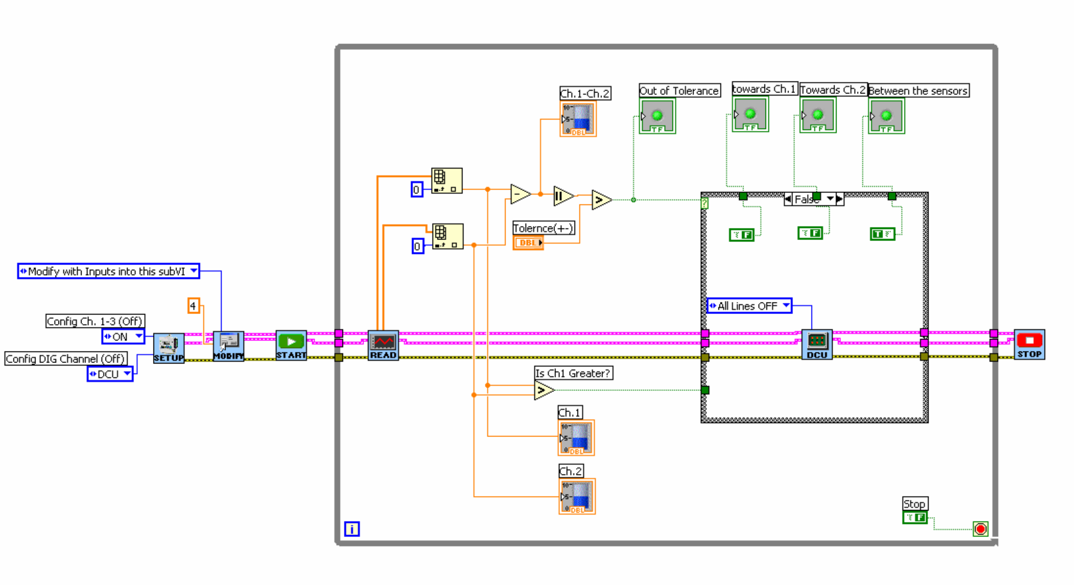

Figure 5: The Block Diagram of the "Light Tracker"

Project 3 – "**STRAIN GAUGE MEASUREMENT**"
In this project concepts about strain gauge measurement were implemented by using Vernier Instrumentation Amplifier (INA-BTA). LabVIEW program was developed to read the signal of an Instrumentation Amplifier connected to Ch1. The INA read the output of a Half-Bridge circuit with 2 strain gauges mounted on a cantilever beam. The output voltage of the circuit was used to calculate the strain in the beam. Following is the front panel and the block diagram for the Strain Gauge Measurement project.

Figure 6: Strain Gauge attached to the Cantilever Beam

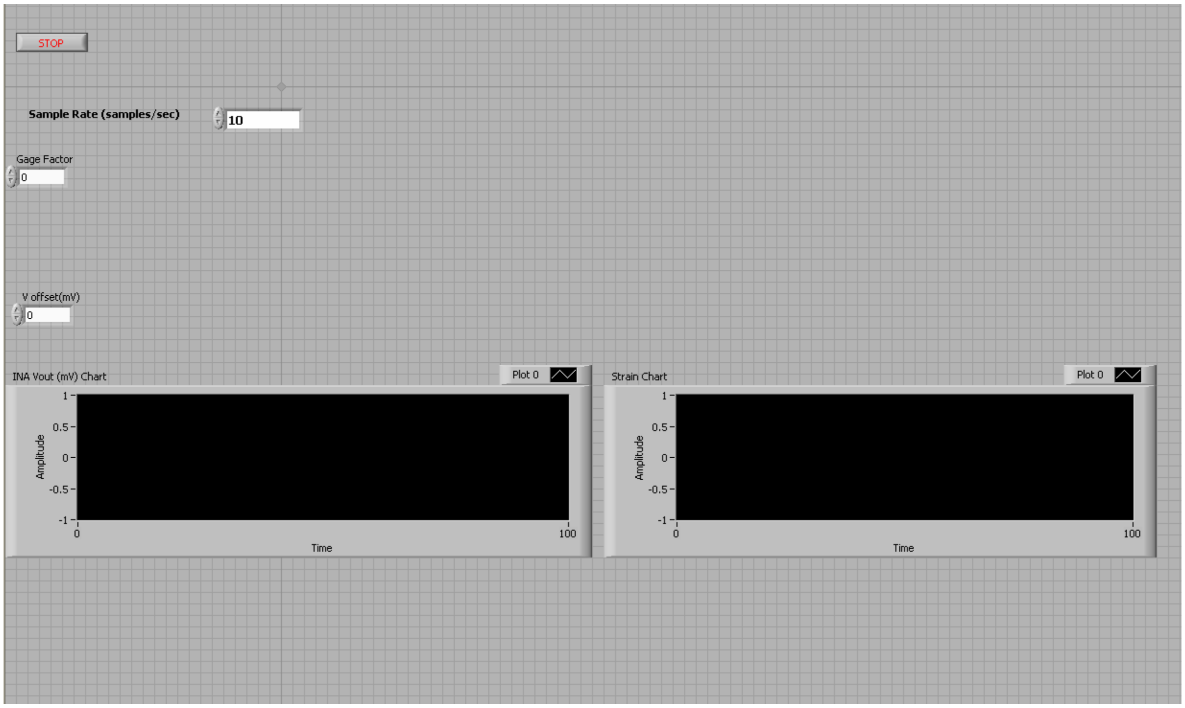

Figure 7: The Front panel for the "Strain Gauge" Lab

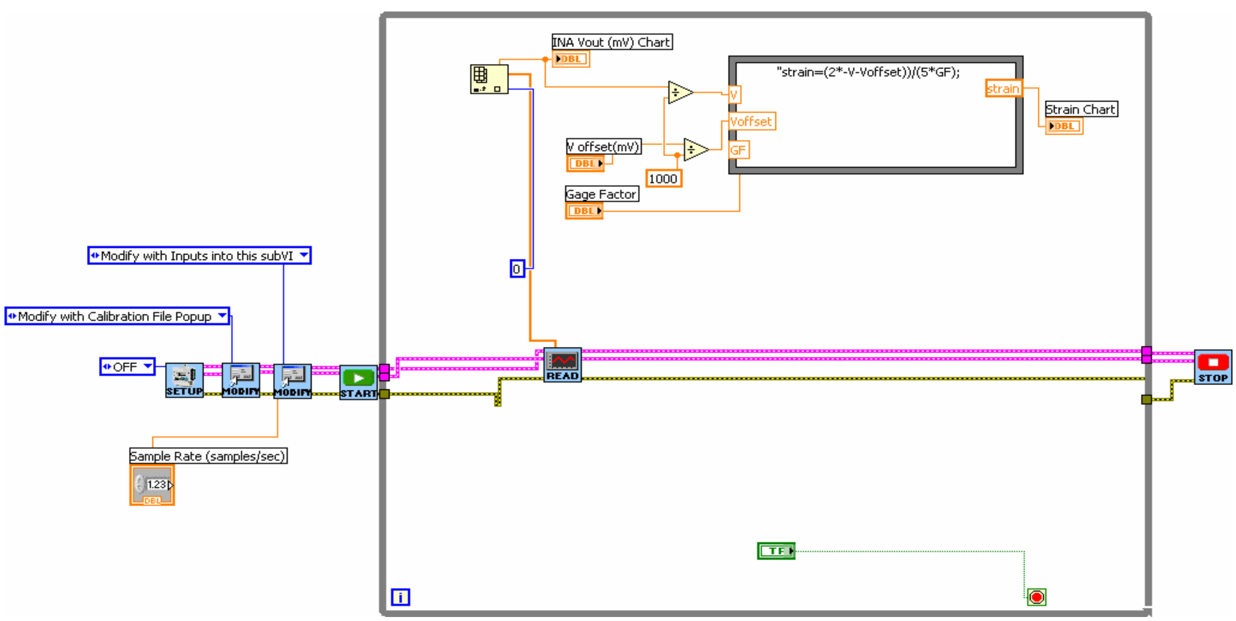

Figure 8: The Block Diagram for the "Strain Gauge" Lab

CONCLUSION

The paper looked at the implementation of Project-Based Learning while conducting experiments in Lab View environment. Utilizing PBL and other resources, students were able to access, analyze, and formulate decisions based on the information provided. There were two essential components of projects:

1) A driving question or problem that serves to organize and drive activities, which taken as a whole amount to a meaningful project
2) Culminating product(s) or multiple representations as a series of artifacts, personal communication or consequential task that meaningfully addresses the driving question.

As technological advancements are continuously made in the 21st Century, new topics of science-related research will receive notable attention that would allow more feasible systematic approaches to obtain answers without full participation of the instructor. Project-Based Learning, not only benefits participants at a college level, but those on a middle, and high school education level as well. Project-Based Learning has not only been exposed on a national level, but on a global level as well.

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