Educate New Generation on Nuclear Technology through Collaborating Engineering Project

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Session: Interdisciplinary programs, sustainability and alternative energy as related to engineering education

Abstract

For the past several decades, nuclear technology has remained as one of the top interested issues due to its application as a new energy resource as well as a threaten weapon of massive destruction. In the United States, the National Nuclear Security Administration (NNSA) within the Department of Energy specifies its national security missions including increasing public awareness of nuclear security and reducing the threaten of global nuclear proliferation. Aligned with the above mentioned NNSA missions, Prairie View A&M University (PVAMU) launched a collaboration project to conduct research on the sensor and detector applications to nuclear materials sponsored by the Department of Energy. PVAMU is the second oldest institution of higher education in the state of Texas and an HBCU (historically black colleges and universities). With the support from national research laboratories, this collaborative project brings together several departments within the College of Engineering at PVAMU, which include Chemical Engineering, Mechanical Engineering, and the leading department Electrical and Computer Engineering. With a focus on developing a portable nuclear detection device, a solid state nuclear track detector (SSNTD) was studied and implemented with Cadmium Zinc Telluride (CZT) detector along with hand-held feature provided by National Instruments (NI) LabVIEW PDA Mobile Module to meet the demand. Different radiation sources were tested through data acquisition, analysis, and data presentation to prove the effectiveness of the system. At the same time, undergraduate student education is another important feature of this project. Student researchers, senior design projects, and summer workshops were engines to disseminate research findings to the next generation in order to produce qualified workforce to protect national security. The success of this project serves as an example to introduce recent academic achievements and industry products to the new generation through interdisciplinary research activities.

Background

The September 11, 2001 terrorist attack imposed upon the United States the fundamental importance to our safety of the reduction in the global threat from terrorism and weapons of mass destruction. High on the list of threats are nuclear weapons and nuclear devices. In the future, the threat is less likely from a massive nuclear attack, but more likely from crude devices, such as

dirty bombs perpetrated by an individual or group of terrorists. Detection and prevention of these nuclear devices are critical to the safety and security of the general population.

In order to meet the needs of national security, the NNSA sponsors PVAMU engineering faculty on the research and educational program entitled "Sensor and Detector Applications to Nuclear Materials" starting in 2006. PVAMU is a member of the Texas A&M University system, and also a member of the Sam Massie Chair of Research Excellent Program which includes ten Historical Black College and Universities (HBCU). The project consists of two aspects: 1) Research the application of sensors to nuclear detection; and 2) Training for undergraduate and graduate students as well as high school students.

Collaborated Research

The research objectives and goals of this project are:

1. Secure nuclear weapons and nuclear and radiological materials at vulnerable sites around the world.

2. Conduct cutting-edge nonproliferation and national security research and development.

3. Develop advanced detection technologies that will play an important role in the Nation's ability to successfully prevent proliferation.

4. Create and leverage enhanced relationships with other scientific organizations and institutions to ensure scientific and technical excellence in the NNSA workforce and foster long-term, synergistic ventures.

To achieve this goal, PVAMU engineering faculty members collaborate with national laboratories. At the beginning of this project, Prairie View Team met with engineers and scientists from Los Alamos National Laboratory, Sandia National Laboratory and Oak Ridge National Laboratory to obtain information on research and continue to gather information on critical research and future trends.

During the exploration of this multidisciplinary project, faculty members from different departments under the College of Engineering (COE) at PVAMU also collaborated together. PVAMU COE has seven programs accredited by Accreditation Board for Engineering and Technology (ABET): Chemical Engineering, Civil Engineering, Computer Science, Computer Engineering Technology, Electrical Engineering, Electrical Engineering Technology, and Mechanical Engineering,. In addition to the undergraduate degrees, the College of Engineering offers Masters of Engineering, Masters of Computer Science, Masters of Computer Information Systems, Masters of Electrical Engineering and a PhD in Electrical Engineering degrees. Besides Electrical and Computer Engineering Department, faculty from Chemical Engineering and Mechanical Engineering also make great effort with their expertise in radiation materials and mechanical measurement.

After three years of collaborated work, we've developed the detection system through Cadmium Zinc Telluride (CZT) detectors.[1] LabView is chosen to be the platform to investigate signals after acquisition. Below we provide the system diagram as Fig. 1. A collection of equipments to acquire data are shown in Fig. 2. The sample simulation result is illustrated as Fig. 3.

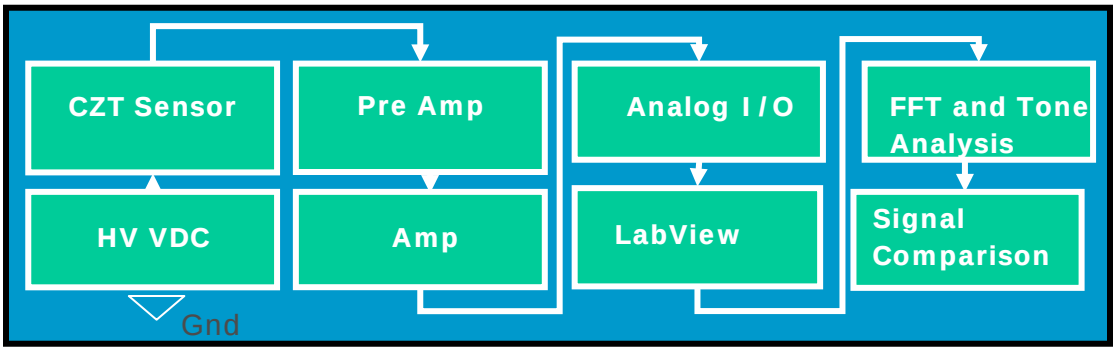

Fig. 1 System block diagram

Fig. 2 Data acquisition equipments

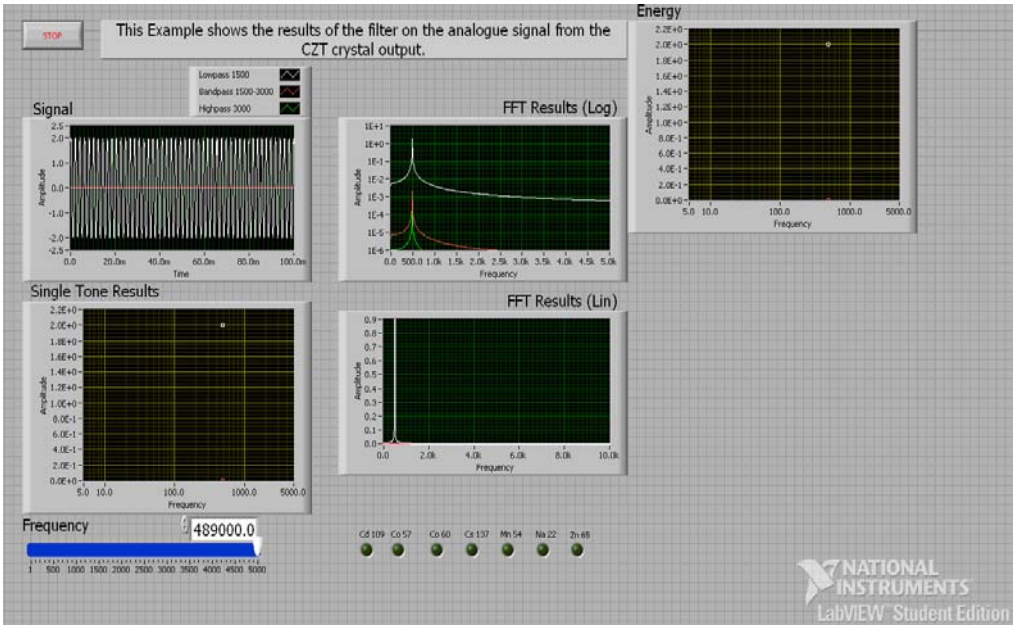

Fig. 3 Simulation result

Electrical and Computer Engineering Department Education Outreach

PVAMU is a major teaching university. One of the university's roles is to disseminate the research results to the undergraduate students. Dr. Fuller, as the principle investigator of the project, also formulates a structuralized educational research module as shown in Fig. 4. Besides the research and collaboration contents, four educational aspects are introduced below.

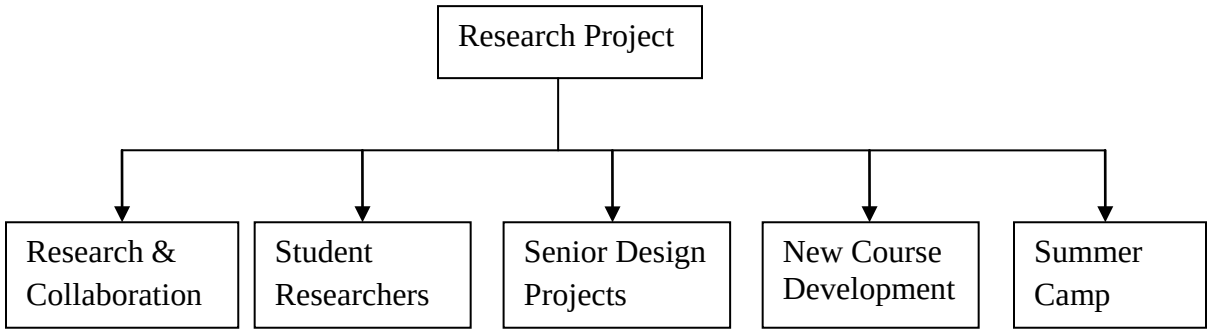

Fig. 4 Project educational research module

1. Student Researchers

This project has supported student researchers for the past fifteen years. Each semester at least two students are given a research assistantship to work with professors in the sensor/detector research laboratory. During the summer break period, undergraduate students

are given the opportunity to visit national research labs for project related training. A total of 19 students have been involved in the research project over the past three academic years.

2. Senior Design Projects

From the start of the research effort, it has been beneficial to the students and to the faculty to work with and give needed support to students working on their senior projects. Student project teams consist of from three to six senior working on a specified senior design project. A most recent project titled "Acquisition System for a Nuclear Radiation Detection System", students tested different radiation sources using sensor/detector systems designed and built in the Sensor/Detector Laboratory. In addition to testing their systems the student groups are also required to wire a paper on their design and to present it to the faculty and students in the College of Engineering. In another project entitled "Hand-held Nuclear Detection Device", differences between hardware processing platforms such as Parallax Basic stamp board and personal digital assistants (PDAs) were compared. Involvement with professors with a wide range of engineering expertise has allowed the students to graduate with a BS degree in engineering well versed on nuclear technology and the application of innovative engineering design to the technology.

3. New Course Development

With the preliminary results obtained from the project, the nuclear related course of CHEG-4103 – Special topics (Radiation Detection and Measurements) introduced in the fall semester of 2006 continues to be developed and work that is being done in the sensor/detector laboratory is used to support the course. This course explores the fundamental principles of the interaction of nuclear and atomic radiation with matter. The course material introduces the fundamental characteristics of various radiation sources (including neutron, gamma-ray, and charged-particle radiation). The students learn the fundamentals of nuclear reactions and interactions. Nuclear properties of matter are governed by atomic and nuclear structure.

4. Summer Camp

A major highlight of the educational module is a summer energy camp hosted by PVAMU's Electrical and Computer Engineering department. The last summer camp offered in the Summer of 2009 was a one week residential camp with the title of "The Renewable Energy Summer Camp for High School Students". The summer camps were developed as a learning tool for secondary school students and as an inspiration for students to enter into fields of science, technology, engineering, and math (STEM). Because energy is a growing issue and today's students are the key to its future, the camp introduced student to energy concerns and possible solutions for the state of Texas and our Nation. The students participated in lectures, discussions, hands-on experiments, a field trip and design competitions involving related to energy and renewable energy sources. The activities were designed to strengthen the students' foundations in math and science. The goal of this camp is to help develop a more skilled pool of college graduates for tomorrow's workforce which is vital to economic success of Texas and the nation.

The summer camp provided seventeen scholarships for students who are sixteen and seventeen years of age from schools located in the state of Texas. The scholarships covered all of the necessary expenses to attend the one-week residential camp at Prairie View A&M University. The university partnered with Austin Energy to provide a tour of the facility, discuss power distribution and renewable energy sources used to create power for the city of Austin and the recently implemented solar panels. The integration of diverse activities with energy related topics was achieved through class discussions, field trips and hands-on projects. The students indicated that these activities were accomplished in their survey responses, PowerPoint presentations and quizzes taken during the camp. Fig. 5 shows the students in the lab working on the energy project.

Fig. 5 Camp participants building a simple wind turbine

Summary

Through the ongoing project of "Sensor and Detector Applications to Nuclear Materials", the faculty and students at PVAMU have accomplished in both research and education. With the development of nuclear detector system, several training opportunities were provided to faculty members, graduate and undergraduate students, as well as high school students. In the future, the PVAMU team is going to continue the research on the hand-held nuclear detector. In the mean time, integrate advanced techniques into educational tasks to equip the future workforce with cutting edge nuclear knowledge.

Acknowledgement

We highly appreciate the collaboration work with Dr. Sukesh K. Aghara from the Chemical Engineering department, Dr. Ing Chang from the Mechanical Engineering department, and Mr. Ramesh Dwivedi from the Center of Applied Radiation Research (CARR) at PVAMU for their valuable input on this project.

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