# Enhance Multi-Disciplinary Experience for Agriculture and Engineering Students with Agriculture Robotics Project

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## Abstract

With the advancement in robotics technology, unmanned agricultural robotics are becoming widely used in precision agriculture. Engineers equipped with robotics knowledge are highly demanded by today's high-efficiency-high-producing agricultural industry. It is critical to offer agricultural robotics training to ensure that undergraduate students are adequately prepared for the agricultural industry job market. To answer this demand, the authors build a fully operated agricultural robotics lab within Prairie View A&M University (PVAMU). An Unmanned Agricultural Robotics System (UARS) was designed, constructed, and operated in both classrooms and fields. The UARS is a precision agriculture vehicle platform for mounting multiple sensors, including crop height sensor, crop canopy analyzer, normalized difference vegetative index (NDVI) sensor, multispectral camera, and hyperspectral radiometer. Such a ground-based automatic crop condition measuring system also will help farmers maximize the economic and environmental benefits of crop pest management through precision agriculture.

The UARS was tested under both laboratory and field conditions. Based on the success of the project, a special topic course was developed and offered for undergraduate students in the Department of Engineering Technology, and also several senior project tasks about building agricultural robotics system were advised. Through these activities, both agricultural and engineering students gained hand-on experiences on technologies of various engineering disciplines, including agricultural, mechanical, electrical, and computer engineering. Students increased their confidence in pursuing future career opportunities in the abovementioned areas, especially in agriculture. By doing so, not only the students were equipped with cutting edge technology but also they will be more competitive in their future careers. The teaching project also provided a platform for collaboration among educators from diversified disciplines for enhancing agricultural and engineering education at PVAMU.

## Introduction

In the 2009 white paper on Human Capacity Development prepared by the Academic Programs Section of the Association of Public and Land Grant Universities [1], challenges were identified as: the rate of investment in human capacity development in Food,. Agriculture, Natural. Resources, and Related. Sciences (FANRRS) has lagged behind investment in the creation of new knowledge, resulting in an increasing gap between discovery and implementation and fewer students are pursuing agriculturally related sciences in higher education than required to meet future needs—especially to provide worldwide leadership. Also, it is widely known that the skills and knowledge that employers value most are not always well-aligned with undergraduate agriculture and engineering programs [2]. Follow the recommendations from [2], we want to identify and propose to enhance multi-disciplinary experience for engineering and agriculture undergraduate students through training with a modern technology requiring knowledge of various engineering disciplines.

As a integration of multiple-discipline technology, robotics is ideal in meeting our requirement. With the advancement of robotics technology, unmanned agricultural robots are becoming widely used in precision agriculture. Modern farming requires making increasingly complex scientific, business, and financial decisions, so advanced education/training in agriculture as well as engineering is important [3]. Thus, it is extremely important for higher education institutions, especially minority serving universities, to offer appropriate education opportunities for students to prepare them adequately for their future career. So, we propose to enhance students' multi-disciplinary experience through training in transferable skills with agricultural robotics technologies.

Also, the wide use of agricultural robots in the agricultural industry demands qualified workers equipped with related expertise and skillful hands-on experience. PVAMU is ready to take this responsibility in providing diversified and qualified workforce for the society. However, due to lack of agricultural robotics facility, agricultural and engineering students enrolled in PVAMU do not have the opportunities gaining hands-on experiences with agricultural robotics technology. This shortage further widen the gap between industry requirement and our students' skills, thus undermines their confidence as well as the local economy.

To answer this demand, the authors build a fully operated agricultural robotics lab within PVAMu. An Unmanned Agricultural Robotics System (UARS) was designed, constructed, and operated in both classrooms and fields. The UARS is a precision agriculture vehicle platform for mounting multiple sensors, including crop height sensor, crop canopy analyzer, normalized difference vegetative index (NDVI) sensor, multispectral camera, and hyperspectral radiometer.

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**Unmanned Agricultural Robotics System (UARS)**

The UARS system (as shown in Fig. 1) is designed to be operated through the means of remotely control. Other unique features include light weight, height adjustable, and sufficient space for plants. Various sensors can be mounted on this UARS system to measure crop conditions (as illustrated in Fig. 2). To measure crop height and volume, laser or radio detection can be used; to measure biomass of plants, LAI or NDVI can be used; for canopy temperature measurement, infrared temperature sensors can used.

Figure 1: Our UARS system

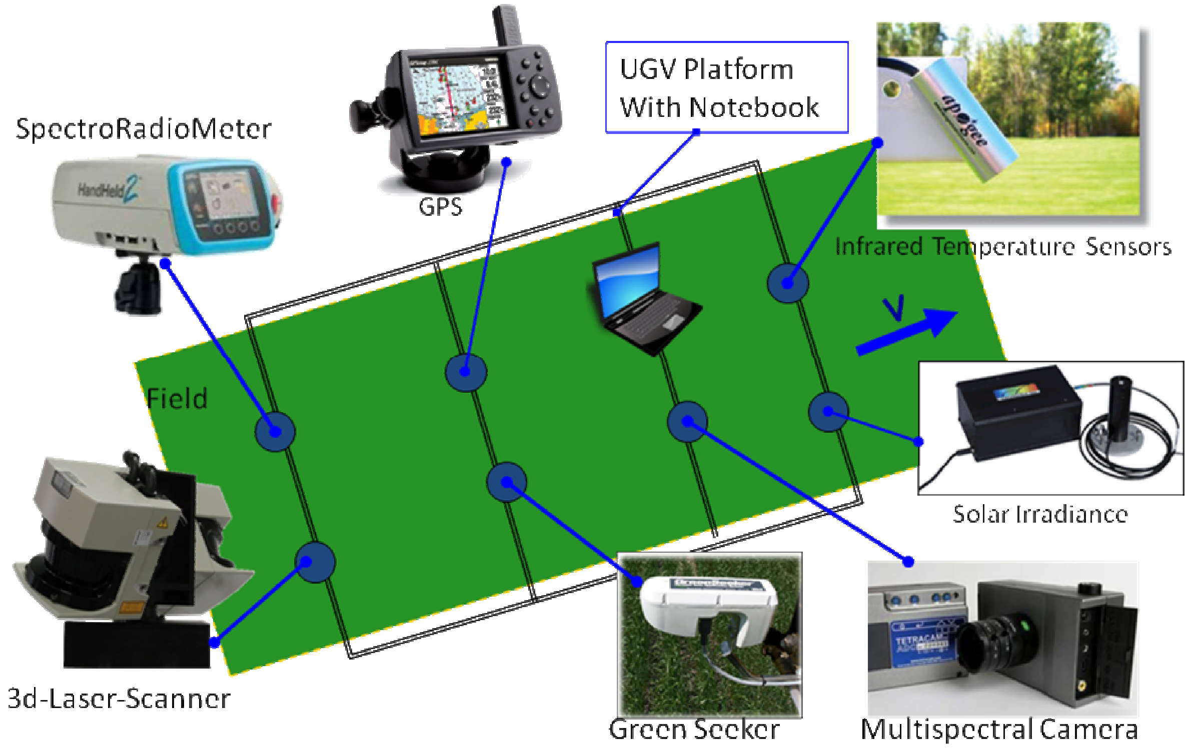


Figure 2: UARS-based crop conditions measuring system

The UARS system is built with T-slotted aluminum structural frames. Such sturdy material ensures that the vehicle can move on any crop field. To drive the vehicle, two 1/3 HP DC motors are used for the two rear wheels. One actuator is used to control the two front wheels for changing direction. Two more powerful actuators are used to lift a platform for sensors mounting. This platform is designed as height adjustable to ensure that the sensors maintain an optimal distance from the plant surface to be measured. Two set of 10000 mAHr battery packs are used to guarantee that the UARS is fully powered for at least half an hour in field. The control system is packed in one box and mounted at the front of the vehicle.

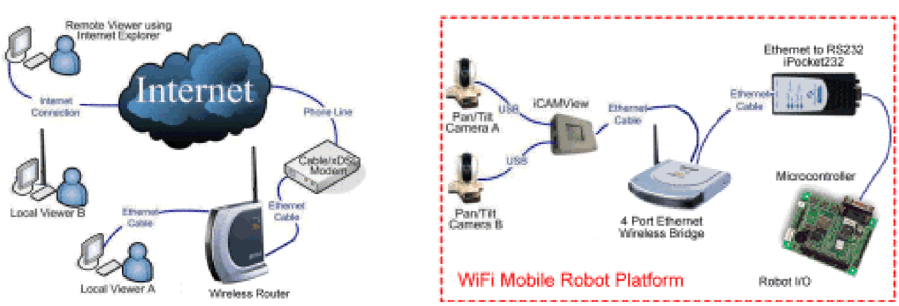


Figure 3: Wireless communication for remote control

A computer is used to remotely control the UARS system. It communicates with the UARS's control system through WIFI, as shown in Fig. 3. By receiving the control signals from the computer, the UARS's control system generate appropriate control signal to drive the corresponding motors or actuators.

## Activities

*a. Special Topic Course*

To better fulfill the primary purpose to prepare students for a successful professional career in diversified technology fields, a special topic class was offered to the Engineering Technology students. The course was featured with general introduction of mobile and agricultural robotics, theory and technology behind mobile robotics, and hands-on experience with mobile robotics. Throughout the semester, the course is divided into two parts: theory introduction (Fig. 4) and hands-on practice (Fig. 5).

Figure 4: Theory introduction

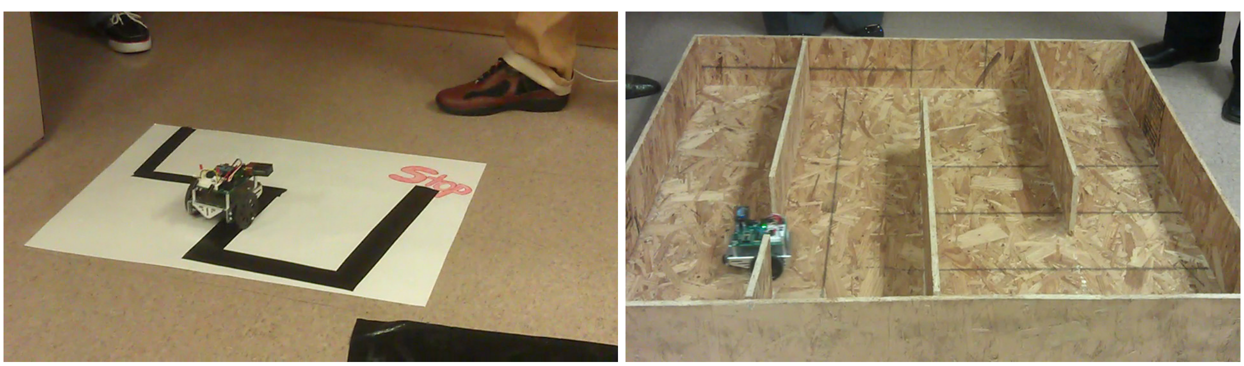


Figure 5: Hands-on practice

*b. Student Poster Presentation*

A female undergraduate engineering technology student was hired for this project. The student actively participated in the project and presented her experience in research symposium (Fig. 6). She was a winner of the best presenters.

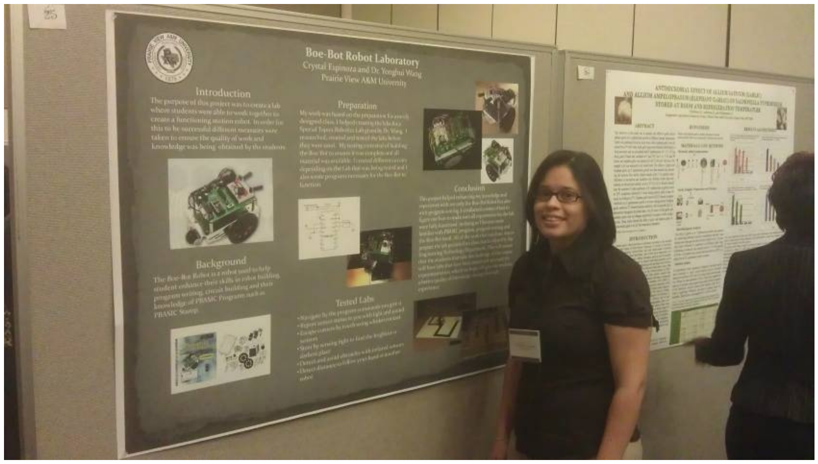


Figure 6: Student poster presentation

*c. Rice Field Test*

The UARS system was tested in rice field, as shown in Fig. 7. In the test, various data was collected with the sensors mounted on the UARS. Students also identified some problems and helped improved the robustness of the whole system.

Figure 7: Rice field test

*d. Fruit Field Test*

More test activities were performed in a fruit field, as shown in Fig. 8. The shapes and volumes of the trees were measured and collected with the 3D scanner mounted on the UARS system. Students gained more experience of using UARS system for precision agriculture.

Figure 8: Fruit field test

*e. GIS Day*

The system was tested and demonstrated on university agriculture garden during the university GIS day (as shown in Fig. 9). Students and visitors showed high interests on the system.

Figure 9: GIS day field demonstration

*f. Senior Design*

Several groups of senior design students were involved in the designing and construction stages (as shown in Fig. 10). In the designing stage, students helped to conduct the literature review and collect ideas; while in the construction stage, students worked with faculty members for both mechanical and electrical parts. Students gained hands-on experience as well as confidence toward their future career.

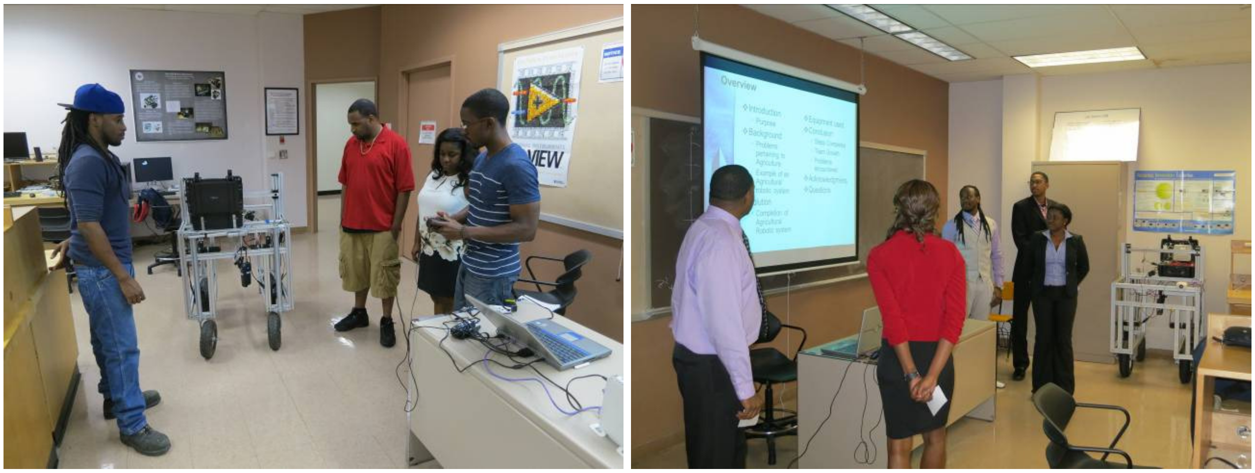

Figure 10: Senior design

**Discussions and Conclusions**

Sponsored by a federal agency, the objectives of this project are to: 1) enhance multidisciplinary teaching/research collaboration and integration; 2) improve teaching/research capability in Agriculture Sciences, Mathematics, and Engineering; 3) strengthen underrepresented students' working skills on up-to-date agricultural robotics technology; and 4) establish a fully operated agricultural robotics lab. Based on the activities listed in the previous section, these objectives are fulfilled very well. Specifically, a fully operational UARS system was designed and constructed; a special topic course was offered to enhance students' understanding and hands-on experience about robotics technology; field tests provided real application experiences for undergraduate students; and senior design groups received extensive training to prepare them for their future career.

This project has two folds. For engineering students, these trainings broaden their knowledge with introduction of technologies as well as career opportunities in other disciplinary, and also this project is an advertisement of agriculture to students with engineering background. While for agriculture students, this project provides a valuable opportunity for them to get firsthand experience about robotics technology, which helps them getting familiar with agriculture robots early and further prepares them well for their future career.

Our future work will focus on transferring the UARS system to a full automatic system. More sensors will be integrated into the system. Students and faculty members are working toward this direction.

**Acknowledgments.** This work was partially supported by the U.S. Department of Agriculture's 1890 Capacity Building Program award # 2010-38821-21461.

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