# AC 2012-5398: BROADEN ENGINEERING TECHNOLOGY STUDENTS' KNOWLEDGE THROUGH HANDS-ON WITH MOTION ROBOTICS

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# Broaden Engineering Technology Students' Knowledge through Hands-on with Motion Robotics


## Abstract

The skills and knowledge that employers value most are not always well-aligned with undergraduate engineering technology programs. With the support of a federal grant, we identify and propose to broaden the undergraduate student experience to include training in transferable skills with agricultural robotics technologies. With the advancement of information technology and control theory, agricultural robotics technology is becoming more advanced and more widely used in the labor intensive agricultural industry. Modern farming requires making increasingly complex scientific, business, and financial decisions, so qualified workers with advanced education/training in diversified technology background are highly demanded. 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.

As a relatively new discipline, Engineering Technology is the application of engineering principles and modern technology to help solve or prevent technical problems. The programs are designed to meet the growing need created by the technology revolution for college-educated problem solvers who can support the engineering process. Thus, the ET program is featured with its emphasis on hands-on skills training, to enable ET students to solve production and system implementation problems and help them explain solutions. Therefore, to prepare the students to meet the industry requirements in the job market, it is urgent to update the educational curriculum along with technology trend in the ET program.

To better fulfill the departmental primary purpose to prepare students for a successful professional career in diversified technology fields, in the current phase of the project, an special topic class is offered to the Engineering Technology students. The course is featured with general introduction of agricultural robotics, theory and technology behind motion robotics, and hands-on experience with motion robotics. This paper introduces the current progress and implementation strategies on this course and discusses the future plan of the project in better aligning the goal of the department to that of the sponsoring agent.

## 1. Background

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], the authors identified the challenges: 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. Follow their recommendation for acquisition of new technology, we focus our attention on training students with high tech and attracting more students with diversified background to agriculture programs.

The skills and knowledge that employers value most are not always well-aligned with undergraduate agriculture programs [2]. Follow the recommendations from [2], we identify and propose to broaden the undergraduate student experience to include training in transferable skills with agricultural robotics technologies. With the advancement of information technology and control theory, agricultural robotics technology is becoming more advanced and more widely used in the labor intensive agricultural industry. Modern farming requires making increasingly complex scientific, business, and financial decisions, so advanced education/training in agriculture 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. On the other hand, according to the CRS Report for Congress on January 31, 2007 [4], in FY2001-FY2002, 53% of the estimated 1.8 million workers employed on crop farms were unauthorized aliens. This situation not only endangers the US national security [5], but also affects the government's tax income. Automatic unmanned agricultural robotics technology also provides an effective and immediate solution to this social problem.

The wide use of agricultural robots in the agricultural industry demands qualified workers equipped with related expertise and skillful hands-on experience. Prairie View A&M University (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.

Future B.S. level employees of the agricultural industry would benefit from a broad educational background and hands-on experience with agricultural robotics technologies. To offer our Engineering Technology students these highly demanded experiences, a special topic course was designed and offered to undergraduates with combined knowledge of agricultural science and engineering. In fact, an important section of the market for engineers nowadays is the biotechnological industry. Therefore, an agricultural mobile robotics course can also provide training to our engineering technology students, help them understand the basics of the unit operations in this industry, and equip them with relevant expertise in pursuing a career in

biotechnology. From the agricultural industry standpoint, this course helps to attract new blood with diversified technical background.

Engineering Technology (ET) is defined by American Society for Engineering Education (ASEE) as “the profession in which knowledge of mathematics and natural sciences gained by higher education, experience, and practice is devoted primarily to the implementation and extension of existing technology for the benefit of humanity”. The particular feature requires ET graduates to be more skillful in hands-on. Through physical experiments in each course, students can achieve better understandings of theories in the lecture, and gain experience in real world applications. In order to train our students with most up-to-date technologies, faculties need to design and offer new courses with hands-on practice continuously. Especially, Electrical and Computer technology has experienced significant developments in the past several decades, and ET graduates are demanded in other disciplinary such as agriculture industry.

## 2. Class Activities

To better fulfill the departmental primary purpose to prepare students for a successful professional career in diversified technology fields, in the current phase of the project, a special topic class is offered to the Engineering Technology students. The course is 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 and hands-on practice.

### *2.1 Theory Introduction*

In the first half semester, mobile robotics related theory and examples were introduced. We started with introduction of history of robots, and then we talked about the basic concepts behind mobile robotics technology. After having basic knowledge about mobile robotics, students spent their most time in this period learning different bodies of knowledge, which are integrated in mobile robotics design. These technologies include but not limited to: mechanics and locomotion, electronics, sensors, perception, control theory, and etc. For example, different agricultural sensors were introduced to the class, as shown in Figs. 1 and 2. The knowledge learned in this period prepared students for the second part of the class: hands-on practice.

Figure 1: Sensor Theory Introduction

Figure2: Sensor Demonstration

### *2.2 Hands-on Practice*

Equipped with basic theory behind mobile robotics technology, students were ready for realistic challenges. In this part, students had opportunities working with Boe-Bot robot kits (as shown in Fig. 3) to design their own mobile robots. Boe-Bot robot kit is chosen because it's sturdy and easy to use. It is designed by Parallax. The kit is to help the users to build their own rolling robot with a BASIC Stamp 2 microcontroller brain. Coming with the kit, there is a manual book with very clear, step-by-step instructions and illustrations.

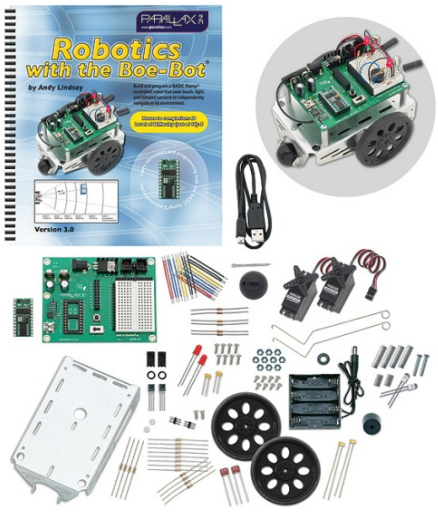


Figure 3: Boe-Bot Robot Kit

In this part, students started with robot kit assembling and basic programming. After getting familiar with the kit, students then worked on simple projects like avoiding table edge, navigation with whiskers, and etc. Equipped with all the expertise, students were ready for the final project challenge. The recommended final project challenge was to develop an autonomous machine that was capable of following a crop edge. This type of tool is very helpful in harvesting

operations, where a part of the crop has been cut and the machine follows the resulting crop edge in subsequent passes. Also, students were free to choose whatever they wanted.

The final project challenge turned out very successfully. Students enjoyed the learning while practicing study model. One group of students was excited about the final project, and they even worked until midnight for several days. Most of the students expressed their hope that we can introduce this kit to the younger students in their early college lives. This practice not only helped them getting familiar with robotics technologies, but also directly showed them what engineering technology can do. Examples of students' final projects are shown in Figs. 4, 5, and 6.

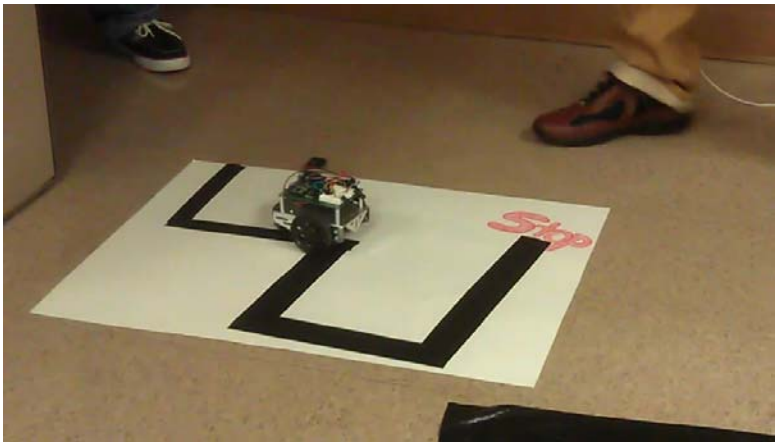

Figure 4: Final Project Example 1


Figure 5: Final Project Example 2

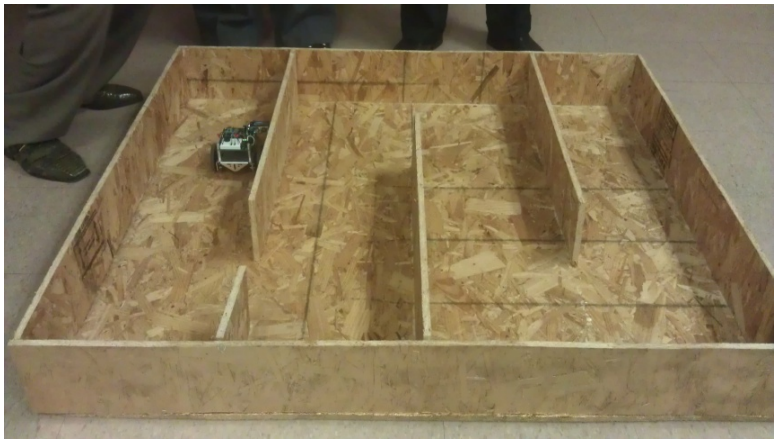

Figure 6: Final Project Example 3

### 3. Student Survey

The course was very successful. To better understand what we did well and how we can do better, student survey was conducted to collect feedback and comments for future improvement. The questions are listed in the following Table 1 and the results are shown in Fig. 7.

Table 1: Student Survey Questions and Results

| No. | Question | Strongly Agree (%) | Agree (%) |
|---|---|---|---|
| 1 | The lecture did help me understand the intelligent robotics technology | 33 | 67 |
| 2 | Robot design project enhanced my comprehensive skills in use of hardware and software | 40 | 53 |
| 3 | Robot project give me new ideas for my senior design project | 33 | 40 |
| 4 | The experience with robots design increased my excitement about Engineering Technology | 40 | 60 |
| 5 | I believe that the knowledge I learned in this course will make me better prepared for future employment | 40 | 53 |
| 6 | The course helps me see career opportunities in agriculture industry | 27 | 47 |
| 7 | I am inspired by this special topic course | 40 | 60 |

For each question, students may select one answer within five options: (i) Strongly Agree; (ii) Agree; (iii) Disagree; (iv) Strongly Disagree; and (v) N/A. Students' responses are listed in the table as well as shown in Fig. 7. Obviously, the feedbacks are generally quite positive. For example, 100% students selected (i) Strongly Agree or (ii) Agree for question No. 4 “The experience with robots design increased my excitement about Engineering Technology.”

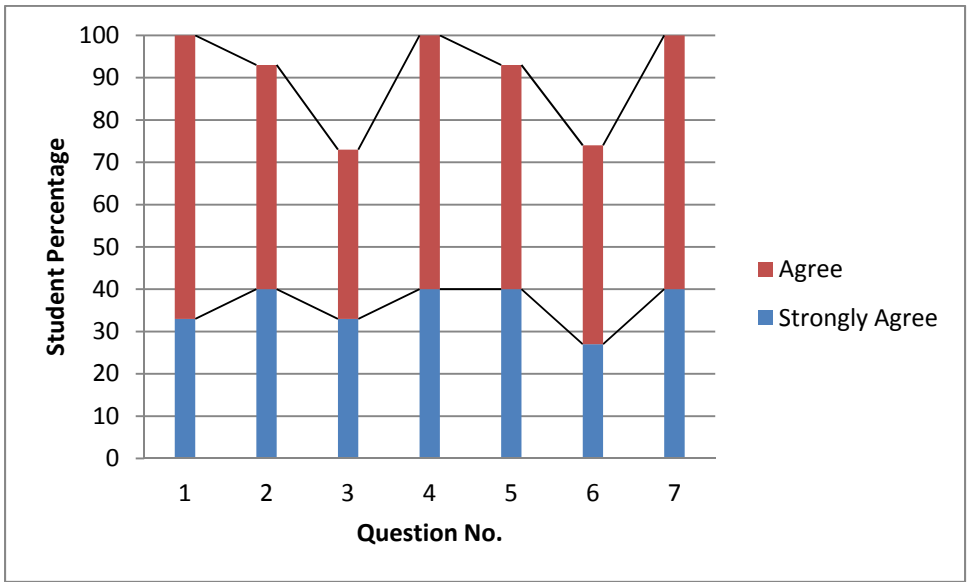

Figure 7: Students Survey Results

## 4. Conclusions and Future Work

Sponsored by a federal agency, a special topic course introducing mobile and agricultural robotics was designed and offered, and this course achieved great responses among students. The course broadens ET students' knowledge with introduction of technologies as well as career opportunities in other disciplinary. This course is also an advertisement of agriculture to students with engineering background.

With the success obtained from this first class, we are working on transferring this special topic course to a regular class, which will benefit more technology students. Also, in order to achieve a sustainable success for the ET department in seeking external resources to further enhance its teaching and research, it is critical to engage more faculties and courses in the plan, such that the latest facilities can be further utilized in the other related courses, as well as to provide a leverage for the other faculties to achieve their success in professional developments.

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