# EDUCATIONAL ROBOTICS: A CASE STUDY WITH THE PARALLAX SCRIBBLER ROBOT AS A BOT-MATE

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**ABSTRACT**

Participating in the Distributed Research Experiences for Undergraduates (DREU) program is an invaluable opportunity for me to proactively explore the computer science profession as well as explore myself. The Parallax Scribbler robot has been my bot-mate throughout 10 weeks working in the DREU research program, at the University of Minnesota, under the guidance of Professor Maria Gini. After I got accustomed to the Scribbler robot, my mentor and I have come up with a project that can deploy the Scribbler as an effective tool to teach computing at the university level. This paper will present what I have learned and what I have achieved through working with the Scribbler robot in the DREU research program.

*Keyword:* Parallax Scribbler Robot, University of Minnesota, Computing, Language Engineer, Research Interest, DREU, Distributed Research Experiences for Undergraduates.

## I. INTRODUCTION

In June 2010, a group of Japanese students at the University of Tsukuba started to show off their robotic infant named Yotaro at robot competitions, and, according to Kyung Lah, the students were surprised by the reactions from the public and media towards Yotaro [8]. Despite the fact that it is a robotic baby and has a particularly large head, Kunimura, the Yotaro project leader, said, "The people who came to the robot exhibitions enjoyed touching Yotaro, like a real baby" [8]. The positive reaction of people towards Yotaro is one of many examples showing that humans have started to get comfortably familiar with robots so that people can pay more attentions to the effects which the robot brings. In his interview with CNN, Professor Noel Sharkey, a professor of robotics and artificial intelligence at the University of Sheffield, UK, explained, "There are more service-oriented robots in the world than industrial bots, which tend to work factory lines and the like," [12] and among those service-oriented robots are the educational robots.

Although educational robots may not be as sophisticated as or have not had a glamorous job as the robots that fight wars, dismantle bombs, or aid surgeons, educational robots can provide hands-on learning experiences for many students and eventually can affect the way people think about a profession. For example, in many universities, people have employed educational robots as an effective tool to help increase the number of students, especially, female students in the field of computer science. Using my own experience working with one of the educational robots, the Parallax Scribbler as a case study, I can strongly testify that the Scribbler robot can provide students an opportunity to proactively learn programming languages, boost students' confidence about the profession, and engage them deeply to explore their research interests.

In the following sections, I will introduce an overview of the Scribbler robot and the valuable Myro library. Then, I will take a look at the general practice of using educational robots in university teaching. Finally, I would like to investigate a specific case study about the benefits of working with the Scribbler robot.

## II. OVERVIEW OF THE SCRIBBLER ROBOT

The Scribbler robot comes with hardware, software, and documentation that are ideal for students in introductory computing courses. The robot is a combination of a base coming from Parallax, Inc and a fluke which was developed by the Institute for Personal Robotics in Education (IPRE).

First of all, even though the Scribbler robot is not really expensive (around $200 included the fluke), its moderately complex hardware package allows students to have some controls over the robot's components. The Scribbler robot comes with several separately programmable components and many sensors: three light sensors, a pair of infrared emitter/detector for obstacle detection, a pair of line sensors located underneath the base for following lines and reading barcodes, a stall sensor, two independent DC motors, three indicator LED lights, and a speaker. In addition, the fluke enhances the robot with wireless power using a Bluetooth wireless chip as well as equips the robot with a color camera. Consequently, the robot can communicate with people and objects using its "senses". For example, combining the robot's infrared emitter/detector with the robot's camera on the fluke, the Scribbler robot can "see" an object and "show" people what it saw.

Secondly, the fluke and its Python library, Myro, make it easier for faculty to use the Scribbler robot to teach computing. In their paper titled "Finding your Bot-Mate: Criteria for Evaluating Robot Kits for Use in Undergraduate Computer Science Education," Richard Weiss,

and Isaac Overcast at the Evergreen State College, said, "The [Myro] library does a very good job of abstracting away all of the dirty hardware details and leaves the student developer with a clean, sensible interface to the Scribbler" [13]. At this point, I would like to acknowledge that there are many Parallax Scribbler robot enthusiasts who take pride in working fluke-free with the robot. Because they consider the Scribbler robot as a toy to tinkering and exploring about robotics, their work's purpose is totally different than the academic usage of the Scribbler robot. As a result, those enthusiasts are not the focus of this work. In order to use the Scribbler robot in academic environments, the presence of the fluke is a must because the fluke enables using Python with the robot. There are many benefits of using Python with the robots. For example, Python is easy for beginning students to use; it can run on several robot platforms and simulators, and, especially, Python can scale-up conceptually by remaining useful as users gain expertise [2].

Together with the software and hardware advantages, the rich documentations about the Scribbler can also be really helpful for Scribbler's users who are students or instructors alike. For example, in its website, Parallax hosts a forum in which people discuss about the Scribbler's hardware [10]; and the Myro wiki page provides many references about the robot, as well. Furthermore, instructors can also find many useful suggested curricular materials in the wiki page of the Myro library. Especially, the IPRE makes available free of charge a fourteen chapters book titled "Learning Computing with Robots" [6] which is a really informative book for students so that they can learn programming in a robot-driven way.

## III. GENERAL PRACTICE: USING EDUCATIONAL ROBOTS IN INTRODUCTORY COURSES OF COMPUTER SCIENCE

History of educational robots in university can be traced back to around 1990s. The idea of using small, low-cost, and programmable robot platforms has been emerged in the mid 1990s. However, at that time, the robots were more or less restricted to laboratory assignments in the junior/senior-level artificial intelligence courses, according to Deepak Kumar, one of the IPRE fluke's developers [7]. Simultaneously with the appearance of robots in the curriculum, a new area of research and development, called educational robotics, has also emerged and a diverse range of robot platforms have also been developed over times [7]. Although educational robotics has been available for less than two decades, developers of this new methodology believe that it is mature enough to hopefully tackle the current crisis in the computer science profession, which has led to losing students and to gender imbalance.

There are a number of reasons why women quickly rule out computer science as their career choice. In the paper titled "Women in CS: An Evaluation of Three Promising Practices," Christine Alvarado and Zachary Dodds refer to different studies and research and point out some reasons such as an unattractive/hostile culture, misperceptions of the discipline, lack of role models and/or mentoring support, and lack of confidence [1].

Keeping those reasons in mind, educators started using educational robotics into introductory courses of computer science. There are some justifications for the belief that this general practice can reinvigorate the computer science classrooms. First of all, students, as intelligent agents of their own, connect viscerally with the endeavor of Artificial Intelligence (AI) which is the root of robotics programming [4]. Therefore, using robots in early computer science courses is a reasonable and natural approach to attract students. As a result, new students

in the field would not feel that computer science is an unattractive/hostile environment. For example, intrigued by different sensory-based, AI-inspired assignments on a simulated robot, in the summer of 2007, three first-year female students of the Computer Science department of Harvey Mudd College had opted to stay on campus in order to extend the computational capabilities of the robot named iCreate [4].

Furthermore, by introducing robotic programming into the introductory courses of Computer Science, faculty can provide students with more hands-on learning experiences which can somewhat eliminate any misperceptions of the discipline and show students that Computer Science can be fun. For example, the authors of an article titled, "Personalizing CS1 with Robots," said that: "Using robots to teach problem solving, programming and fundamental computer science concepts is not novel… We have been convinced by anecdotal reports that our robots attract other students into the course because they are seen in public,"[11]. In other words, educational robots have shown that Computer Science is not all about looking into the computer screen all the time.

At this point, I would like to point out that there are some cases in which the instructors have had negative experience teaching with the robots [11]. However, I would want to argue that the problems does not lie with the robots; rather, those negative experiences stemmed from the method of using the robots. For example, in those cases, the students have only had a chance to work with the robots in laboratory setting. Under time pressure, students have not had enough time to do the work and to reflect on the process; as a result, they missed out on the purpose of using educational robots in computer science curriculum which is productively fun. Without the ability to comfortably manipulate the robots as dumb peripherals, students cannot have fun learning about computing.

## IV. A CASE STUDY: BENEFITS FROM WORKING WITH THE SCRIBBLER IN THE DREU PROJECT

### IV. 1 Background

Currently, I have just finished my general education requirement and planned to declare my major in the Spring 2011. In summer of 2010, I had the honor to participate in the Distributed Research Experiences for Undergraduate program. For 10 weeks, I worked at the University of Minnesota under the guidance of Professor Maria Gini who is an ACM (Association for Computing Machinery) Distinguished Scientist, and College of Science and Engineering Distinguished Professor [9]. There are some special characteristics in our way of working with the robot: first, Professor Gini let me have one Scribbler robot as my personal robot which meant that I could take it home and work with it whenever I liked; secondly, I worked in a team with another undergraduate student, Emily, on a robot-driven schedule which meant that we were thinking of something for the robot to do and then thought of a way to program it how to do that; thirdly, we used the Myro library to abstract away the hardware details and "talk" to the Scribbler using Python which is a simple yet powerful programming language. After 10 weeks working with the Scribbler robot, I feel that the robot has brought computer programming to life; the experience has also boosted my confidence about the profession and has engaged me deeply into doing research.

**IV. 2 A Fun Way to Learn Computer Programming**

I entered the research program with no experience in Python, but when I finished the program, I can say that I can comfortably work with Python, thanks to my experience working with the Scribbler robot. Comparing to the traditional programming classes, learning Python through the Scribbler is really more fun because I used programming to serve my creativity with the robots and I learned computing in the process; in other words, the Scribbler robot took away the pressure of the learning task. For example, as the first project in the research program, Emily and I wanted to write a color-sorting game in where the robot would compare a color ball against three color flags, then, it proceeds to move the ball towards the flag with the similar color. In order to make that idea reality, we had to learn about the syntax of Python. For a minute, we forgot that we were learning; rather, we were motivated to overcome challenges to reach our goal. Needless to say, the knowledge that we acquired through this process will stay with us much longer.

At this point, I would like to address a potential disagreement in which opponents may discredit the robots and say that media computation also has the same effect. According to Guzdial in his article titled, "A Media Computation Course for Non-Majors," he defined media computation as learning to program from manipulating sound, images, and movies [5]. Even though with media computation, the students can still see the result of their programming effort, it is still "live in computer" [11]. On the other hand, with the robot, the student can still manipulate sound, take images, or make movies and do many more things with a real target object. For example, the student can ask the robot to turn, take a picture and make a movie about its surrounding. I would like to make clear my point is that I do not say that media computation

does not help to attract students at all; rather, I would want to say that learning programming with robots can be more effective and fun.

**IV. 3 An Effective Means to Boost Student's Confidence in the Profession**

Being able to think of a new idea and make the idea become reality has given me a sense of accomplishment. In my opinion, having confidence is a big deciding element for whether or not someone will do something. For example, Alvarado et al. describe and analyze the situation in the Harvey Mudd College as follow: "After getting involved on ongoing projects in artificial intelligence and robotics in a short summer research program, even though these students started out with very little experience of one or two semester of computer science, they made concrete progress on real research problems and their representative response about the experience is that, 'Doing research made me much more confident about my skills and knowledge in computer science.' As a result, 40% of 449 study participants have responded that because of the confidence they felt, they decided to choose a computer science major" [1].

I can totally relate to those students' feelings because my experience with the Scribbler robot has also improved my self-perception about achievement. For example, as the idea for the second project in my research program, Emily and I thought that it would be fun if we could control a group of robots dancing and singing using one computer. We started out with the idea that we would take advantages of the Bluetooth network, yet, we ran into a web of problems such as we could not use the Myro library if we did the Bluetooth programming directly in Python. Fortunately, at the end, we figured out how to use the Myro built-in remote robot control feature to fulfill our second project, and there is no word to describe the feeling of achievement and confidence that we feel.

### IV. 4 An Engaging Method to Foster Research Interests

Recognizing a way to effectively learn computing and experiencing the feeling of confidence about ones self can lead to a desire to do more research and to innovate what we have. For example, the Scribbler robot has acted as a real target object so that I could effectively learn the programming language Python; furthermore, my robot-driven agenda has led me to explore ways to accomplish my creativity, and while doing that, I felt the need to evolve the Scribbler so that it can do more. The sense of involvement, the confidence and the interest to do more are the recipe to make a successful student in any major. In addition, educational robotics has its root deep in artificial intelligence, and the field of artificial intelligent is a constantly growing and evolving field. It is obviously that some interest in robots can trigger a big stride towards research interests in the field of artificial intelligence generally and educational robotics specifically. For my case study, it is definitely in my future work to incorporate the openCV library to enhance the image processing capabilities of the Scribbler robot.

## V. CONCLUSIONS

Although it has been less than two decades since low cost, small, and programmable robots made their entry into computer science curriculum, educational robots have made their marks about their role in teaching computing., Lately, many educators have looked at using robots to reenergize the computer science classroom as well as tackle the gender imbalance crisis in the field of computer science, where women represent only 11 percent of the bachelor's degrees awarded in the field [3]. Undoubtedly, there is a great need for female engineers in the computer science profession because technical products produced from a team composed of men and women are much more comprehensive than those produced from a single gender team,

according to Hudachek-Buswell, an instructor at Clayton State University [3]. Faculties in many colleges and university have started using robotics with the hope to change the perception about Computer Science major and to attract new students, especially female students, into the field. As people realize a powerful technique of using robots in the curriculum, there has been a lot of developments in the area of robot platforms so that they can be used in introductory Computer Science courses, as well as there is an significant growth in the market of educational robots, such as Lego Mindstorms, the iCreate, and the Scribbler just to name a few. Among those, the Scribbler robot provides a medium with respect to cost, flexibility and ease of use [13]. This report describes my experience of working with the Scribbler robot and the benefits that I acquired from the experience: learning computing with the Scribbler robot, a real target object, made my learning experience more fun and effective; I gained a lot of confidence about myself in the profession of computer science, and specially, my experience with the Scribbler has also deepened my interest in research activity which can led me further in my academic career.

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