

# Experiential Learning with Robots

Habilou Ouro-Koura, A.S., Abhijit Nagchaudhuri, Ph.D.  
University of Maryland Eastern Shore, USA,  
[hourokoura@umes.edu](mailto:hourokoura@umes.edu), [anagchaudhuri@umes.edu](mailto:anagchaudhuri@umes.edu)

*Abstract— Current trends in multidisciplinary engineering education and real world challenges make it necessary for students to not only acquire but apply knowledge. Robots in general and mobile robots in particular provide an integrated platform for teaching engineering basics and programming. This paper documents the preliminary efforts undertaken by a student in the engineering program at the University of Maryland Eastern Shore under the charter of the Louis Stokes Alliances for Minority Participation (LSAMP) program over the spring semester of 2017.*

*Keywords— Engineering education, robotics, programming.*

## I. INTRODUCTION

Robots are mechanical systems that are integrated with sensors, controls, electronics, and microprocessors to provide an integrated platform that can be programmed to accomplish various tasks. Experiential learning efforts using articulated robotic arms and ground based mobile robots provide exposure to students to real world utilization of robotic devices in manufacturing, household vacuum cleaners and self-driving cars. The iRobot Create® 2 provides an easy to learn platform to introduce students to robotics using various programming languages which can be integrated as a teaching tool in the K-12 environment as well as within the undergraduate engineering education programs. With Create® 2, students learn to write code to send commands to the robot to accomplish specific tasks. During the spring semester, we used the Create® 2 to program in three different languages: Scratch, Matlab, and Python. At the time of writing this paper, efforts are underway to embed a Raspberry Pi in the Create® 2 to make it into a self-driving mobile platform. The learning experience of the LSAMP student is outlined in this paper.

## II. IROBOT CREATE ® 2

iRobot Create® 2 (Fig. #1) is an educational robot easily available and ready to be used by students [1]. The robot comes with a charging dock and a serial-to-usb cable. The robot is actually the base platform for the popular vacuum cleaner, Roomba, and it can be used for many creative projects. iRobot Create® 2 also has the advantage to be programmable, portable, and has built-in sensors that can be used for advanced programming. In developing countries where many universities cannot afford expensive standard equipments for their students, iRobot Create® 2 is an excellent tool to learn practical robotics and programming.



Fig. #1 iRobot Create ® 2

## III. IROBOT CREATE ® 2 WITH SCRATCH

### A. Scratch Programming

Scratch is an easy-to-use programming language created at the Massachusetts Institute of Technology (MIT) [2]. Scratch is used by middle and high school students. Its advantage is that it provides simple user interface. It also gives an idea to first time programmers on how programs are executed using an actual device. Scratch for iRobot Create® 2 consists of blocks that the user builds together to have the robot accomplish certain tasks.

### B. Using Scratch with iRobot Create® 2

Scratch can be opened with any web browser and also a scratch plugin is required to have it working. During this experiential learning effort, Google Chrome was used. We followed the tutorial for Scratch project listed on the iRobot website [3]. The robot was connected to a laptop via the serial port. The Create® 2 experimental extension was loaded into Scratch. The green light in Scratch interface turned on and the 'Dirt Detect' light on the robot was 'on' indicating the robot was ready to be programmed with Scratch. We used basic commands to control the robot and drive it around. Other projects for scratch with Create® 2 can be found online [8].

Scratch is an easy programming language to practice with, especially for programming beginners.

**Digital Object Identifier:** (to be inserted by LACCEI).  
**ISSN, ISBN:** (to be inserted by LACCEI).

### III. IROBOT CREATE® 2 WITH PYTHON

Python is a programming language that is widely used for learning and practice. Python can be downloaded from Python Software Foundation website [4]. For learning, we used Python version 2.7.9. We used the tutorial on iRobot website [3] and implemented the project titled ‘Create® 2 Tethered Driving Using Python’. A ‘Pyserial’ library is needed with Python to control the robot via the serial port. The actual code called ‘Create2\_TetheredDrive.py’ can be downloaded [5]. After the installation, we followed the instructions to execute the code. The program worked very well using the serial-to-usb cable of the iRobot Create® 2 connected to a computer.

While using “Create® 2 Python Tethered Driving Using Python”, it is important to note that we also learned to appropriately interface and send commands using Python to the robot based on objectives and tasks we conceived. Students can easily create their own programs using Python to control the robot. Python is easy to learn and perfect for beginners and STEM students from various fields. The Python codes can be directly used on the Create® 2 robot which enhances learning.

### IV. IROBOT CREATE® 2 WITH MATLAB

The popularity of Matlab in the engineering field makes it an important tool for undergraduate students to master.

An effective way to learn Matlab is to practice it at the same time. We also used Matlab to send commands to the iRobot Create® 2. The Matlab Toolbox for iRobot Create® 2 (MTIC2) has been developed by an engineering professor at the United States Naval Academy and can be downloaded for free. Matlab project for iRobot Create® 2 (MTIC2) is available online. During this project, we had Matlab installed on our computer and downloaded the MTIC2 files to work with the Create® 2 [6]. After installation and following the instructions, the robot was successfully connected and a Matlab script file (.m) was created. The script file is a program created and run by Matlab. We wrote basic commands to control the robot using script files available in the MTIC2.

We used Matlab on the iRobot Create® 2 to extensively control the robot and at the same time to learn the tools that both Matlab and iRobot Create® 2 robot offer for various engineering applications. The built-in sensors in the robot can be used in the Matlab code as well to have the robot respond to its environment; this aspect has close parallel with real world scenarios for many applications such as controlling space rovers, automobiles, and controlling machines used in medicine, construction and various other tasks.

### V. EMBEDDED SYSTEM: USING THE RASPBERRY PI WITH IROBOT CREATE® 2

Raspberry Pi is a micro-computer used for programming, robotics, research, and several projects with embedded microprocessor applications [7]. The Raspberry Pi can also be

embedded in the Create® 2. Thus, the robot can be controlled without being tethered to a laptop anymore and can be operated wirelessly.

The Raspberry pi is also an excellent learning tool for STEM students. The Raspberry pi 3 model B used for the experiential learning efforts reported here came with pre-installed programming languages such as Python and Java. We used Python on the Raspberry Pi to write codes to control the iRobot Create® 2.

*Python* was chosen as an intermediate level programming language to move the robot around using a VNC (Virtual Network Connection)

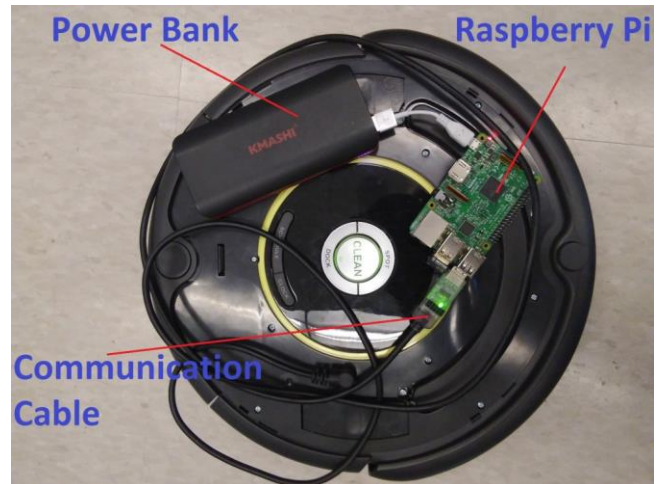


Fig. # 2 Create 2 embedded with a Raspberry Pi

Several projects are available online for students to program the iRobot Create® 2 with Python using the Raspberry Pi [9].

### VI. CONCLUSION

The work reported here utilizes the iRobot Create® 2. This is a low-cost, practical and an easy way for students from various backgrounds as well as STEM students to learn. This paper also presented tools for teachers and faculty to encourage practical programming and robotics lessons for their students. The inexpensive equipment and materials used during the experiential learning reported here can be adapted for students in Latin-America and developing countries to provide them with an opportunity to embrace advanced technology through hands-on learning experiences. IRobot Create® 2 presents many avenues for learning for engineering and technology students; it also enhances students’ creativity, performance, and research skills through various projects. It also provides the faculty an opportunity to incorporate a hands-on tool to enhance learning in a real-world setting.

## ACKNOWLEDGMENT

The authors acknowledge the special support from the Louis Stokes Alliances for Minority Participation (LSAMP) program. Dr. Nagchaudhuri made the Create® 2 platform available to the student(s) through a project funded by Maryland Space Grant Consortium. Other students working on various projects with Dr. Nagchaudhuri and in particular Mr. Rakesh Joshi and Mr. Nathan Bane supported the efforts.

## REFERENCES

- [1] IRobot Create® Programmable Robot. Accessed on February 27, 2017. <http://www.irobot.com/About-iRobot/STEM/Create-2.aspx>
- [2] Scratch website. Accessed on February 27, 2017. <https://scratch.mit.edu/>
- [3] Create 2 projects. Accessed on March 05, 2017. <http://www.irobot.com/About-iRobot/STEM/Create-2/Projects.aspx>
- [4] Python software foundation website. Accessed on March 21, 2017. <https://www.python.org/>
- [5] Create® 2 Tethered Driving Using Python. Accessed on March 21, 2017. [http://www.irobotweb.com/~media/MainSite/PDFs/About/STEM/Create/Python\\_Tethered\\_Driving.pdf](http://www.irobotweb.com/~media/MainSite/PDFs/About/STEM/Create/Python_Tethered_Driving.pdf)
- [6] Matlab Toolbox for the iRobot Create 2 - MTIC2. Accessed on March 28, 2017. <https://www.usna.edu/Users/weapsys/esposito/roomba-matlab.php>
- [7] Raspberry pi website. Accessed on March 24, 2017. <https://www.raspberrypi.org/>
- [8] Accessed on March 01, 2017. <http://irobotstem.github.io/CreateScratchX/>
- [9] Accessed on March 18, 2017. <http://www.irobotweb.com/~media/MainSite/PDFs/About/STEM/Create/camerabot.pdf>