Create® 3 Robot in the Classroom: Teaching ROS 2 to Undergraduates

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About Us

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Agenda

1. State of ROS 2 in Undergraduate Classrooms
2. Making ROS 2 Classroom-Friendly Using Create® 3 Robot
3. What We’ve Learned
State of ROS 2 in Undergraduate Classrooms
Why should ROS 2 be introduced in the classroom?

- Not widely integrated into undergraduate curricula
- Important to prepare students for industry positions
What's keeping ROS 2 out of the undergraduate classroom?

- Requires some knowledge of intermediate computer science concepts
- Limited availability of educational resources for teaching ROS 2
- Configuration challenges within university infrastructure
Making ROS 2 Accessible: Classroom-Friendly Configurations
Using the Create® 3 Robot to Teach ROS 2

Opportunity to start in Python and advance to ROS 2

Learn and apply ROS 2 concepts using various functionalities of the robot

Hands-on activities allow for integration of multiple engineering disciplines
Classroom-friendly Configurations

Virtual Machine

JupyterLab Server

Raspberry Pi
Classroom-friendly Configurations

- Virtual Machine
- JupyterLab Server
- Raspberry Pi
JupyterLab Server

Pros
- Works on any computer
- No Linux knowledge required
- Simplified interface

Cons
- Server build out with IT support
- Instructor material prep time
JupyterLab Server

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Recommended for First Year Undergraduates
Raspberry Pi

Student’s Computer  Wi-Fi  Raspberry Pi  Eth over USB  Create® 3 Robot

Pros
• Reduce network traffic
• More flexibility
• Full access via SSH/VNC
• Add & control additional sensors & actuators

Cons
• Uncontrolled environment
• Instructor prep of image required
Raspberry Pi

Pros
- Reduce network traffic
- More flexibility
- Full access via SSH/VNC
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Recommended for Upper Level Undergraduates
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<tbody>
<tr>
<td>Topic</td>
<td>Basics of Python &amp; using Python with the Create® 3 robot</td>
<td>Intro to Linux &amp; Raspberry Pi</td>
<td>Intro to ROS 2</td>
<td>Intro to rclpy Sensors and actuators on Create® 3 robot</td>
<td>Cloud-based teleoperation obstacle course</td>
<td>Invisible Springs - proportional control</td>
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<td>Gears, linkages &amp; actuators</td>
<td>ROS 2 via terminal</td>
<td>Create® 3 robot</td>
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<td>ROS 2 Concept</td>
<td>Nodes &amp; Topics</td>
<td>Subscribers &amp; Publishers</td>
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<td>Topic</td>
<td>Color sensor line follower - PID control &amp; sensor integration</td>
<td>E-stop and reset position</td>
<td>Square drive</td>
<td>Navigation Using Object Recognition</td>
<td>Mapping &amp; Nav2</td>
<td>Custom interfaces &amp; packages</td>
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<td>ROS 2 Concept</td>
<td>Subscribers &amp; Publishers</td>
<td>Services</td>
<td>Actions</td>
<td>Subscribers, Publishers &amp; Actions</td>
<td>Parameters &amp; Launch Files</td>
<td>Messages, Services &amp; Actions</td>
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What We've Learned
Challenges

- Network connectivity & interfacing with campus IT
- Fostering an environment where “experienced coders” and “non-experienced coders” feel equal
- Facilitating students in understanding complex concepts
Successes

- Project-based learning through hands-on activities
- Opportunity to combine multiple engineering disciplines in projects
- Collaborative environment
Key Takeaways
Acknowledgments
THANK YOU

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20% off the iRobot® Create® 3 robot and its accessories

code: TUFTS-ROSCon-23

Offer code valid through November 3, 2023 on edu.irobot.com/shop and code must be entered at checkout. Cannot be applied to previous purchases or combined with any other offer. Not redeemable for cash or credit.