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

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State of ROS 2 in Undergraduate Classrooms

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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

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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

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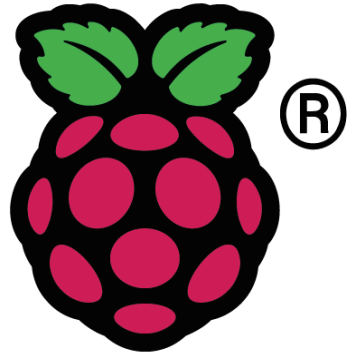
Classroom-friendly Configurations

Virtual Machine

JupyterLab Server



Raspberry Pi

Classroom-friendly Configurations

Virtual Machine

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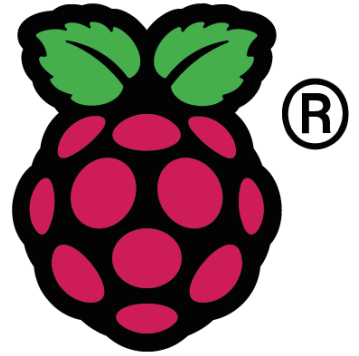
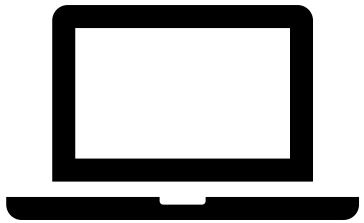


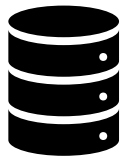
Raspberry Pi

JupyterLab Server



Student's Computer

Wi-Fi

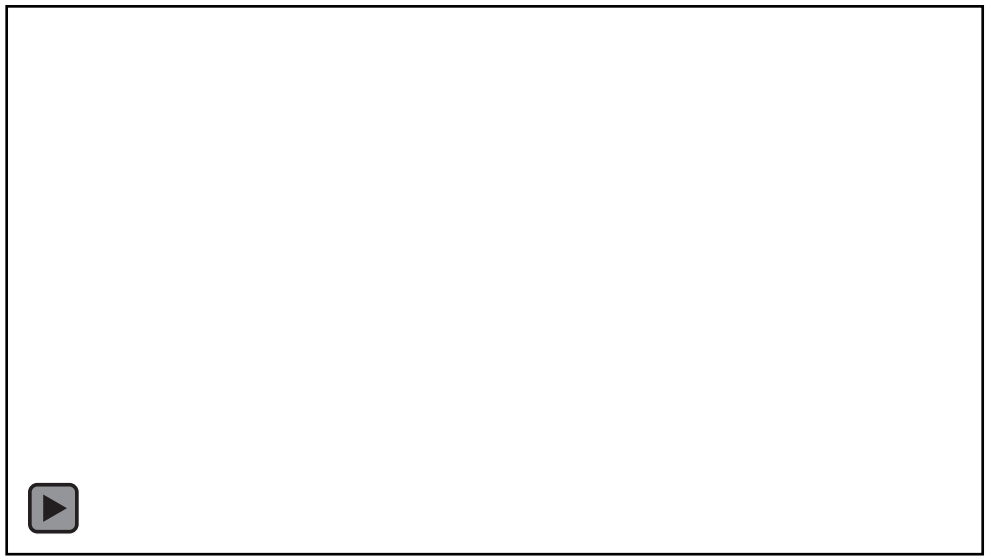


Server

Wi-Fi

Create® 3 Robot

Pros	Cons
• Works on any computer • No Linux knowledge required • Simplified interface	• Server build out with IT support • Instructor material prep time



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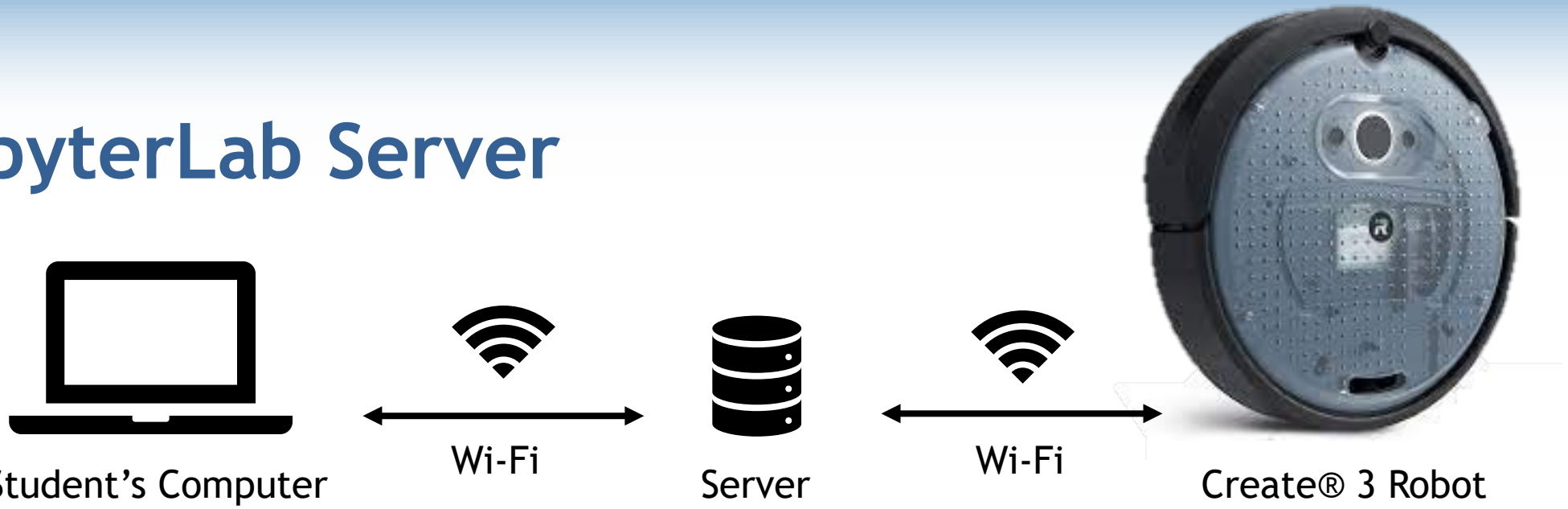
JupyterLab Server



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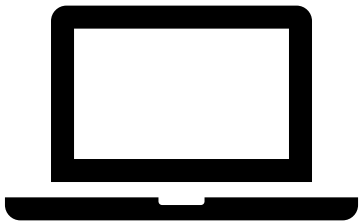
Recommended for First Year Undergraduates

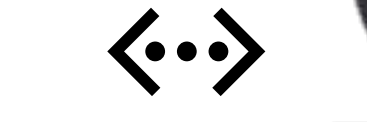
Raspberry Pi



Student's Computer

Wi-Fi

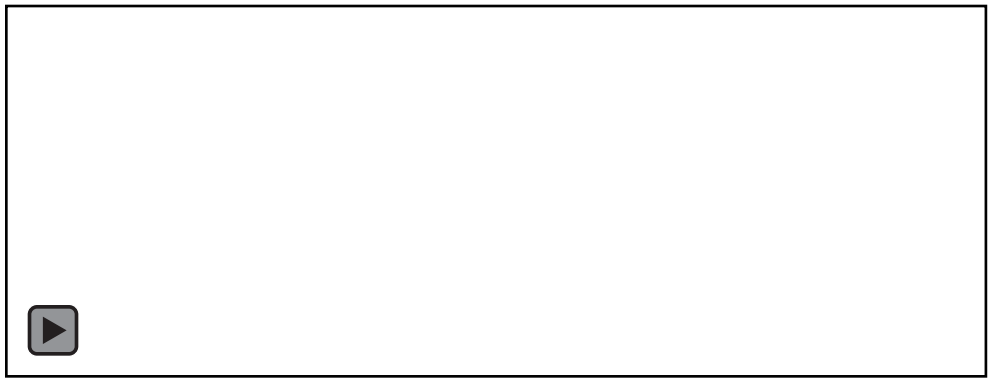
Raspberry Pi



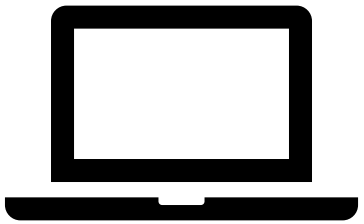
Eth over USB

Create® 3 Robot

Pros	Cons
• Reduce network traffic • More flexibility • Full access via SSH/VNC • Add & control additional sensors & actuators	• Uncontrolled environment • Instructor prep of image required



Raspberry Pi



Student's Computer

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Eth over USB

Create® 3 Robot

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Recommended for Upper Level Undergraduates

Sample Curriculum - Undergraduate Robotics

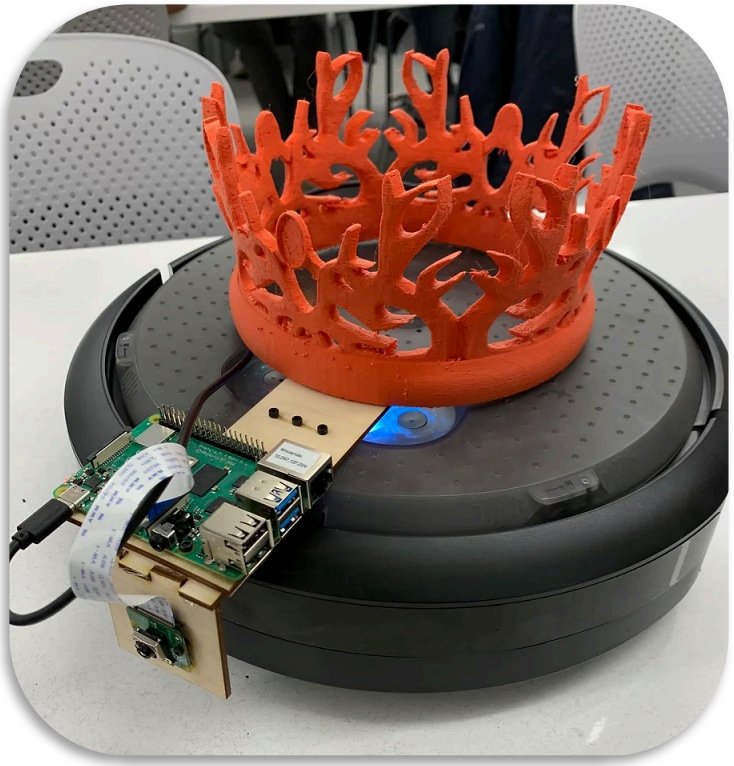
Week	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Topic	Basics of Python & using Python with the Create® 3 robot	Intro to Linux & Raspberry Pi Gears, linkages & actuators	Intro to ROS 2 ROS 2 via terminal	Intro to rclpy Sensors and actuators on Create® 3 robot	Cloud-based teleoperation obstacle course	Invisible Springs - proportional control
ROS 2 Concept			Nodes & Topics	Subscribers & Publishers	Subscribers & Publishers	Subscribers & Publishers

Week	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Topic	Color sensor line follower - PID control & sensor integration	E-stop and reset position	Square drive	Navigation Using Object Recognition	Mapping & Nav2	Custom interfaces & packages
ROS 2 Concept	Subscribers & Publishers	Services	Actions	Subscribers, Publishers & Actions	Parameters & Launch Files	Messages, Services & Actions

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

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Acknowledgments

iRobot™ Education

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Center for Engineering Education and Outreach

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.

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