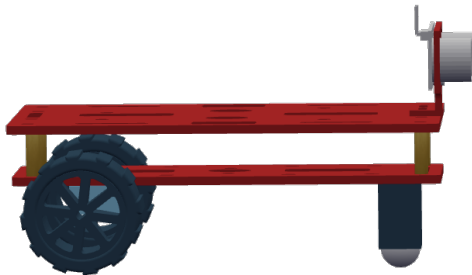# DISRUPTED LESSONS IN ENGINEERING ROBOTICS: AUTHENTIC LEARNING EXPERIENCES WITH VIRTUAL LABS AND OPEN-SOURCE HARDWARE

+ GUIDELINES FOR USE

SALTISE 2021

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OVERVIEW

- **Education 4.0:** Learning for the Fourth Industrial Revolution (*4IR*)
  Arduino microcomputing use case

- **Engineering Robotics:** Active, hands-on learning in and out of the classroom
  A COVID-19 pivot to the virtual

- **Blended Learning:** Virtual labs + physical labs
  Guidelines for use: Open discussion

ARDUINO 101: WHAT IS ARDUINO?

- Arduino is an open-source microelectronics platform based on easy-to-use hardware and software.

- Arduino microcontroller boards can read inputs and turn them into outputs.

- Arduino is composed of two major parts:
  1. Hardware microcontroller
  2. IDE software to program the microcontroller
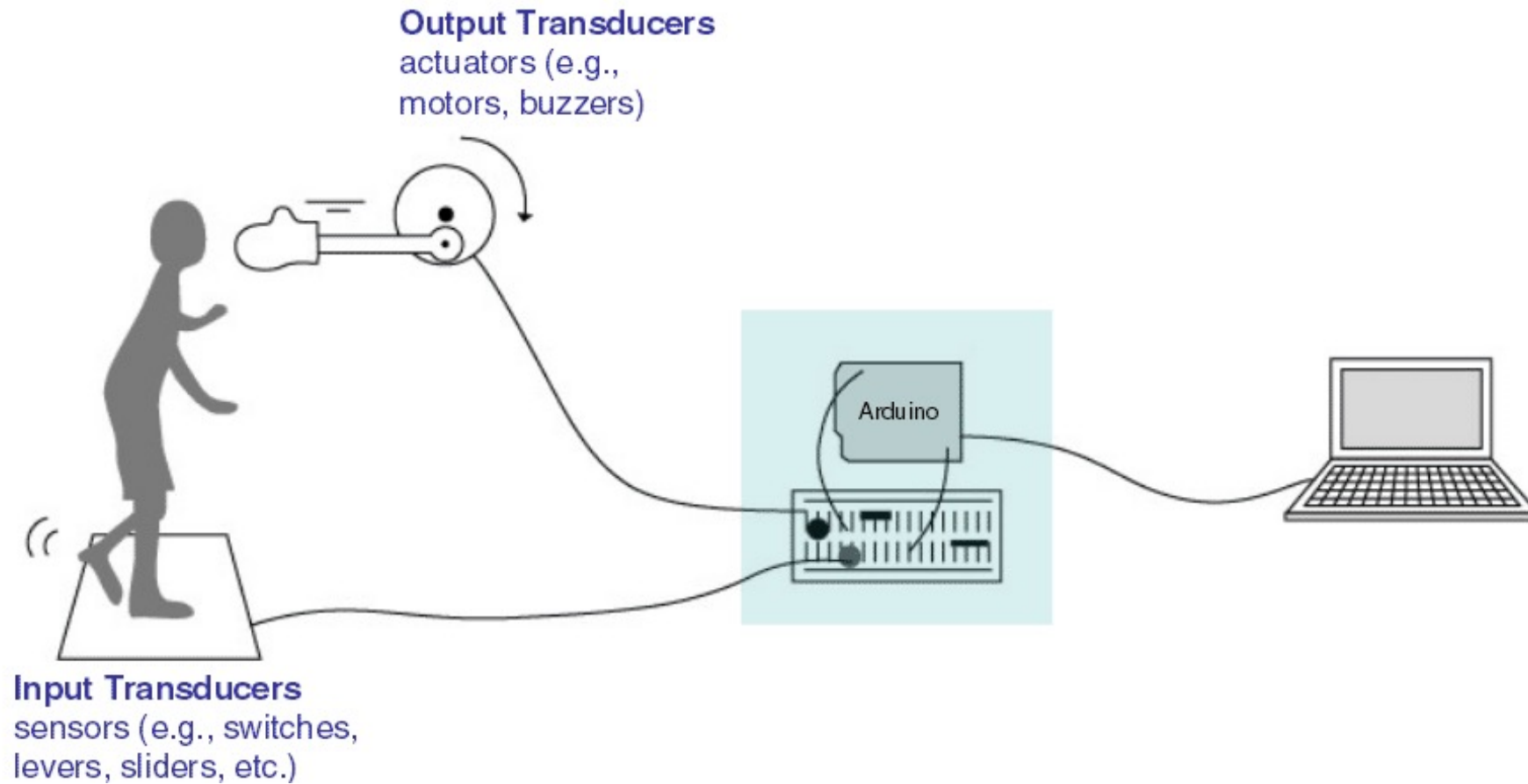
ARDUINO 101: HOW IT WORKS

Output Transducers
actuators (e.g., motors, buzzers)

Arduino

Input Transducers
sensors (e.g., switches, levers, sliders, etc.)

Image: *Theory and Practice of Tangible User Interfaces* at UC Berkley

ENGINEERING ROBOTICS PRE-COVID USE CASE

Sample

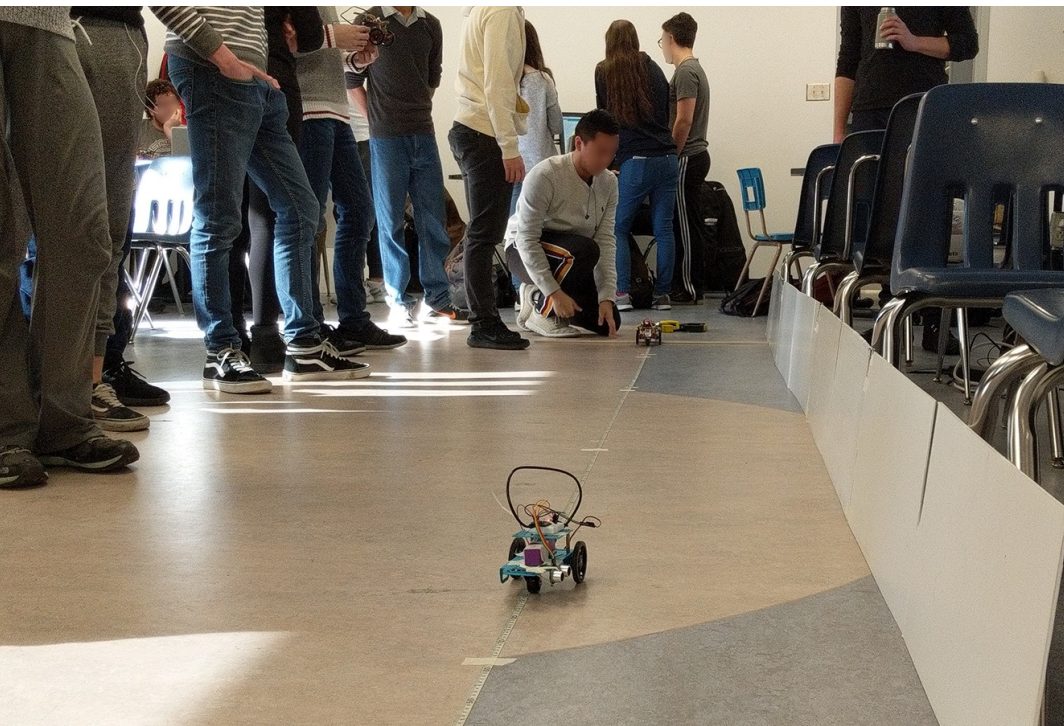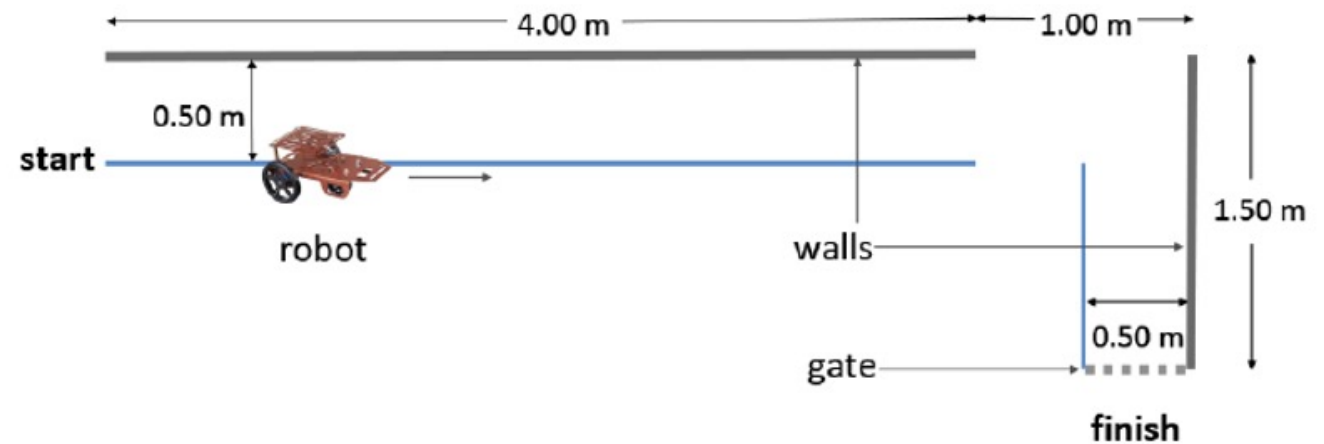- N = 58 (17F, 40M, 1 missing)
- Final semester Engineering Physics course

Figure 1
Navigation Challenge Before COVID-19 Lockdown

Autonomous Navigation Challenge

4-lab sequence in two Engineering Physics final semester courses culminating with class challenge: *Using sensor feedback program a robot to navigate along a complex path in the shortest possible time.*

First 2 labs done before Covid-19 lockdown
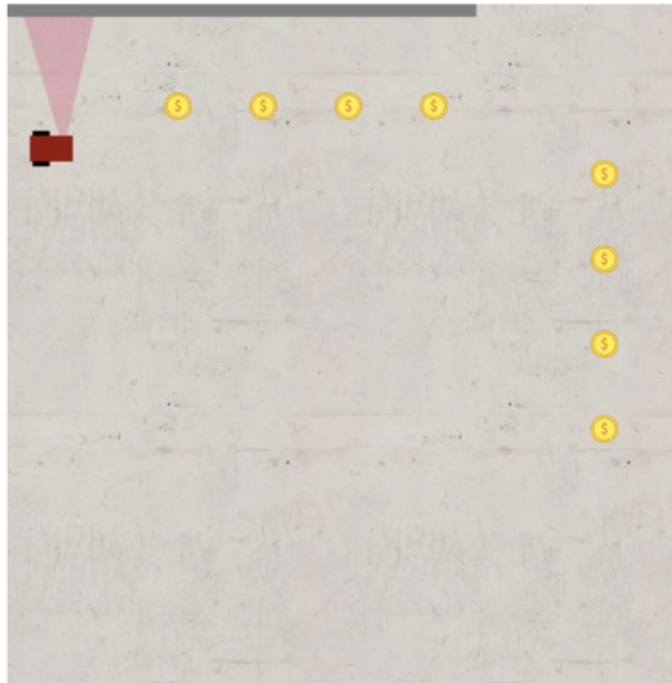
Video

Dawson College Engineering Robotics

Class Navigation Challenge Robot Testing

ENGINEERING ROBOTICS POST-COVID USE CASE

Figure 2
Navigation Challenge Ported to a Virtual Lab Environment

Surveys were administered by a research assistant during class time at the beginning and at the end of the sequence of labs.

Instructions

The coins are approximately 110 cm away from the top wall and approximately 70 cm from the right wall. Use the data from the ultrasonic sensor to navigate the robot to collect all coins.
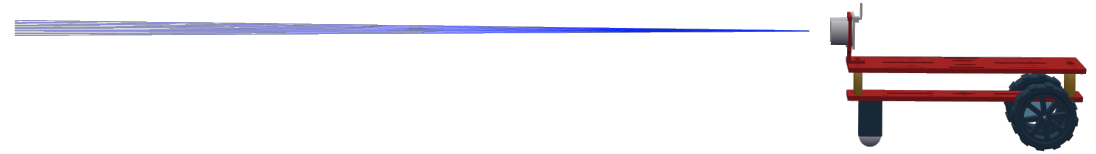
Last 2 labs done after Covid-19 lockdown

Video

Dawson College
Engineering Robotics

Class Navigation Challenge Virtual Simulation

http://englab.dawsoncollege.qc.ca/

OUTCOMES FROM INITIAL STUDY

- We showed how a customized robotics learning activity in an engineering physics course provided **opportunities for students to learn, apply, and experiment with engineering competencies** that often overlap between college and undergraduate levels.

  "I think this was a great lab activity to do related to this class and it was very well modified for the COVID situation we are in. It taught me something I have never fully worked with and showed me something that I did not know I found interesting."

- We posit that the knowledge and skills needed to successfully complete computing-based modules have the **potential to generalize to other learning environments.**

OUTCOMES FROM INITIAL STUDY

"I really appreciate the online simulation we got to play around with. It allowed for individual exploration and a deeper understanding."

" It was a really fun project to participate in, although I'm a bit sad that we could not do it in reality due to the unfortunate circumstances. However, I appreciate the teachers doing everything they can to […] create something very similar and very fun."

WORK-IN-PROGRESS
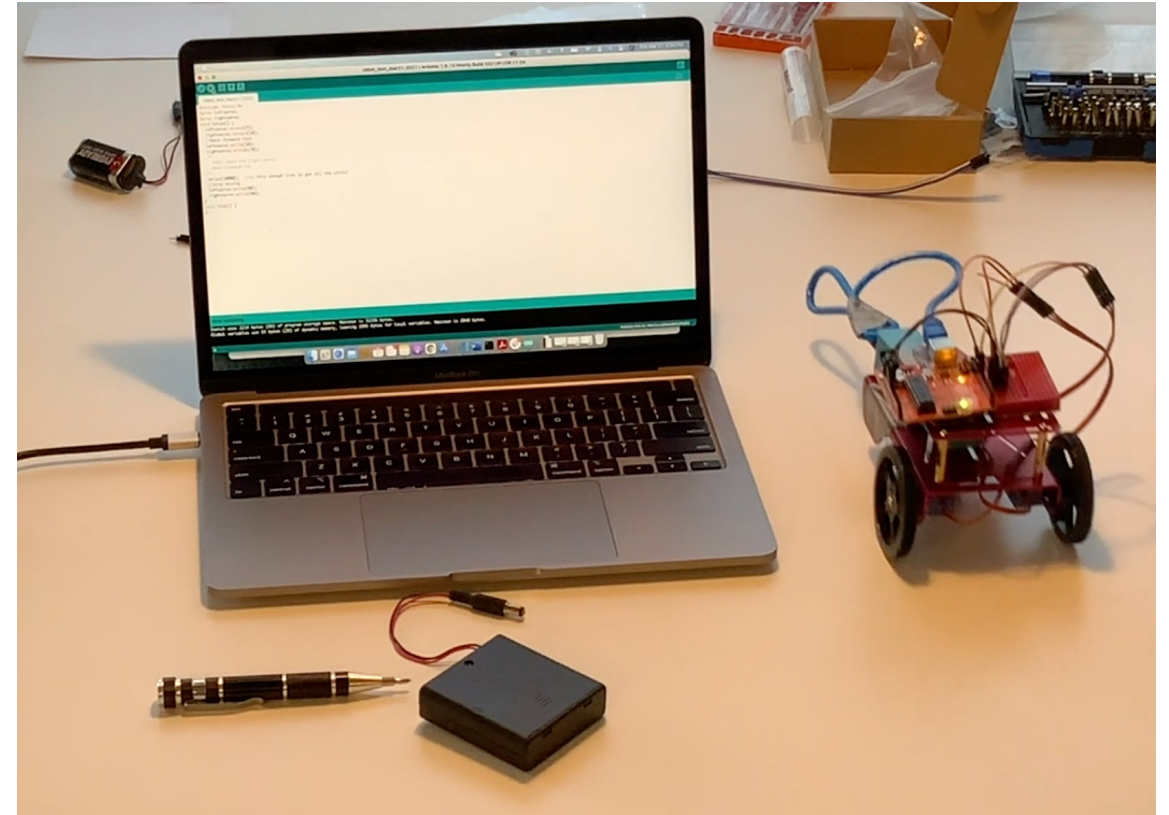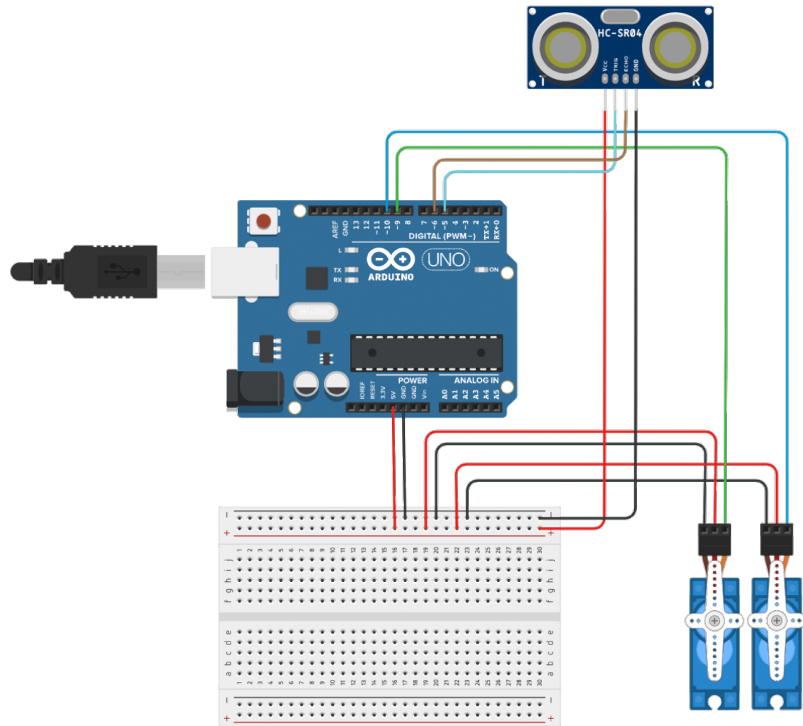
- Recently we have reintroduced robotics hardware designed for home use and expanded the 4-lab engineering robotics sequence studied here to 6 labs.
- Future work will report on outcomes of these authentic blended learning experiences.

WORK-IN-PROGRESS
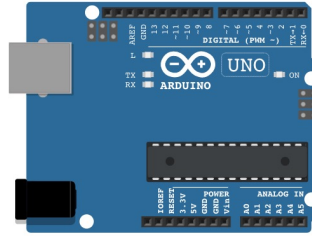
Several learning activities have been created to introduce skills and knowledge (programming and microcomputing) while developing computational thinking and problem-solving prowess.

FUTURE WORK

- Designing experiential learning solutions to develop *4IR* competencies, targeting the overlapping levels of high school, college and undergraduate

- Generalizing the Arduino-based modules to other hardware and customizable environments

- Developing a support model for custom curriculum implementation and teacher training

WORK WITH US

Video of SALTISE 2021 presentation at https://englab.dawsoncollege.qc.ca/saltise2021

THANK YOU!

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THANK YOU!

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