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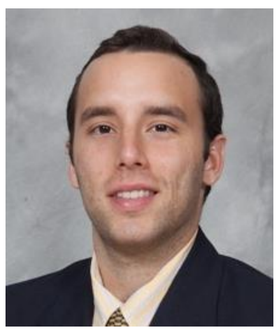

Integrating Co-Robots and Machine Learning in Engineering Lab Environments to provide personalized feedback
CIE 2018 Graduate Research Poster

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Abstract

A **machine learning method for predicting students' performance** prior to the start of a task in an engineering lab environment is presented. The method employs students' facial expressions captured while reading the instruction of a task to predict their performance. A case study is used to validate the method. Furthermore, this work explores how this method could be implemented in a Collaborative-Robot (Co-robot) system to aid students towards the successful completion of an engineering assignment by providing students with real-time feedback. This personalized intervention and real-time feedback have the potential to improve students' performance and learning, as well as to improve the retention of students in STEM fields.

Motivation

Grand Engineering Challenges of the 21st century:
Development of Personalized Learning*

In traditional learning environments, instructors are able to provide **personalized** and **real-time feedback** based on the facial or body language **cues students project**, as well as their **performance** on the task at hand.

Unfortunately, this personalized assistance and real-time feedback is **DIFFICUL TO ACHIVE** where **in-person interactions** are challenging, or the **student to instructor ratio** is high. (e.g., *E-learning*, *Eng. Laboratories*)

Research Question

- *Can a machine learning model predict students' performance with accuracy greater than random chance, by using their facial expressions captured while reading the instruction of a task?*

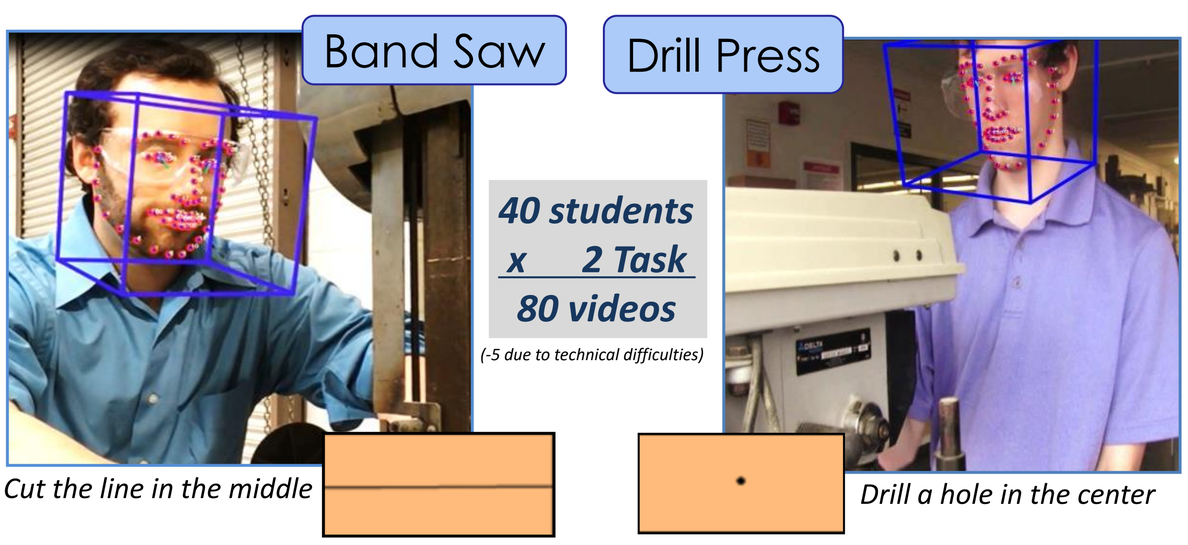
Findings : **Models' performance** (Support Vector Machine models with LOOCV)

1) **Student-Task model:** Task performance ~ *f*(Facial Expression, Tasks, Student)
   -Accuracy= 80% , 95% CI: [69.2% - 88.4%]
   -F_1-score: 85.2%
2) **General model:** Task performance ~ *f*(Tasks, Student)
   -Accuracy= 58.7% , 95% CI: [46.7% - 69.9%]
   -F_1-score: 73.9%

Case Study

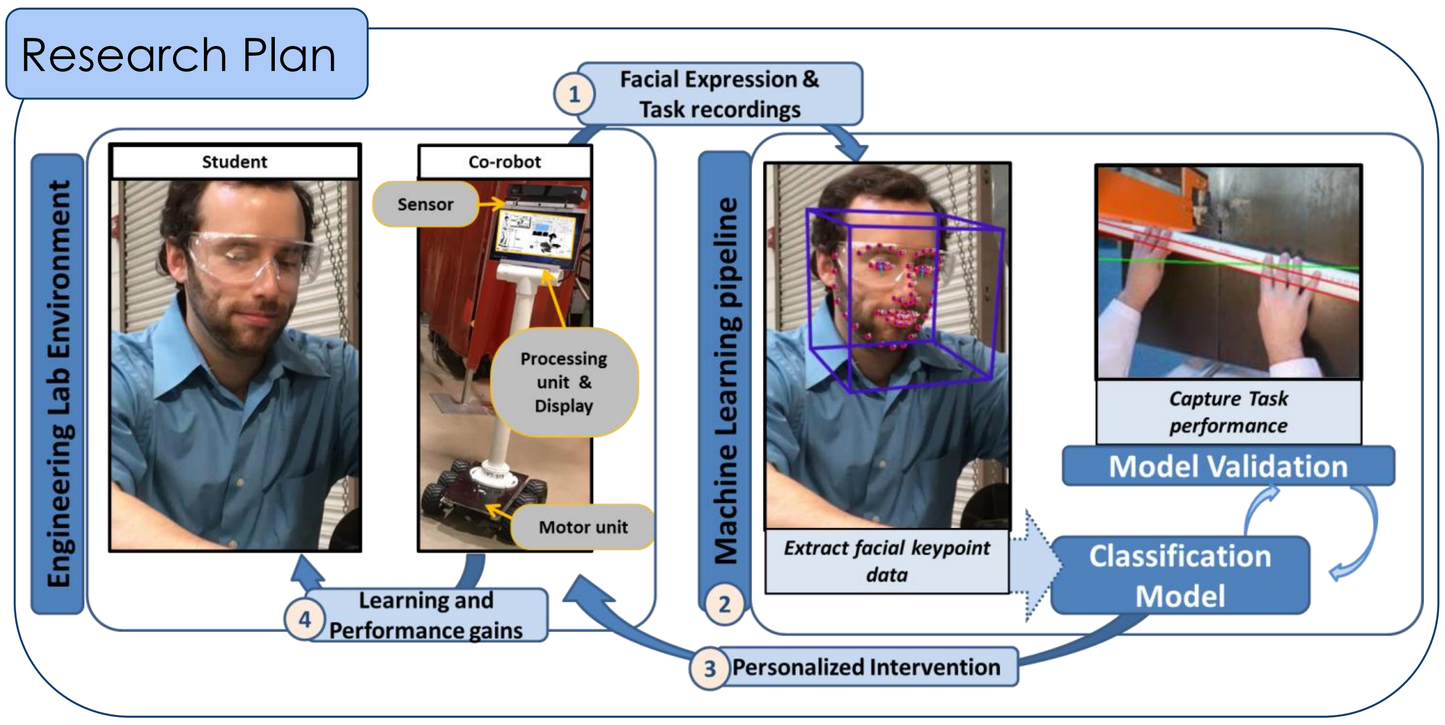
Participants: 40 freshmen engineering students enrolled in EDGSN-100 *Introduction to Engineering Design* at Penn State.
(18 to 19 years of age, 27.5 % females)

Tasks and Lab workstations



Tasks performance: *Below* or *Above* average completion time
(average of all students given a task)

Research Plan



Conclusion and Future Work

This work highlights the potential of using machine learning models and students' facial expression to predict their performance, prior to the start of a task. The next steps are to implement this method in a Co-Robot system to aid students towards the successful completion of engineering assignments by providing students with real-time feedback, which are step 3 and 4 of our Research Plan.

Acknowledgement

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* Grand Challenges for Engineering, by the National Academy of Engineering Vest, C., 2008, "Context and challenge for twenty-first century engineering education.," J. Eng. Educ., 97(3), p. 235–236.