Development of Modular Education Projects for High School Students in Mechatronic Energy Storage Engineering

Relevance to the Automotive and Autonomous Systems Industries:	Automotive engineering has changed significantly over the past several years due to ongoing electrification of powertrains, in large part to make them more climate neutral. This change necessitates optimization of electricity usage and storage in such vehicles. Various technologies and strategies are currently being investigated for these applications, including batteries, flywheel mass storage, and their combinations. Hence the importance of mechatronics in energy storage engineering is increasing, as is the need for more engineers entering this field. High quality educational modules are therefore needed to help inspire younger generations to pursue STEM disciplines and eventually mechatronics and energy storage engineering.
Research Location:	Technische Universität Darmstadt Institute for Mechatronic Systems (IMS)
Homepage (Engl.):	http://www.ims.tu-darmstadt.de
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Project Description: May 22 - Jul 28, 2023 (10 weeks, 40 h/week)	The Institute for Mechatronic Systems (IMS) at Technische Universität Darmstadt offers internships annually to high school students to provide them with introductory insights into research. The goal of this NSF REU project is to design an educational module for these students, through which they can develop a basic understanding of current developments in the field of mechatronic energy storage engineering. It is important that this module is interdisciplinary across all three fields of mechatronics (mechanical, electrical and software engineering); while being framed around the engineering product development process, from the design through the implementation of a prototype. **PHASE A** (3 weeks): Investigate existing educational programs for children and adolescents with respect to mechatronics in energy storage engineering. Develop an overview of potential concepts that include 3D CAD, 3D printing, and programming/controls. Identify and define the final concept for the training module. Detail the work plan, including the complete bill of materials with all the components identified. Become familiar with the microcontrollers, software, and 3D printing tools that will be used in the training module. **PHASE B** (5 weeks): Source, price, and order the purchased components (e.g., batteries, electric motors, microcontroller), and fabricate the 3D printed components. Set up and test the design of the educational module. Program the microcontroller with visualization of data (e.g., serial communication instruments) and usage of controls (preferably PID). Test and validate that the training module functions as intended and adjust to address problems that might have emerged. **PHASE C** (2 weeks): Write final report, document educational module, and deliver end-of-summer presentation on research performed.
Target publications:	• IEEE SmartGridComm 2023, camera-ready paper due 05 August 2023
Necessary Skills/ Knowledge:	• Experience with MATLAB, Python • 3D CAD
Desirable Skills/ Knowledge:	• Interest in STEM education, mechatronics, and energy storage engineering • 3D printing
Additional Online Resource(s):	

NSF REU Students must have completed at least two semesters of engineering studies prior to the proposed summer research, and they must have at least one semester remaining before they can earn their BS in Engineering.