2021-2022 ECETDHA MINI-GRANTS APPLICATION

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Abstract – An overall STEM goal is to increase female enrollment in Engineering and Engineering Technology programs. One possible factor which may increase female enrollment and retention could be a greater focus on "socially conscious technologies"[1] which would improve the quality of life for people such as the design and use of BioMEMS devices. BioMEMS (Bio MicroElectroMechanicalSystems) is an emerging technology developed to support medical research, diagnosis and therapies within the medical community. BioMEMS are microscopic (1 mm to 200 um) sensors, transducers and actuators that can be used inside (vivo) or outside (vitro) the human body. An example of this type of device is a BioMEMS Continuous Glucose Monitoring with a Glucose Sensor and Micropump. Use of BioMEMS can lead to a better quality of life for patients. Understanding and designing the functioning of these types of devices by engineering and engineering technology students is essential in the support of medical technologies. Therefore, this grant application proposes the development of a jointly developed educational kit which is based on Arduino UNOs, LabView, pumps, sensors and wireless technologies like the Xbee modules. The kit should be developed to mimic previously developed kits by ITCC for SCME and the MNTeSIG organizations.

General Background - Ivy Tech Community College and Purdue University Polytechnic educate engineers in many areas to include: electrical circuits, electronics, mechatronic design and analysis and MEMS (Micro-Electo-Mechanical-Systems). These degrees rely on the use of science, technology, engineering and mathematics in support of the design, analysis and manufacturing of devices and systems for the support of our society. Our overall goal is to design and build what is needed for the greater good.

We train technicians and engineers to design, build and test, components, devices and systems that can be used to improve the quality of life for people around the world. The technology used today is rapidly changing and the education we provide must keep pace with the demands for new products. The challenge of education is to innovate and evolve but still teach the basic principles that govern how things work within budgetary restrictions.

Historical Background - In 2014 we establish a working relationship with SCME from UNM for MEMS educations and we quickly adopted the use of three inexpensive kits. These kits could be used to teach students about MEMS devices. Then as part of a separate grant (DUE 1400470 - Microsystems Certification Project) we developed two Arduino Uno and LabView kits that could be used in engineering technology training. These kits have been documented, distributed and presented at various HI-TEC, MNTeSIG and ATMAE conferences (see references 3 to 13).

Figure 1 Microcantilever Kit based on SCME kit, LabView and Arduino Uno

BioMEMS background[14] - The use of BioMEMS is an application of MEMS devices that can be used for applications for BioMEMS devices exist in clinical medicine, environmental, biological and chemical analysis. Applications from one area often overlap with other areas.

Applications can be broadly placed into the categories of clinical diagnostics and therapeutics, environmental applications including Homeland Security, food safety, and bioprocessing.

In addition, there are basic research applications that inform and drive applications in other areas.

Example BioMEMS[14] – MEMS Glucose Monitor and Micropump shown in Figure 2 would be the bases of a new BioMEMS kit and functionally would include:

- The glucose is constantly monitored using an in vivo (implanted) chemical transducer (C).
- A micropump in (A) delivers insulin via a cannula (B) on an as-needed basis.
- D is the transmitter that relays the information from the glucose sensor (C) to the computer (A).

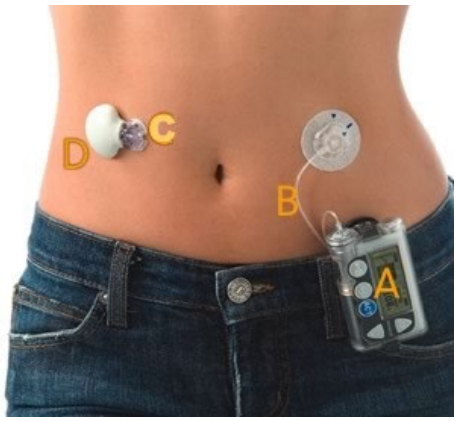

Figure 2 MiniMed Paradigm[R] REAL-Time System from Medtronic Diabetes [Printed with permission from Medtronic Diabetes]

Proposal – Jointly developed an educational kit which is based on Arduino UNOs, LabView, pumps, sensors and wireless technologies like the Xbee modules. The kit should be designed to mimic previously developed kits by ITCC for SCME and the MNTeSIG organizations. Each school would receive $500 from ECETDHA and would find additional matching $500 each. (See attached proposed budget for specific proposed items needed.)

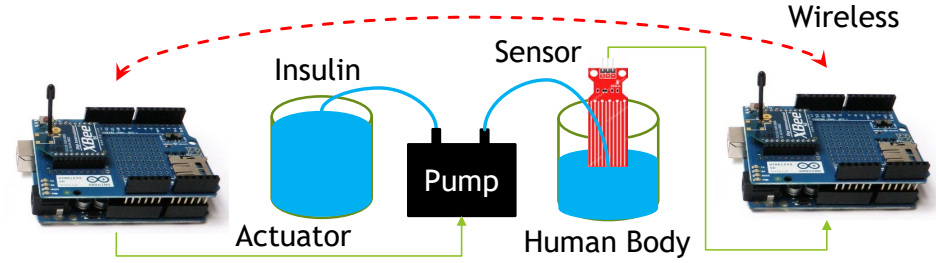

Figure 3 New BioMEMS kit[2]

Phase 1 Purdue and Ivy Tech - Codevelop a BioMEMS Continuous Glucose Monitoring kit with a Glucose Sensor and Micropump kit than can be used for MEMS and BioMEMS education. Would probably be based on existing technology like Arduino UNO, Xbee wireless modules and shields with a tank and level sensor with a targeted cost per kit of $150 each.

Phase 2 Present and Document – The kits would be shared with the ECETDHA, SCME and MNTeSIG. Presentations would be proposed for MNTeSIG, HI-TEC and ASEE.

Phase 3 Offer Kits to others – Ideally, the BioMEMS kit would be offered to other schools through a digital storefront like the SCME MEMS digital Storefront but this would still need to be determined. The kits could be used to improve the focus on socially conscious technologies to increase female enrollment in Engineering and Engineering Technology programs.

Project Co-Directors

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Justification – Inclusion of MEMS devices has not been typically a point of focus in engineering education per se, especially at the Community College level since so much time is spent on teaching the basic theories versus applications. However, if "technology kits" are developed which could be directly integrated into coursework/lab work that includes technology and address interests of female students this would be a win-win proposition. In addition, the development of BioMEMS devices addresses broader societal needs because they could bridge the gap between the needs for medical research and treatment and MEMS and engineering technology education.

References:

1 Why Do So Many Women Who Study Engineering Leave the Field? https://hbr.org/2016/08/why-do-so-many-women-who-study-engineering-leave-the-field
2 2021 Indiana CTSI Regional Campuses Retreat - Education of Engineering Students to Support Medical Research
3 2020 ATMAE Conference (virtual) - Using Arduino Uno and Labview in Teaching Natural Frequencies of SCME Microcantilevers Kits Workshop - video
4 2020 HI-TEC Conference (virtual) - Using Arduino Uno and Labview in Teaching Natural Frequencies of SCME Microcantilevers Kits Workshop - presentation
5 2019 HI-TEC Pre-Conference Workshop - Using Arduino Uno and LabView to Learn MEMS Concepts
6 2018 HI-TEC Conference - Design, Build and Test Arduino Modules Using NI software and Discovery Based Learning for MEMS
7 2017 HI-TEC Conference - Development of MEMS Course Content Using LabView and Arduino
8 2017 MNT Conference - Development of MEMS Course Content Using LabView and Arduino (Poster)
9 2016 ATMAE Conference - Using Arduinos to Teach Engineering Concepts
10 2016 NSF ATE PI Conference - Using Arduinos to Teach Engineering Concepts
11 2016 HI-TEC - Using Arduino & LabView for Teaching MEMS Devices
12 2016 MNT - Using Arduino & LabView for Teaching MEMS Devices
13 2015 MNT Conference - Data Acquisition for SCME Kits
14 Excerpts from SCME BioMEMS Applications online short course https://scme.online/