Embedded Systems Applications in Agriculture Letter of Intent

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Working group: Computing and IR

Subgroup:

Call: Africa strategy for fundamental and Applied Physics

Introduction

At the Physics department of the University Of Cape Coast, our interest is in a course on embedded systems for applied Physics, with specific applications in robotics for agriculture, which falls within mechatronics (Applied mechanics)

The goal of this course is to introduce students to the development of computer programs for applied physics via model-based design [1] with specific applications in mechatronics. This will enable the understanding of the inner workings of embedded systems and the underlining technology, which include the development of electronic circuits and embedded software programs. It exposes students to the structure and components of embedded controllers and the tools necessary for the development of embedded systems solutions. Students will also be exposed to the design and implementation processes of embedded systems for specific applications in Agriculture.

Robotics in Agriculture

Agriculture is by far the single most important economic activity in Africa which employs about two-thirds of the continent's working population [2]. Each country contributes an average of 30 to 60 percent of gross domestic product and about 30 percent of the value of exports. Nonetheless, Africans approach to agriculture is still traditional [3].

Model-Based Design is a process that enables faster, more cost-effective development of dynamic systems, including control systems, signal processing, and communication systems [4]. It reduces time to market and the products have higher safety and reliability.

Many products are mechatronic and this design approach is dedicated right for this type of product.

Learning Objectives:
At the end of this course students should be able to:

- Identify devices built around embedded system technology.
- Describe and explain the operation of each microcontroller component.
- Write programs using physics theories and equations.
- Model and simulate microcontroller programs using software development tools.
- Program embedded controllers using hardware tools.
- Interface different input devices with an embedded controller.
- Interface different output devices with an embedded controller.
- Interface different motors, including dc motor, stepper motor, and servo motor, with a microcontroller.

References

1. dSpace GmbH, "Model-Based Control Design", available online at http://www.dspace.com/en/pub/home/products/systems/controldesign.cfm
2. Dieterle, W. (2004). Mechatronic systems: industrial applications and modern design methodologies. IFAC Proceedings Volumes, 37(14), 1–5. https://doi.org/10.1016/S1474-6670(17)31071-6
3. Singh, R., Singh, G.S. Traditional agriculture: a climate-smart approach for sustainable food production. *Energy. Ecol. Environ.* **2,** 296–316 (2017). https://doi.org/10.1007/s40974-017-0074-7
4. MathWorks, Inc., "What is Model-Based Design?" available online at http://www.mathworks.com/model-based-design/.

Recommended Readings:

- Embedded C Programming And The Atmel AVR,2nd Edition, by Richard H. Barnett, Sarah Cox, and Larry O'Cull: Delmar Cengage Learning, 2006

- Atmel AVR Microcontroller Primer: Programming and Interfacing, by Steven F. Barrett and Daniel J. Pack: Morgan & Claypool Publishers, 2008

- Embedded Systems: Architecture, Programming, and Design, by Raj Kamal, McGraw Hill, 2008.