This laboratory assignment accompanies the book, [*Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers, ISBN-13: 978-1463590154*](https://www.amazon.com/Embedded-Systems-Real-Time-Interfacing-Microcontrollers/dp/1463590156), by Jonathan W. Valvano, copyright © 2021.

**Goals**  • Collect and test all hardware components for the project,

• Write low-level software for each I/O interface,

• Validate that overall project is possible and update the requirements document.

**Review**  • Data sheets for your microcontroller, and your hardware components

**Starter files** None

**Team Size: 4**

## Background

Normally, one passes around the design cycle multiple times. However, in this class, Labs 7, 8 and 11 represent one pass around the design cycle. In this lab, you will perform prototype hardware and software implementations. The goal is to verify your collection of chips, resistors, capacitors and connectors will operate as intended when you get to Lab 11. Furthermore, you will write and test low-level software drivers for all I/O interfaces. The more you develop and test during this lab, the higher the probability your product in Lab 11 will function as intended.

## Preparation (do this before your lab period)

1. Four or more identifiable subcomponents such that each student is responsible for at least one subcomponent (including but not limited to sensors, actuators, WiFi, BLE, enclosure, power, user interface) TAs will judge if the project is sufficiently complicated. This subcomponent breakdown is required as preparation to Lab 8.
2. Collect all resistors, capacitors, chips, connectors, and components you require for your project. At this point, you should have all parts needed to build the system except for the PCB.
3. Write all the header files (prototypes for public functions) for your entire system. The most efficient process is to have designed, implemented and typed all software as part of the preparation. In this way, you can build the circuits and debug while the TA is present.

## Procedure (do this during your lab period)

1. Please procure or build the box for the project. See Lab 7 for examples of enclosures
2. Write all low-level device drivers required to interface with the hardware. You are not required to have the high-level software written in Lab 8. Test all your low-level device drivers and ensure you can interact with the hardware as expected.
3. Modify the requirements document to reflect any changes in your system. For example, you may find your system will have higher or lower performance than originally conceived. You may also need to modify the functionality of your system.
4. Collect preliminary performance data as appropriate. This step is especially important if your device has transducers.

## Deliverables (exact components of the lab report)

A) Objectives

1-page requirements document (Procedure c)

B) Hardware Design

Modified circuit diagram (SCH file), as tested in Lab 8

C) Software Design

Include the low-level I/O drivers (Preparation d, Procedure b)

D) Measurement Data

Give any performance data you collected (Procedure d)

E) Analysis and Discussion (none)

## Checkout (show this to the TA)

Show the hardware/software prototype of your system to your TA. Explain how the prototype is different from the final product. Discuss the testing features of your design. Discuss your top three worries about finishing Lab 11 on time.

## Lab 8 grading (different from labintro.pdf)

Lab 8 is the second of three parts to your own project. The grading rubric for this lab will be different from the one mentioned in the labintro.pdf document.

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You will be graded on the quality of your prototype design. More specifically, you should make this Lab 8 prototype system as close to the final system as possible. You should be able to state where all your prototype design differs with the actual system and how you will account for this difference while doing your measurements.

**Preparation (20)** shown to TA before lab starts

Show all parts to the TA, except the processor and surface mount accelerometer. (10)

Most recent SCH file (5)

Header files for software drivers (5)

**Checkout (30)**

Prototype demonstration, quality of design (25); points will be deducted if you do not have 80% or more of the parts and connectors needed for the final project.

Identifying top 3 worries (5) - Not identifying a worry is a worry. The earlier you identify it, the better it is. So think hard on it.

**Software Quality (30)**

Modularity and organization (10)

Readability (10)

Functionality (10)

**Report (20)**

Refined requirements document (10)

Measurement data (5)

Modified Hardware Circuit SCH (5), identifying any modifications to the PCB that will be needed