Feasibility Model Design

F2019 – Edit this document into a deliverable.

Lab Section:	6	Group:	17

System-Level Design

Our ECE 298 projects start with a conceptual architecture, like the block diagram in Figure 1a). Specific example in Figure 1b). **Replace this figure with a high-level block diagram of your system.**

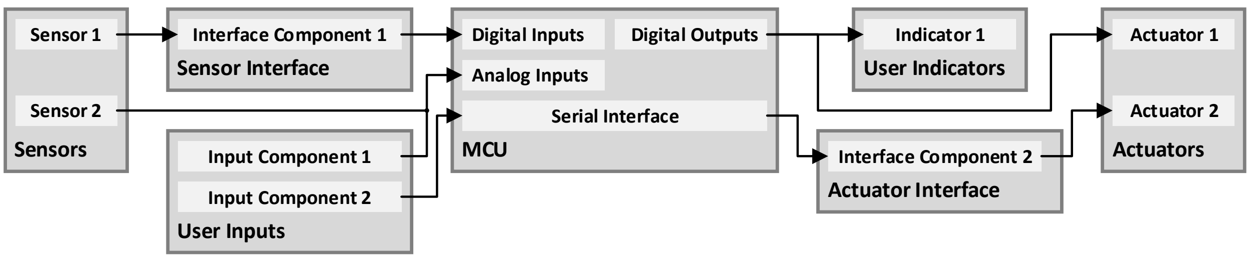
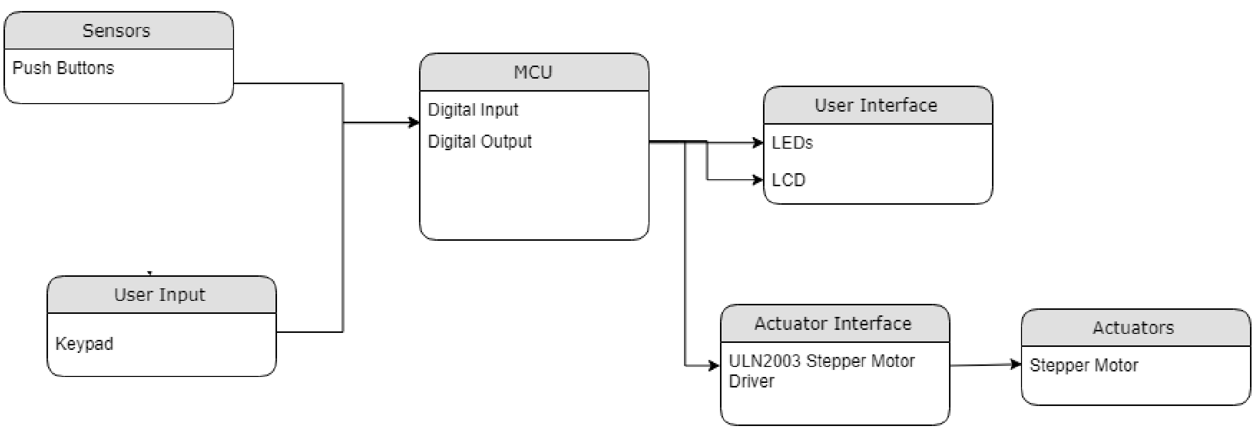


Figure 1a: ECE 298 Project Conceptual Starting Point



Project Design Requirements

In PD 21 you learned about engineering requirements. they fall into three major categories, as follows:

1. **Functional requirements** are quantities that specify the performance of a design. They are related to the functions of the design, identified as answers to the question, "What does it do?" For example, a functional requirement for a coffee maker may specify the time required to brew a pot of coffee, a DC power supply may specify its maximum voltage, and a vehicle alarm system may specify how much noise it makes when it is set off
2. **Non-functional requirements** specify characteristics of the design that are not performance based. Theses are typically features or qualities that are desirable to the client. For example, ease of use, ease of manufacturing, and use of recycled materials.

3. **Constraint requirements** place limits on the design space, and often reflect budget or other project limitations. For example, cost, weight, and noise.

The basic form of most of these requirements is the same: a short description, followed by a relationship (equals, less than, or greater than) and a value.

State three to five major Functional Requirements that your project must meet to successfully solve your problem statement.

1. The project must intake a number of pairs of single-digit numeric inputs through a keypad. The number of pairs that is taken in must be equal to five.
2. The project must display the location of the plotter head on the LCD display. The number of indices the LCD must be able to display in each direction must be equal to nine.
3. The project must move stepper motors, representative of an X and Y axis of a plotter to coordinates in sequence. The number of stepper motors must be equal to two.
4. The project must use sensors (mechanical endstops) to halt the movement of the stepper motors (and by extension the plotter head) and light up LEDs when the maximum limits of the plotter in the x or y axis have been reached. The number of sensors must be equal to four, as there must be one for each axis limit.

Project Sensors and User Inputs

- List the types of sensors and user inputs you may require (light, sound, temperature, magnetic field).
  - 3x4 membrane keypad
  - 4 push buttons, representative of mechanical endstops.
  - The LCD display
- For each sensor and user input, list how you will connect it to the MCU, including additional interface components, if needed.
  - 3x4 membrane keypad is attached through 7 GPIO pins, and input data is decoded on the MCU.
  - Push buttons are attached through GPIO pins, and input data is interpreted on the MCU.
  - LCD is already connected to the MCU, will just write to it through the connected pins.

Project Actuators and Indicators

- List the types of actuators and indicators you may require (e.g. light, sound, mechanical motion)
  - 2 Stepper motors, representative of the x and y axis of a plotter.
  - 4 LEDs, representative of when a mechanical endstop (pushbutton) has been hit.
- For each actuator and indicator, list how you will connect it to the MCU, including additional interface components, if needed.
  - Each stepper motor will be connected to a ULN2003 stepper motor driver that is also supplied with 5V (USB/DC power supply for prototype, 5V jack and supply or USB for final daughter board). The ULN2003 stepper motor driver board will connect to the MCU through 4 GPIO pins.
  - The LEDs will be connected to the MCU through GPIO pins, as the 3.3V digital signal is enough to safely power a 3mm LED.

Project MCU Peripherals

- List the resources inside the MCU that could be used to implement your project (e.g. ADC, timers, interrupts, GPIO functions).
    - Typical GPIO functions can be used to turn on the output and input of GPIO pins for various actuators and sensors. A short list has been compiled below.
        - GPIO_setOutputHighOnPin(),GPIO_setOutputLowOnPin(), GPIO_toggleOutputOnPin(),GPIO_clearInterrupt(),GPIO_enableInterrupt()
    - Interrupts will be used for the mechanical endstops to halt stepper movement
    - Timers may be used to add an appropriate delay between the change of input to the stepper motor to ensure smooth rotation.
- List parameters that the software running on the MCU might require.

Project Testing Methodology

- For each sensor, user input, actuator, indicator, and MCU peripheral listed above, state how you will verify that each one is functioning as expected (a table may be helpful)

Keypad	Push buttons	LCD Display	Stepper Motors	LEDs	GPIO functions	Interrupts	Timers/Clock
Intake a number and write to LCD	Use push buttons to cause interrupts to toggle LEDs	Write characters from keypad to LCD display.	Spin forwards and backwards using prebuilt ULN2003 driver boards.	Use push buttons to cause interrupts to toggle LEDs	Used in literally every other test.	Use push buttons to cause interrupts to toggle LEDs	Use Timers/Clock to properly control stepper motors.

- State how you will validate that each Project Design Requirement has been met

Feasibility Model Diagram and Software Flowchart (High-Level)

A simplified example is shown in Figure 2 and Figure 3. **Replace these figures with high-level block diagrams of your system.**

See next two pages.

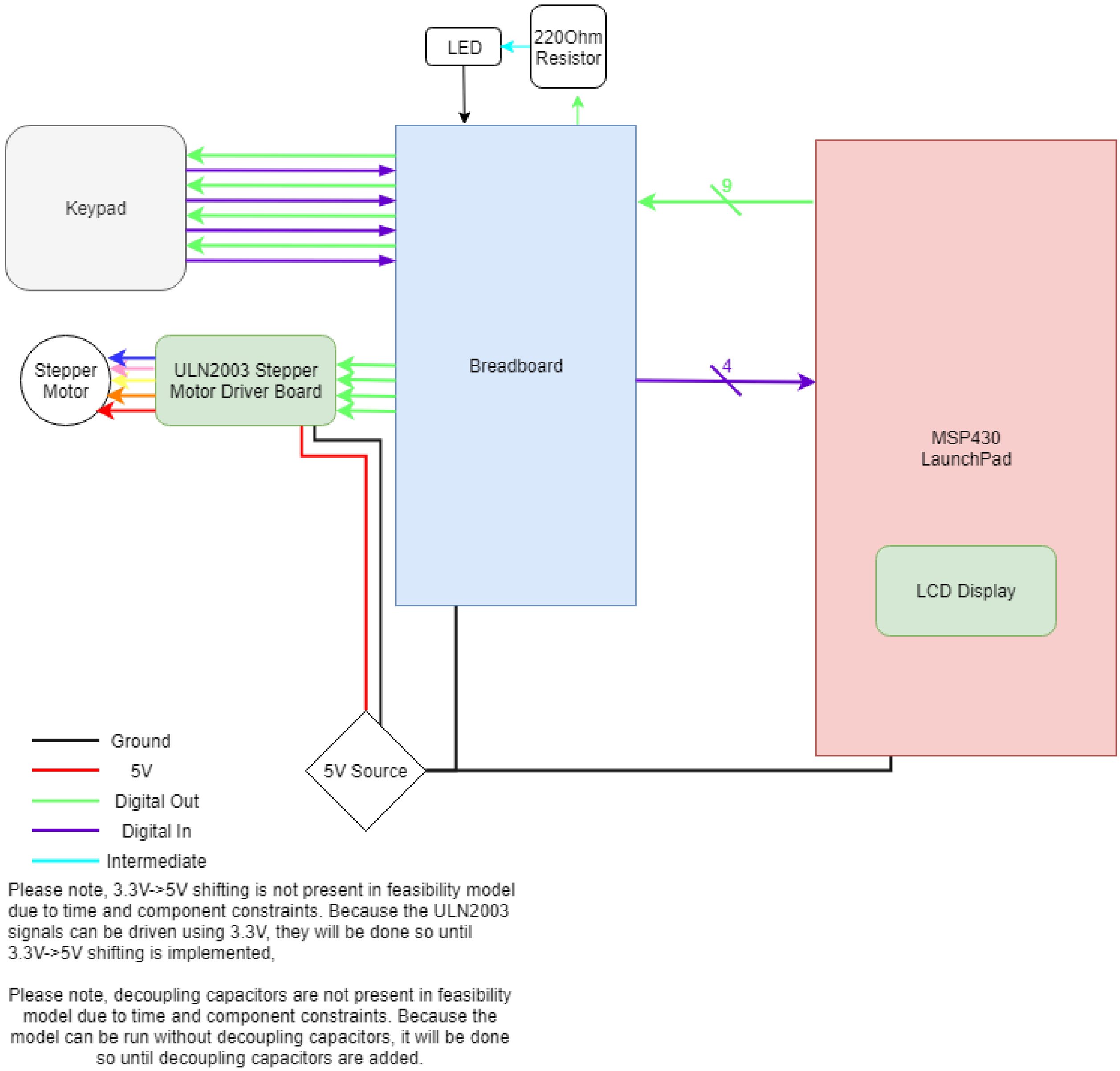


Figure 2: Feasibility Model Design

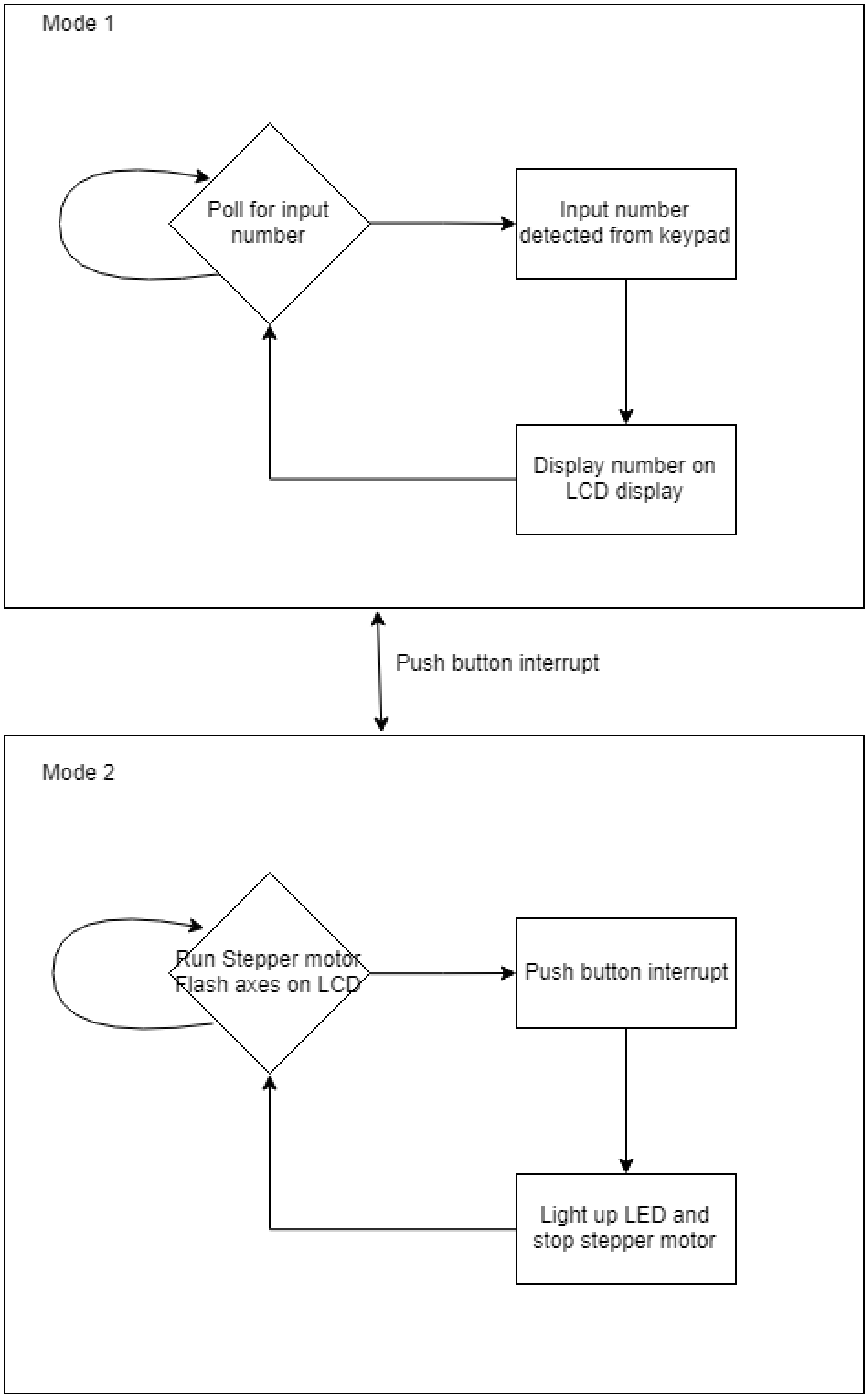


Figure 3: Software feasibility model

Initial Bill of Materials

- List what modules and components (including quantities) are needed from the ECE 298 Parts spreadsheet for your Feasibility Model Design

Module Name	Part Reference	DipTrace ID	Part #	Price	Quantity
MODULE - Stepper Motor Driver	Amazon Distributed Longmire ULN2003 Stepper Driver Board		4916796	$2.30	1
MODULE - Keypad 4x4	Sparkfun COM-14662		4915977	$6.00	1
MODULE - Stepper Motor 5V	Amazon Distributed Stepper Motor		4916741	$2.30	1
COMPONENT - Break-away Module Header Pins (Male/Male) 1x40	Male to Male Module Header Connector for soldering to SMD Adapters and Modules		4916278	$0.15	1
COMPONENT - RED LED - Diffused (3mm)	Digikey 1497-1030-ND	QPARTR3D1	4916303	$0.40	1