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Design Definition Progress Report

EGEN-310R, Team E7

Computer Engineering

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Define Progress Report

***Instructions****: Read all Milestone 2 information. Answer all questions. Digitally submit this document with your answers inserted. Name the document your-last-name. Any other documents requested should be uploaded as well, with a similar naming convention, eg your-last-name\_ 1. Realize that your design responsibilities do not end with the questions you answer. The questions are simply there to guide you to pertinent information, relevant steps you might need to take, etc. One Milestone 2 document should be submitted for each discipline involved in the design. That means if there are multiple designers working within the same discipline then* ***while each must submit*** *a Define Milestone, it may be the* ***same*** *document. Note that Discovery and Define progress reports are graded as pass/fail, with a “passing” grade indicating that the instructor acknowledges that the student has attempted to answer all questions with some level of depth. DESIGNERS are responsible for ensuring the accuracy of ALL calculations.*

***Design process steps included in this Milestone:*** *The main purpose of the Define Progress Report is for the design team to work towards turning verbal and written requirements into engineering specifications and design metrics. Designers should continue to research areas of technical relevance and begin working towards creating initial purchase lists (AFTER specifications have been determined) and begin planning physical experiments and numerical modeling exercises such that they may better understand design tradeoffs.*

***Teaming Expectations****: If more than one designer on a team is working within a discipline, for this milestone they may work together. The entire team will have to work together to form a complete set of functions, objectives and constraints which will then define the entire multidisciplinary design problem.*

***Documentation Considerations****: The final report will have a chapter devoted to the “discovery” and “define” phases of the design project so keeping relevant, organized notes is imperative. At this stage, the majority of the discovery work should be completed. Consider writing a draft of this chapter of your report. The final report will need to include a correct functional diagram and objectives tree for the multi-disciplinary design project as a whole. The group should strive to have these diagrams finalized by the time the Define Progress Report is submitted.*

## Design Theory

At this stage in the process, designers may have enough knowledge to understand what physical and technical concepts may be important to the design, but still lack clear definition of exactly what the design **must do** and what the **goals** are for the design. Each design team has compiled a list of *solution neutral* attributes, which were derived from asking “WHY?” Why might we want a particular feature or component in the design? Asking “why” enough times, eventually led us to a list of **design attributes**. Now the attributes must be organized into those that are functions and those that are objectives.

**Functions** refer to things that the design must DO. Functions are verb oriented, action words. Once identified they are organized into a “Black-Box” functional diagram (see Dym Chapter 4) which forces the designer to clearly identify **inputs** and **outputs** of the design. Design inputs are typically materials, energy and/or information. Design outputs are transformed materials, energy and information (including waste). Once inputs and outputs are very clear to the designer, the second stage functional diagram is created, in which the “top” of the box is removed and **subfunctions** are identified. Most, if not all, subfunctions should be assigned a **functional specification**. A specification answers, using specific numbers and engineering units “How much?”, “How large?”, “What size?”, etc. All potential design solutions need to satisfy the functionality identified in the functional diagram.

**Objectives** are the goals for the design. Objectives are adverbs and adjectives, describing what the design should be or how or to what extent the design should do something. Objective should be organized into a tree that relates high level objectives to lower level ones (see Dym Chapter 3). Objectives at the lowest level of the tree should be assigned **metrics**. That is, designers should ask how could two competing designs, each satisfying minimal functionality, be judged against the objectives? Measurable metrics could have units, could be binary (yes/no), or could be some way of quantifying an essentially qualitative metric (think “aesthetically pleasing”).

**Constraints** arise when there are clear limits on the design that don’t necessarily relate to the functionality that it needs to achieve. Constraints might stem from safety-related objectives. They could be physical dimensions if the design must “fit” somewhere. They often relate to following standards or design codes. Constraints form go/no-go boundaries for the design and MUST be satisfied.

Looking forward, we will use functions for design **ideation**. Designers can brainstorm different ways of satisfying each function and then mix and match those methods together, resulting in a large number of potentially viable solutions to the design problem. Feasible design concepts (those that satisfy minimum functionality) will then be compared against design objectives and metrics will be applied to decide which design satisfies those objectives to the highest degree.

Functional Specifications and Measurable Metrics

Include a copy of your team’s functional diagram (both with the black box top “on” and “removed”) and objectives tree with this document submission. NOTE: These diagrams should be digitized and report ready; NOT a snapshot of a hand drawn diagram. They should be saved as a separate pdf document.

1. **Complete the table below to the best of your ability for sub-functions that fall within your discipline purview (add rows as necessary). You will need to determine as many specifications for those functions as you can – some will come from numerical models, some from background research, some may be educated guesses. Indicate where your specifications came from in the appropriate column.**

|  |  |  |
| --- | --- | --- |
| **Function** | **Specification** | **Reference/Resource** |
| **Sends electrical signals to motors** | **See attached microcontroller specification** | **See attached microcontroller specification** |
| **Distribute power between motors** | **See attached motor controller specification** | **See attached microcontroller specification** |
|  |  |  |
|  |  |  |

1. **Complete the table below to the best of your ability for all low-level objectives that fall within your discipline purview (add rows as necessary). You will need to provide a measurable metric for each low-level objective.**

|  |  |
| --- | --- |
| **Low-level objective** | **Metric** |
|  |  |
|  |  |

1. **List any constraints relevant to your portion of the design problem. Be sure to check all relevant Cat’s Conundrum Documentation.**

# Microcontroller Specification Sheet

Yellow highlighted column is required. “Actual Product Specifications” recommended as you consider different products, but not required for this Progress Report. You will be required to demonstrate that chosen product meets specifications in the final report.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Ideal Specifications** | **Actual Product Specifications** | **Actual Product Specification** | **Actual Product Specifications** |
|  | **Values be based on calculations with reasonable assumptions** | **Product Name:**  Arduino Uno | **Product Name:**  Raspberry Pi 3 Model A+ | **Product Name:**  HCS08QG8 |
| **Cost ($)** | $20.00 | $18.33 | $25.00 | $83.94 |
| **Programing Language** | Python (preferable language for our EE) | C/C# | Python, and many more | Assembly, C |
| **Method of wireless com if applicable** | Bluetooth |  | Bluetooth |  |
| **# of GPIO pins** | 40 | 14 | 40 |  |
| **# of analog input pins** | 10 | 6 | N/A |  |
| **Flash memory (KB)** | 16 | 32 | 512 |  |
| **Min/Max Operating Voltage (Volts)** | -9 volts to 9 volts | 0 volts to 5 volts | 0 volts to 5 volts | 0 volts to 3.3 volts |
| **Logic voltage (Volts)** | 9 volts |  |  |  |
| **Maximum output current (amps)** | 3 amps |  |  |  |
| **Dimensions (Length x width x height)** | 50 mm x 35 mm x 15 mm |  |  |  |
| **Weight (grams)** | 4.20 grams |  |  |  |
| **Mounting method** | Wiring holes and zip ties |  |  |  |
| **List safety features (voltage protection, thermal shutdown, etc):** | Waterproofing, |  |  |  |
| **Control Interface (USB, TTL Serial, analog voltage, I2C, etc.)** | USB to serial communication |  |  |  |
| **Is CAD drawing available (yes/no)** | Yes, in addition to wiring schematic and pin-out |  |  |  |
| **Level of internet support: 0 to 5 (with 5 = incredible support)** | 5, if goal is to communicate over shared wireless network |  |  |  |
| **List Additional Features Below** | Internal current reversal and variable resistor network |  |  |  |

# Motor Driver Specification Sheet

Yellow highlighted column is required. “Actual Product Specifications” recommended as you consider different products, but not required for this Progress Report. You will be required to demonstrate that chosen product meets specifications in the final report.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Ideal Specifications** | **Actual Product Specifications** | **Actual Product Specification** | **Actual Product Specifications** |
|  | **Values be based on calculations with reasonable assumptions** | **Product Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Product Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Product Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Cost ($)** | $7.00 |  |  |  |
| **# of Motor Supported** | Four motors |  |  |  |
| **# of Servos Supported** | Four servos |  |  |  |
| **Stepper Motor Compatible (yes/no)** | Yes |  |  |  |
| **Min/Max Operating Voltage (Volts)** | 5 volts to 35 volts |  |  |  |
| **Continuous/Peak Output Current per channel (Amps)** | 2 amps |  |  |  |
| **Dimensions (Length x width x height)** | 43 mm x 43 mm x 27 mm |  |  |  |
| **Mounting method** | Wiring holes and zip ties |  |  |  |
| **Input pin min/max voltage** | 0 volts to 5 volts |  |  |  |
| **List safety features (voltage protection, thermal shutdown, etc):** | Small heating, strong anti-reference |  |  |  |
| **Specific microcontroller compatibility (no or yes with board name)** | Arduino – Yes, Raspberry Pi – Yes |  |  |  |
| **Control Interface (USB, TTL Serial, RS-232, CAN, analog voltage, I2C, etc.)** | USB to serial communication |  |  |  |
| **Is CAD drawing available (yes/no)** | Yes |  |  |  |
| **List Additional Features Below** | Internal current reversal and variable resistor network |  |  |  |

Planning for physical experiments and/or numerical modeling

1. **As you consider which microcontroller to choose, it would be logical to try controlling a motor and/or servo with each microcontroller under consideration. The Makerspace has microcontrollers and motors and servos which you can borrow for such a comparative test.**
   1. **Choose at least two different microcontrollers to test. Identify them here.**

* **Arduino Uno Rev3**
* **Raspberry Pi 3**
  1. **Choose at least two different loads to test. Identify them here.**
  2. **Sketch the circuit that you create with any other required components.**
  3. **Refer to your stated design objectives. What metrics are important in this test?**
  4. **What do you conclude from the test, based on those identified important metrics?**
  5. **Will addition of the motor driver to the circuit make a difference to the choice of microcontroller? Why?**

1. **Identify *at least* one other experiment or numerical model that you will create to better understand design parameters. One idea might be to add the complication wireless control on the motor control circuit (work with CS if you have one). Plan out this/these experiment(s)/model(s). Keep in mind this can/will be used in the final report.**
2. **Experiment/model seeks to determine:**
3. **Design parameters to be investigated:**
4. **What constitutes a “good” result?**
5. **Supplies required:**
6. **Data/information to be recorded:**

Mathematical Model

Update your spreadsheet model with any parameters which have been determined since Milestone 1. Be sure to note how such parameters were determined (experimentally, through research, or estimation with sound basis). **Resubmit your excel spreadsheet(s) and summarize major changes made HERE:**

## Purchase List

**Begin to identify any other items that *may* need to be purchased for your portion of the design. Begin to compile a list of those items here and their estimated costs.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Part name/part #** | **Vendor** | **Quantity** | **Item cost** | **Shipping cost** | **Ship Time** |
| **Raspberry Pi 3 Model A+** | **Adafruit** | **1** | **$25.00** | **$11.31** | **8 days** |
| **L298N H-bridge Motor Controller** | **Amazon** | **2** | **$7.01** | **$0.00** | **2 days** |
| **Venom 20C 2S 3200 mAh**  **7.4V LiPo Battery** | **Amazon** | **1** | **$31.99** | **$0.00** | **2 days** |

## References

**Include those that you used to complete this assignment, use standard formatting so that these references can be copied into your final report.**

Adafruit Industries. “Raspberry Pi Model 3 A .” *Adafruit Industries Blog RSS*

“Arduino Uno Rev3 (DIP) by Arduino Corporation | Embedded System Development Boards and Kits.” *Arrow.com*, Arrow.com

Arduino Uno Rev3, store.arduino.cc/usa/arduino-uno-rev3.

Boxall, John. “Tutorial - L298N Dual Motor Controller Module 2A and Arduino.” *Tronixlabs Australia*

"MC9S08QG8 HCS08 MCU 8-Bit HCS08 Embedded Evaluation Board." Digi-Key Electronics. Digi-Key Electronics, Web. 4 Feb 2019.

“Raspberry Pi 3 Model A .” *Rotate Display 90º? - Raspberry Pi Forums*