ECE 4950 Project 4
Customer Requirements and Final Design Parameters

Goals

1. To design an autonomous robot that will compete against the other team's robot for the game completion ability.

General Customer Requirements

- The robot plays the game according to the rules which are provided in a separate document.
- Uses the provided game stage, electrical and mechanical interfaces.
- Costs <300*
- Use the provided Arduino, camera, and DC motor.
- Power source for custom electronics (beyond the standard computers and peripherals such as the USB camera:
- No batteries
- Reliable
- Durable
- Safe
- Low noise – no hearing protection required
- Guarding as necessary to protect users
- Fast solving times
- Easy to use/user-friendly
- Electric/electronic circuits built from off-the-shelf components.
- Runs autonomously – user places their own pieces
- **Must have at least one degree-of-freedom that has closed loop position control using the provided DC motor where the loop is closed through the Arduino.**

User Interface

- A GUI must be available which displays the initial configuration of your game set up and the final configuration as specified by the user. <u>The GUI shown in Figure 1 is just an example</u>. The GUI will be graded based on design, relevant information, and usability. The Solving Time must begin the moment "Start" is clicked. An example GUI is shown below in Figure 1. Note that the "Decode QR Code" button is not necessary for this project since we will not be using them. You will have to provide an option for the user to pick a location to place the X/O or Red/Yellow coin, depending on your project.

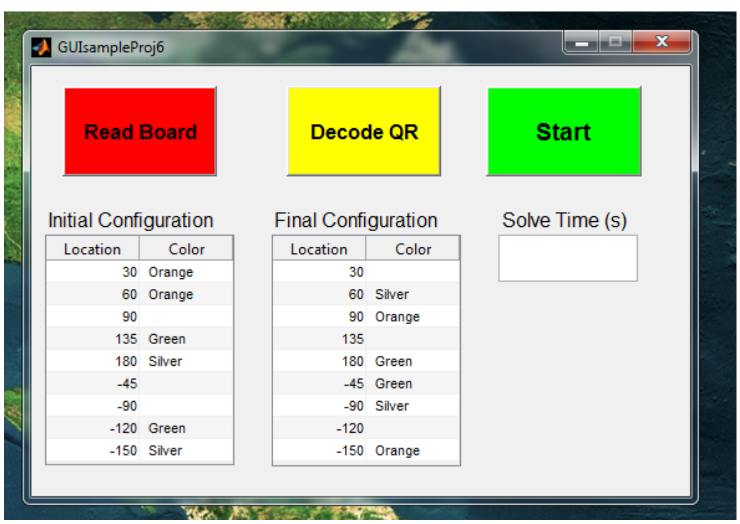

Figure 1: Sample GUI panel

<u>Prototype Evaluation (Sample)</u>
The prototype will be compared against the field of competitor robots (all of the other team's robots on the same project).

Connect 4:
Systems will have to play a single game of Connect 4 with the goal of getting 4 Orange/Purple coins in a row. The human will place a coin on the gameboard which will have to be detected by the system. The choice of coin color should be the humans, and the system can determine who plays first. Upon completion, the winner or draw must be declared.

Checkers:
Systems will have to play a single game of Checkers with the goal of capturing or blocking their opponent's pieces. The human will place a coin on the gameboard which will have to be detected by the system. The choice of coin color should be the humans, and the system can determine who plays first. Upon completion, the winner or draw must be declared.

* **Note on cost:** Cost must be determined using reliable suppliers, i.e. an entity that would be able to supply the component in the future. Generally, auctions and donations cannot be used in determining cost (These are however acceptable ways of acquiring components for your prototype, just find the true cost for the cost accounting). As an example, if a 1Kohm resistor from Digikey (a well known supplier) costs \$1 but you actually buy and use a resistor on eBay (not a reliable industrial supplier) for \$0.2 then you should use \$1 as the cost. The cost of your laptop can be listed as \$2000.

<u>Design Details to be included in the Final Report</u>
<u>System Architecture</u>
Begin by refining the lowest (most detailed level) of your **Functional Decomposition**. Fully define the functionality of the blocks and the signals between blocks and call this **"The System Architecture"**. Describe the detailed design of each block in the System Architecture. The description of each block in the design report should be a narrative that describes the key design features detailed below:

<u>Block with Electronic Components</u>
1. Calculations and simulations used in the design
    a. A SPICE simulation of the circuit (if used).
    b. Calculations of component sizing, e.g. $(0.5A)^2$*4 Ohm ~ 1 W resistor
    c. Resolution calculations, e.g. need 0.2 V resolution over the range 0-5 V ~ 5/0.2 bins ~ better than 5 Bit DAC needed.
2. Behavior models, e.g. model for the RC Servo motor PWM interface as shown in Figure 2.

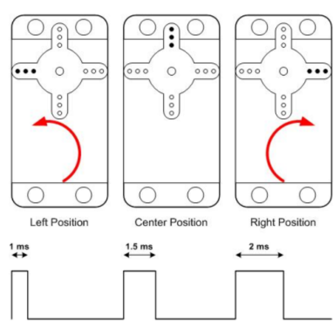

Figure 2: Servo positioning diagram (Reference http://robot.avayanex.com/?p=48)

3. Circuit Diagrams
4. Component selection
    a. May include parts of the data sheet, providing references to the data sheet
    b. A computer or controller may only require selection – no circuit diagram.
5. Cost

6. Circuit board layout diagrams
7. Timing diagrams (if any)
8. Wiring diagrams (if any)
9. Photos of the final circuit
10. Tests performed to verify circuit
    a. Oscilloscope plots
    b. Voltage/Current data collected

Block with Mechanical Components

1. Calculations and simulations used in the design
    a. The torque on a motor required to produce a force of 10 N arm of length 0.25m is 2.5Nm
    b. Resolution calculations, e.g. if a motor with resolution of 0.1 degrees is used to position a 1m arm, then the resolution at the end of the arm is 1.7mm
2. Component Selection e.g. 2.5Nm motor -> Baldor DC Servo Motor: MT-4070-BLYCE, Continuous Stall Torque= 28.0Lb-In = 3.2Nm, Continuous Stall Amps = 9.2A
3. Mechanical Drawings
    a. Detailed drawings of each part with dimensions
    b. Assembly drawings
4. Photos
5. Cost
6. Tests performed to verify performance
    a. For a ping pong ball launcher, We performed 30 trials of the spinning wheel mechanism and measured the following relationship between motor speed and distance from the launcher as shown in Figure 3.

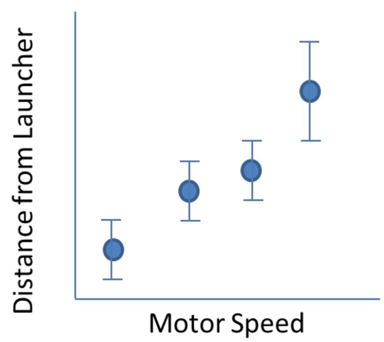

Figure 3: Testing of the ping pong ball shooter

Block with Software Components

1. Behavior models such as flow chart, state diagram, data flow, entity relationship digrams, a UML view
2. Order of magnitude calculations, e.g. storing x frames per second at 60Hz will require xxGB of onboard memory
3. Implementation language,
    a. Simulink diagram could be used in the body of the document
    b. Put the final code on the website only (don't print)
4. Data structures, database design
5. Testing of component
6. Cost

System Integration

1. Assembly diagrams for all subsystems
2. Timing diagrams (if any)

3. Wiring Diagram for all subsystems
4. Test results for the entire system
5. Cost

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Use the guidelines below to complete your report and add at the end of your report.
Group Member Last Names:____

Score	Pts	
	5	**General Format - Professional Looking Document/Preparation (whole document)** a) Fonts, margins (11pt, times new roman, single spaced. 1" margins on all sides). b) Spelling and grammar are correct c) Layout of pictures – all figures need numbers and captions and must be referenced in the text d) Follows the page limitations below. e) References. Use IEEE reference format. f) This grading sheet is included as the final page.
	0	**Page 1: Title, Group Name, Group Members, and Date** **Executive Summary** (1 concise, well-written paragraph) Provide an overview of this project. Briefly describe what you did and what you learned.
	5	**Page 2: Engineering Requirements** (<1 page) Bulleted list of Final Design Engineering Requirements
	10	**Pages: 3-7: Design Details (<5 pages)** Describe a system that can be built including System Architecture and System Integration based on the Engineering Requirements. Do not include data sheets or software code.
	10	**Page 8: Analysis of Final Prototype Performance** (<1 page) Did it succeed or fail to meet customer requirements? What went wrong and what happened in the design process to allow this problem? Make a table of the customer requirements and address how well your design met these expectations.
	5	**Page 9: Project Schedule/Gantt Chart** (<1 page) Create a schedule (Gantt chart) that shows the tasks and schedule for your project. Start from the very beginning of your project and extend to the end (completing final report and presentation).
		Page 10 This grading sheet is included as the final page.
	50	Laboratory demonstration of your prototype (evaluated by instructor and TAs). Evaluator will manipulate the interface and evaluate how well the system provides the timing and display functions (i.e. how well does the closed loop control work). Is it well built? Neat wiring? (.6 * the prototype evaluation score)
	15	Rating by reviewers after competition
	15	Poster for Demo containing the following from the report: • Executive Summary • Customer and Engineering Requirements • Software Explanation • Prototype Design Explanation • Performance Analysis