P4, Part B: Design Refinement

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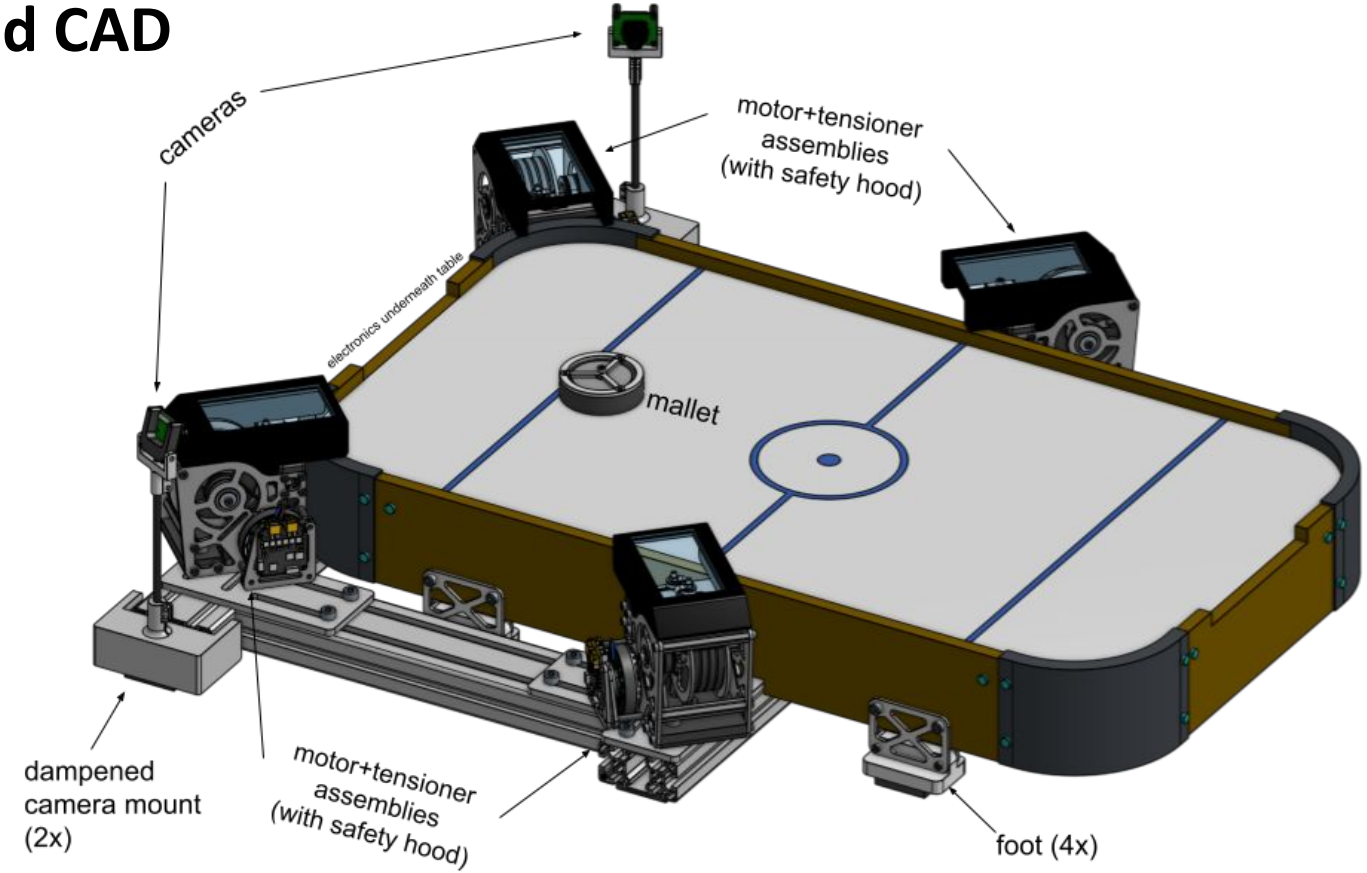
Refined CAD


cameras
motor+tensioner assemblies (with safety hood)
electronics underneath table
mallet
dampened camera mount (2x)
motor+tensioner assemblies (with safety hood)
foot (4x)

Updated Calculations

Transmission calculations, cable forces, spool torque calculations, and bearing load calculations are done in the following spreadsheet. Briefly, we do the following

- **Transmission**: overspecing the speed to desired mallet vel. 6m/s with a 75mm spool. We determine the motor max RPM via $KV*V_{PSU}$ =8000RPM and the target spool RPM $=V_{des}/(\pi*d_{spool}/1000)*60=7900$ so we just need a 1:1 transmission ratio.
- **Cable Tension**: with a mallet mass of 0.5kg and an assumed acceleration of 15m/s^2 we find the force and the cable tension with a factor of safety of 2 is $(F_{acc} + F_{pretension})*2$ where we take a 10N pretension yielding 35N.
- **Motor torque validation**: the torque is $T_{cable}* r_{spool}$ which yields 1.3125Nm and comparing to a MJ5208 peak torque of 1.7Nm, we don't need a gear reduction to meet our req. acceleration.
- **Bearing Loads**: the effective circumferential force, given we have 1:1 ratio means the V-belt wrap angle is 180 deg, so our force is $2*T_{spool}/d_{pulley}$ which is 206.7Nm

Standard and Codes

Uxcell F6801ZZ Flanged Ball Bearing (12mm ID). Based on updated calculations, we determine the max circumferential force acting on the spool. This translated to a radial load on the bearing. We use the *ABMA's standard boundary dimensions for combined radial and thrust loading*: $F_e=X_iVF_r+Y_iF_a$.

- Radial Load is F_c=206.69Nm, F_a is assumed to be 0 since the timing belt and cable will apply perpendicular forces on the shaft.
- V=1 since the inner ring of the bearing rotates with the spool shaft.
- X_i and Y_i are the load factors which for F_a=0 come to X_1=1 and Y_1=0. So F_e=206.69Nm.

Then from ABMA for a 68 series, 12mm bore, and ZZ double shielded deep groove ball bearing, we find the static load to be 1.06kN and the dynamic load to be 1.9kN. Comparing this to our bearing load, it is less than 20% of the bearing's rated static capacity.

BOM

Our bill of materials can be found here.

Our total cost is ~$930, with a breakdown as follows:

- Electronics: $560 (~60%)
- Motor assembly: $230 (~25%)
- Frame: $140 (~15%)