10 - Design Justification

March 19, 2021 10:37 AM

START : 10:45 A.M.
END : 12:30 PM

No.	Type	Specification	Unit
1	Constraint (inequality)	Must be >= 75% accurate at identifying/sorting paper, plastic, metal, glass, and "other"	% Number of Items
2	Constraint (inequality)	Must be made from >= 30% recycled material	% Composition
3	Constraint (inequality)	Must identify/sort >= 6 items in a minute (one every 10 seconds)	Items/Min
4	Constraint (inequality)	Must cost <= $250	CAD
5	Constraint (inequality)	Must accept items of up to size ~~15x15x30~~ cm rectangle 7.5x7.5x22.5	Volume
6	Constraint (inequality)	Must weigh <= 25 kg	kg
7	Constraint (inequality)	Must not misidentify glass/Styrofoam/trash into other types more than 10% of the time*	% Items
8	Constraint (Yes/No)	Must meet all applicable Canadian safety standards	NA
9	Constraint (Yes/No)	Must be compatible with standard recycling/garbage bin sizes	NA
10	Objective (inequality)	Should be low power <= 50W	Watts
11	Objective (inequality)	Should have long lifespan >= 15Yr	Years
12	Objective (inequality)	Should fit in average Canadian appliance footprint for residential design	m^2
13	Objective (Yes/No)	Should be open source	NA
14	Objective (Yes/No)	Should be modular	NA
15	Objective (Yes/No)	Should be scalable	NA
16	Objective (Yes/No)	All parts should be available locally/within Canada	NA

* constraints/objectives relevant to mech design highlighted in blue

Constraints/objectives highlighted in yellow still need to be verified

Constraint 2: Must be made from >= 30% recycled material

- Moving components are majorly made of new material
  - Motors have to be purchased, parts are 3D printed (such as the flap for the trap-door mechanism)
    - BUT 3D printed components were designed with PLA in mind as the material
      - Not necessarily recycled, but is biodegradable: https://www.creativemechanisms.com/blog/learn about polylactic-acid-pla-prototypes
- Outer housing (not designed due to time constraint) can definitely be made partially of recycled material
  - Outermost housing is essentially a stationary box
    - Can be made of any flat surface that can be combined together via fasteners/glue/etc.
      - Wood, recycled plastic, metal even, etc.
      - These materials can be sourced from recycled/repurposed materials

Constraint 3: Must identify/sort >= 6 items in a minute (1 every 10 seconds)

Constraint 4: Must cost <= $250

Constraint 5: Must accept items of up to size 7.5 x 7.5 x 22.5 cm rectangle

- Get screenshots of box fitting in all components (CAD)

Constraint 6: Must weigh <= 25 kg

- Add up total weight of all components

Constraint 8: Must meet all applicable Canadian Safety Standards

- Kept safety in mind while designing: limiting pinch points, designing enclosures for moving parts, etc.
- Further safety standards would have to be verified in the prototyping/testing stage, which is out of scope for our project
  - For example, motor testing: https://www.machinedesign.com/markets/article/21828181/how-to-meet-canadian-standards

Constraint 9: Must be compatible with standard recycling/garbage bin sizes

- Modular design allows for customizability
- Outer casing not designed (out of scope for this project) but it is not vital to the success of the sorting system itself
    - Can be designed however user sees fit to fit the user's exact needs and output bin sizes/geometry
        - Compatible with all bin sizes by default due to open source/modular nature

Objective 11: Should have a long lifespan >= 15 years

- Under regular conditions in a room, PLA can survive for up to 15 years: https://3dprintergeeks.com/pla-3d-printed-object-durability/
    - We will likely not reach our 15 year objective without needing some upgrades/replacements, but we could get close
        - This also likely depends on frequency of use
    - However, luckily, PLA will begin to fail because it will begin to biodegrade
        - Supports our environmental ethos for this project
        - Replacement parts could simply be reprinted and the cycle could continue

Objective 12: Should fit in average Canadian appliance footprint for residential design

Objective 13: Should be open source

- 3D printed components are modelled in SolidWorks
    - Can easily upload them to a platform such as GrabCAD or thingiverse for use by others

Objective 14: Should be modular

- Because many major components are 3D printed, adjusting the design to fit exact user needs is fairly simple

Objective 15: Should be scalable

- Similar note as with modularity. Only concern would be the strength of the materials - i.e. You would probably have to start looking into stronger materials for 3D printing to handle increasingly large torques
    - May lose biodegradable perk of using PLA
    - Could use metal for very large scales though, which would be recyclable

Objective 16: All parts should be available locally/within Canada

- Much of the mechanical design consisted of 3D printed components
    - PLA printing filament can be found locally
- Other parts are hobby level (items such as the bearings and timing pulleys)
    - Could potentially be found at local hobby shops
        - Slightly different sizes are acceptable too (because of the modularity/scalability of the design)
- Items such as rotary shafts can be found at any metal supplier - wouldn't be difficult to find local source
- US sources were just used as a base sometimes for this design because they provided unit prices without having to request quotes
    - Quick way to estimate the cost