Date: November 11th & 13th 2019 4 - 5PM

Room: FF 303

Week 11: Final Report & Presentation Contents

Leader: Aleisha Cerny

Secretary: Sofia McGurk

Attendance:

Individual	In Attendance
Catherine Greenwood	Y
Jenna Moledina	N
Clement Asiedu-Antwi	Y
Isabela Taketa	Y
Aleisha Cerny	Y
Sofia McGurk	Y

Prior to Meeting with Chad:

1. Make the set up
2. Measure the height of the camera
3. Take a picture with the lights on and the measuring tape in the frame
4. Take the same picture
5. Print an overhang

   Print Parameters Good Object:
   - Source: https://www.thingiverse.com/thing:2298057?fbclid=IwAR1Cd6jevOEbg1M-SNvmfl8l86bttQ4gMUMrnUkB-RVE_xrgyWwrZs1IcrA
   - First Layer height 0.2 mm, every layer after that is 0.15 mm
   - No support material generated
   - Temperature: First layer as 220 °C (PLA) and 60 °C (Bed)
   - Print settings optimal

   Print Parameters Failed Object;
   - First Layer height 0.2 mm, every layer after that is 0.35 mm
   - No support material generated

    - Temperature: First layer as 215 °C (PLA) and 55 °C (Bed)
    - Temperature: First layer as 210 °C (PLA) and 55 °C (Bed)
6. Define Spaghetti monster
7. Pick a defect size
   Want to detect defects that are equal to the layer height (this is a parameter that can be changed by the user). But it can only go down to 1.5 mm anything smaller than that is it not within our accuracy which we will determine (we will find precision once we take new images and analyse them).
8. Detectable defects:
    - Can detect for- detachment, collapse in structure (total collapse), missing material flows (including viewing window), surface errors (if larger than the thickness of a layer, and if it propagates), cracks between layers only if they propagate and create “spaghetti monster”.
    - Can’t detect for surface errors if it is just in an isolated spot or too small, and cannot detect deviation from the model (too late)
    - If the defect is not directly under the laser then we will find it later…
    - Defect size can only be as large as the thickness of a layer

Agenda for Meeting with Chad:

1. Status Update

Hardware:

Chad: Printed part: print faster, increase/ decrease nozzle temperature, increase/decrease bed temperature.
Chad: Print exact same part to make it fail.
Cat: Finalized setup and taking good pictures which we send to software.
Chad: Prelim setup is ok
Chad: Next steps set up
Cat: 1 laser line attached to the frame, taking the picture at the starting point of each layer. One time every 5 layers.
Chad: Why just 5 layers? Why not every layer
Cat: Need to account for how much time it takes to analyse the image
Chad: How much time will it take to interface? Input into G code a pause at which point you would trigger the camera to take a picture. Then the image will go to computer. Run the edge code, then analyse. Find out exactly what kind of time we are looking at for the whole process? What is the delay time in between layers?
Cat: Looking through pixels and images to get values… can we make the number of layers a variable?
Chad: We can do it every layer as it should only be 1 sec to run code.
Cat: Defects only if thicker than a layer and also if it propagates.
Chad: May not get all defects… but the other side is too high a tolerance = way too many rejected parts. Other way if too low tolerance = lots of bad parts to completion. If you wait too many layers there is a lot of waste. Might help justify why only using 1 line - propagated over 10 layers. We are good with analysis every 5 layers but we need to justify.

Cat: Part too little can't see over the nozzle.
S: Write into G code to move off the part.
Chad: Good: Show that in principle works, bad: things in method that are not optimal (e.g: layers or speed), ugly: harder issues which you don't know exactly what the solution should be but you have ideas.
C: Can we have qualitative justifications?
Chad: Yes but also explain how to get quantitative values.
Cat: What percent of defects will we get? Need to test
Chad: What fraction of defects will we test? What variables? 0.15mm layer thickness, threshold intensities, color of the material. What are the optimum parameter settings for our technique?
Cat: Only see stuff that is propagated which might be really large
Chad: Only see stuff under one line… what is the probability of seeing a defect in the line.
Cat: Defect probability = Area of line over area of the part
Chad: Run many runs to determine what are defect detection relative to the part size (part of the bad section)... Need to do it next term.
Chad: Much smaller till 0.15mm will be too many false positives. Make sure tolerance is higher enough to not have false positives.
I: user can determine the tolerance (layer size)
Chad: How sensitive is our product to the tolerance and thresholding?
Chad: Why not have 2 lasers? Why not scan? Think about the consequences, why is 1 layer good enough? Our technique is going to get worse as the size of the part gets larger.
Convince him that the one laser (quantify) that it is good for what we need. Consider this in our discussion. Why is what we have going to be that way?
I: We are currently using a laser which we need to replace, don't know what it will look like.
Cat: $300-$400 for the printer… other group says $1000
Chad: They paid $300- $400
Chad: Laser and camera is $150, computer (assume the user has it- not being supplied), low cost CCD camera can be found for under $100. Cost not a constraint. Instrument quality laser is v expensive. Adding a laser might be within our budget. What is the benefit of having 2 lasers? Double probability in terms of finding defect (how much will this affect it). Find defect 2x as fast! How much of an impact going to have?
Chad: Will you never detect a defect with 1 laser? No but more chance with more lasers. Will find run-aways and and larger defects. Also easier to find defects on a smaller part. Part of Ugly: lot of waste mtrl that maybe a more specific technique wouldn't.
Cat: Limitation of technique, lasers in the line are the starting points of the defect that's it.
Chad: What are the limitations of the choice we made? 1 laser vs 2? Longer to detect defects with 1 lzr
S: 2 colors will help us if printing red.
C: We can use Will as a resource

Software:
I: Why moving the pixels over by one and subtracting?

Chad: Subtract it from itself so you have a zero everywhere except the front and the far side of the edges.
I: Picture messy
Chad: Issue with the thresholding so when you subtract them you don't get zero.
Chad: Look at plot of intensity and fraction. Need to adjust threshold values into optimal for each image based off of that graph. Purple is 0 and yellow is 255.
Chad: Find where values are equal to 1… plot them as x vs y will make a step change
Cat: How to find the values?
Chad: in python use: where (img = 1) then do another where (img not 1)
Chad: Find where the images jumps by more than 0.15mm
I: Object is metallic and appears in the image - issue with the setup.
Chad: Histogram of the greyscale must be similar for the same thresholding values to be used.
Chad: Think about a setup that is better suited to the object.
Chad: Smoothing of the image might improve things. An easy way to do this is (line 57 in python code… imgred=cv2.erode …)
Chad: Smoothing is a matrix rolling average- cv2 package should have a smoothing function. CV2 smoothing images should give us what we need. Put this in right at the beginning of the code when you read the image.
I: How will computers know where to crop?
Chad: Don't get too far ahead…
Chad: Next week Wednesday- see where we are at with the presentation. Think of it as a presentation to a completely new audience… as if they did not see our MT prez.
Chad: CCD is a fixed working distance so only in focus then.

LCA: Aleisha Meeting on Friday with Chad.

2. Go through the final report outline to see if what we have is good
3. Questions for Chad:
    a. How to go about determining the geometry for having the camera on the same side as the laser (Next semester)?
        - Will figure this out
    b. Once we detect edges how to manually measure height- how to open up image matrix? When we tried got only 255 values for matrix.
        - Answers in the software section.

Action Items:

	Item	Assigned To
1.	Think about: good bad and ugly of current set up	All

2.	Change Threshold Values for each picture	All
3.	Write the Final Report	All
4.	Prepare the Final Slides	All
5.	Print a defective part	Hardware
6.	Chat with Will	Hardware

Next Meeting Time With Chad: Wednesday the 20th @ 3-4pm

Meeting with Will:

1. What defects?
   Part - when finished part is in service and it fails
   Print - we will focus on this… during the printing process

2. How often of a picture analysis? Every layer or every 5 etc.
   If scanning that should be enough information

3. Why just the one laser?
   Use just one for proof of concept and then

4. Scanning laser?
   Yes

5. How did you account for taking pictures of reflective parts? We are getting laser scattering…
   Get rid of background- by taking 2 pictures one with laser and one without
   Thresholding

6. Why a red laser?
   It was cheaper at first to get a red laser. They may not use red in the future because of the blackbody radiation a different color may be better.

7. Do you think that defects that propagate and are at least as big as the thickness of a layer is reasonable?
   Defects are likely not going to propagate in the x-y just stay in one spot and build up.

8. What is the minimum defect size you guys can get?
   With the laser that we have they detected the line on the edge of a loonie.

Contents of Final Presentation:

~15 mins

1. Intro- purposeful and appropriate - **Aleisha (2 Slides)**
    a. What is FDM
    b. Purpose
2. Technical review -**Sofia**
3. Problem Definition
4. Specification definition
5. Design Options
6. Detailed design
7. LCA - **Aleisha (2 Slides)**
8. Summary/ Recommendations - **Sofia**