MTRL 466- Sensing Failure Weekly Meeting Minutes

Date: Tuesday, September 24th, 2019. (3:45pm - 4:30pm)

Room: ORCH 4016

Week 4: Individual Research (defects & solutions) and Midterm Preparation

Leader: Aleisha Reese Cerny

Secretary: Sofia McGurk

Attendance:

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

Agenda:
PRUSA will be located in AMPEL 248.
ID 2 people to be trained on the machine - legally allowed to operate the machine (send email to Chad).
Chosen people will need a 1hr training session t & will have to do a trial print to ensure they know how to use the machine.
2 people at a time need to use it.

Link to Wiki was sent to Chad.

2 weeks till the MT report.

1. Team Name: Spaghetti Monster Task Force
2. Research
    a. Discuss Defects (Cat & Aleisha)
        i. Common defects
        ii. Area of focus

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A: Our goal was to determine common defects then find solutions accordingly.
Cat: Table contains the defects, the causes and the size range (difficult to find). Most common ones- detachment, deformed object or missing material flows. Large defect/ easiest to detect. Also looked into surface errors and deviation from model- hard to find the size (can be infinitely small or really large) would have to pick what we can do.
A: operator error, also debonding and delamination
Chad: Good that we quantify them so we can ID what sensors will be able to achieve. Think about how to present this in the MT where we have a limited amount of space- table large. 3D objects so size is in what direction?
Cat: Deviations in the Z direction (build direction)
Chad: Correct path
Chad: Continuously revise objectives and constraints (numerical or be able to say this is this). Detect defects in the form of height relative to what should be a level plane (not x or y plane).

b. Discuss Sensor Solutions

i. Thermal (Isabela)

I: 7 types but mostly contact. IR is best but very expensive. Using them mostly to determine ideal temperature- not what we want.
Chad: Thermal camera would not allow a direct measure of z-direction defects. From cost and objective out of scope. Could use pyrometer but expensive ~$1000

ii. Sonar (Isabela)

I: Sensor may not detect waves back, deflected weird from object.
Chad: What is the basic operating principle of sonar?
I: Measure of velocity takes to reach object and back to sensor. Varies a lot i.e: humidity.
Chad: Can it tell you about variation in height? Proximity sensors- what is spatial resolution. Area detected might be too large for our application- spatially resolved information for small object hard to achieve.
Chad: Is it enough to know average height of object or do we need specific points. How fine of a resolution. Do we need x y resolution?
Cat: Compare it to model- if it should be flat then average should be flat too.
Chad: What about a meniscus like defect? Some material will be above or below the average height. Warping would do this… An average measure is not enough. Need some degree of sensitivity in the plane.
A: Wanted to explore all the options.

iii. Optical - Light (Sofia)

S: Looked into option with cameras, takes model that is printing, slices into 2D model and communicates with a camera via some algorithm which compares the print and the model in real time to detect any discrepancies.
Chad: Where is the camera situated?

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S: Can only have camera looking at one side for comparison. Printing in one direction and if there is anything greater than 5% deviation in another direction it marks it as an error.
Chad: Is it feasible? 5% of what?
S: Whatever the dimension is, need extra review?
Chad: Defects don't necessarily scale with the object. For a simple tower maybe you will see things but there is an issue with seeing only a 2D image and not 3D. When you take a simple picture how is stored, what does a pixel store?
S: Contrast/Intensity
Chad: Any image is stored as an array representing an x,y point of a pixel location. RGB. Problem is to compare to the model there should be a way to differentiate between what is "part" and what is not "part" (thresholding the image). HARDER problem than you think it should be, may even be easier if could do manually.
S: Paper Chad provided spoke about a thresholding algorithm which discusses this point.
Chad: Thresholding could change depending on the time of day, the temperature of the room and other factors.
A: Can the part be identified through chemical mapping?
Chad: Chemical mapping is hard to do without contact with the material. Possible but quite challenging.
S: Most of the cost will go to the camera but can use open source software.
Chad: Combining multiple cameras will be very costly and might break the constraint.
Chad: His idea was to look down from the top but open to other ideas. Might need optical to see errors in the z direction. What is at the bottom is already done.

iv. Acoustic (Jenna)

J: Detecting stress waves emitted from the source and the extruder.
Chad: Sound emission from the extruder itself.
J: Created a part that would have an error. If they set the sample to be 5M samples per second no error detected. Recorded emission and had data processor- recorded "hits" of sound.
Chad: Sound occurs over a spectrum of frequencies- try to identify specific things that are happening. Can ID defects are formed, you can hear cracks. This will probably be out of our price range.
J: Says low cost but it might be "relative" to the machine.
Chad: You can't just go out and buy this, not a common technique. Not a whole lot of development so it will likely be too specialized for us.
J: Use it in crack growth
Chad: interesting but still and indirect measurement of what we want. Use something else to tell us that maybe there is an issue- must draw correlation. Want to use something more direct.

v. IR - Kinect (Jenna)

J: Uses dot projection. Second generation of this was used to do Virtual Reality stuff for playstation. Trying to move to a more industry based setting. Main advantage is depth projection calculated by time of flight. Thrown out as it is not a very good camera. Depth sensor would be useful but we can find a better camera.

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Chad: Using IR sensor using time of flight. Usually IR does not have very good x, y, z definition.
J: Depth camera would be a good idea.
Chad: For height defects it could work
A/ Cat: Want all directions.
Chad: Try to get x, y, z in every layer- do we need this much detail?
Cat: Most defects will be detectable in the Z direction.
Chad: Probably can detect it in z.

vi. Lasers - D sight (Clement)

C: Not really to do with Lasers used for corrosion in airplanes. Light, screen, scanner picks it up - shows a peak shift. Very precise.
Chad: Very precise in height measurements. How does this work? This also used in line for detection of defects in manufacturing.
Chad: Light comes down and hits surface then reflects. Use a laser for no scatter, LED will scatter and become more diffuse. Laser is narrow and well defined- can have a single color (look into this?). If you know where a point is supposed to be without a defect, then if there is a bump or defect the reflection of that point will have moved and you can calculate how much it moved by. In theory, all we need is a laser and a camera.
Chad: why interesting to use a red laser?
Cat: ambient light wouldn't mess it up.
Chad: red light means the laser has a very specific wavelength. Can put a filter on the camera that would only allow certain wavelengths through.
Chad: whatever device we choose must move with it- machine shakes like crazy. Move point laser, might take time. Is there another way to do this faster? Could use multiple lasers- can get them at home depot: line laser for laying tiles. Flat line if all is good, if it is wiggled then we know there use a defect.
J: So we look at a line not a point.
Chad: use a couple different lasers on a couple different lines.
C: looking from top you have to find the right angle so sensors aren't blocked. That is going to be one of the challenges. Do we want standalone or attached?
Chad: another laser option: laser speckle to tell us about variation in surface height. HP bought it but might still be some information on it.
Chad: IR interesting, laser good. Think back on constraints quantitatively. Are we wanting to measure height variations? Do we need an average height or do we need points? What kind of resolutions do we need in lateral resolution (look into it).

3. Narrow down solutions
    a. Finalize 3

Chad: Thermal, sonar, acoustic are out. Good ones: IR, laser, laser speckle, optical

    b. What does Chad think?

Chad: stop with acoustic- too hard for this scope. Optical and laser- laser has the potential to be more quantitative. Using a camera to look at something but it depends what you are looking at. What's the size per pixel? Will give resolution.

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Chad: Make some quantitative estimates for MT report. So that the computer can give a Yes or No response.

4. Finalize a time to trial FDM printer / where it is located
5. Ask for access/link to LCA software

Aleisha to email about software.
Chad: what are action items for next week. And have an idea of what will go into MT.

Email about 2 people ASAP...

6. PREPARE FOR MIDTERM
    a. Presentation slides due: Oct 10th, Presentation: Oct 11th, Report: Oct 15th
        i. Clarify goal for the midterm (with team)
            1. Coming up with **3** solutions to compare
            2. Focussing on determining the price of all possible sensors and their precision
            3. Comparing 3 solutions by price and functionality
        ii. What does Chad expect for MT?
        iii. Divide MT Report

Action Items:

	Item	Assigned To
1.	ID 2 people to be trained on the machine**-** email Chad to let him know.	All
2.	What kind of resolution do we need? Z or x and y too?	All
3.	Further research into: Optical, Laser, LZR speckle, IR- include quantitative estimates	All
4.	Start writing the midterm report (pick 3 solutions to pursue?)	All

Questions

1. How do we tackle analysing different sides - or one side
    a. Ie. rotation of cameras/scanners

Chad: His vision was looking down from the top.

Next Meeting Time: Wednesday October 2nd between 3-5 pm.