Formal Meeting	Week 5
Location	Frank Forward Room 308A
Date and Time of Meeting	September 30th, 2019, 12:45 – 1:30 PM
Minutes Prepared by	Martin Battilana
Leader	Devang Lamba
Secretary	Martin Battilana

1.0 Attendees

Dr. Chad W. Sinclair
Martin Battilana
Jacob Koo
Hin Yao Chow
Oliver Tian
Devang Lamba
Kevin Zhu

2.0 Meeting Agenda

1) Provide a status update regarding the completion of action items and questions posed in last weeks formal meeting
2) Discuss aspects of 3D sensors and how they can be applied to our solution
3) Discuss creating a laser setup to assist the optical sensor in determining object dimensions
4) Discuss conversion software and algorithms to interpret the sensor data
5) Discuss Speckle noise reduction and its applicability to our solution
6) Discuss our current proposed solution of using a setup to take 3D images from the side view
7) Discuss using MATLAB to develop a routine to detect defects
8) Discuss what data can be obtained from slicer settings
9) Discuss methods of manipulating the data from a matrix so that it can be compared to the STL file in order to detect defects
10) Discuss goals for next week

3.0 Notes from Meeting

1) The upcoming deadlines are the Midterm Presentation and Midterm Report
2) Spot laser hits surface, reflects back and is observed by a camera (or something that measures the intensity of the light)
3) The height on a surface can be measured by the displacement of light on the detector by the angle of incidence (the light comes in at a certain position)
4) Laser scanning can cover the whole surface to get x-y plane elevation profile
5) Issue with MATLAB is that it is a commercial piece of software and a lot of image processing tools are in separate packages that need to be purchased separately
6) If you have an image, you have a set of RGB values in an array
7) If you shine a line laser on a surface, you are going to see the line on the laser (same as 3D scanner with point laser). The concept is the same, you are seeing variations in height as displacement of the incident ray on the camera
8) The ability to measure the height is the ability to measure the angle which represents the distance between the 2 laser elevations
9) Need to be careful when talking about resolution
10) The camera is looking down on a surface which is defined by how close, how focused and the number of pixels for the resolution in the x-y plane
11) The resolution to measure height for a laser scanner is higher than the x-y plane displacement

12) When you present data, you need to know what the data means and be very clear on how it works
13) Speckle pattern is digital image correlation where you take a picture and then subject the part to mechanical loading. The speckle pattern needs to have been already put on the part and the stress and strain can be determined from the deformation
14) Speckle pattern would not be an effective way to proceed with our project solution as it requires the part to be heated and mechanically deformed
15) Make sure to understand the underlying principles on how something works for the Formal Presentation and Midterm (as an engineer, you want to explain how it works)
16) Need to have a very clear aim for the project
17) To determine a defect, one can say that the material in the x-y plane that shouldn't be there consists as a defect
18) Try to detect deviations away from ideality
19) One of the risks is overcooling on a layer
20) Try to aim for the biggest bang for the smallest buck
21) Aim to identify defects (want to detect defects and stop the printer)
22) In FDM printed parts, there is always material where it shouldn't be
23) Detect major defects (the ones that will cascade and end up with something that has no value in its print)
24) Being able to detect small displacements is one step beyond where we currently are
25) Current Design: Use optical camera to look down at top surface, use image thresholding to be able to differentiate part from background, compare this to the .stl file to see if there is material in space where it shouldn't be within 5% - 10% error (error = length of part in empty space divided by the total length of the part in that direction)
26) Interested in the edges for the camera (check and see where your edges are relative to the .stl file
27) 5% difference relative to part size to eliminate size dependence
28) May only need to look at the x-y plane to detect defects in the z direction
29) Keep solution simple
30) For the Formal Presentation: aim to have 7 slides, be a funnel, start broadly with general problem with 1 slide, the design option slide is where you should identify goals, constraints, and free variables
31) If you don't fully understand something, don't present on it
32) Could sell our solution to PRUSA and make it an integrated part or could sell it to the general public
33) The background for the presentation can be what an FDM printer is and why defects are a problem
34) You can use humor to capture audience in presentations, use something shocking or use something that is very graphical (maybe a video)
35) The presentation should tell a story and it must flow together as a story (try to storyboard it)
36) Each slide should only have 1 idea (avoid cramming too much information per slide)
37) Have a good solid footing on what you present on (this shows that you have thoroughly thought it through and avoided missing something important)
38) One can feed the computer several failed parts and have the computer then identify for us what would be considered a failed part (machine learning)
39) The majority of challenges will be in image processing, be able to robustly go through this and detect defects, use phone cameras for this term to show proof of concept
40) Build up a library of failed parts, first step is to do all the processing offline

41) Print up to a point where you can take a picture and then show that it can detect defects and do some test
42) The minimum requirement is to be able to show some defective parts that have been printed do contain defects using our solution

4.0 Action Items for Next Week

1) Remove any redundancies from our design to get the biggest bang for the smallest buck
2) Go systematically through the design process, target precision, and identify the worst case scenario and stop the printer under the worst case scenario
3) Focus on edge detection of image (detect where edges are and compare edges in the .stl file to the printed part)
4) Go over rubric for Formal Presentation
5) Prepare for potential questions to be asked in the Formal Presentation
6) Do a socio or economic analysis (reduce waste or lowest price)
7) Look into machine learning and how this can be applied to our solution
8) Delegate tasks for Midterm Presentation and Midterm Report
9) Complete rough draft of Midterm Presentation by Monday
10) Complete rough draft of Midterm Report by Tuesday

5.0 Questions

1) What is seen on a detector from a laser scanner?
2) How will you know the different height of a surface on a laser scanner?
3) Will our end users have MATLAB to run the code?
4) How does a line laser differ from a 3D scanner?
5) What determines the resolution for laser scanners?
6) What determines the resolution for 3D scanners?
7) If you reduce the camera resolution, how will this impact the solution?
8) Where does speckle pattern come from?
9) What is the sensor for speckle pattern?
10) How does a laser give you the speckle pattern?
11) How do heating conditions relate to FDM printing?
12) How does speckle pattern work?
13) How do you put a speckle pattern on an FDM printer and then what are you measuring it relative to?
14) How much time do you have to be able to do our analysis per layer before the part cools down too much?
15) What kind of defects do we want to detect and what happens when these defects occur?
16) What are the differences compared to the stl file of edge and the print file of the edge?
17) How will we detect the “spaghetti monster”?
18) What is the minimum information needed in order to detect the defects?
19) If the filament changes colour, how will our solution deal with this?
20) Do we need a laser set up in addition to an optical sensor?
21) Who is our potential customer?

Group Meeting 1	Week 5
Location	Frank Forward Computer Lab
Date and Time of Meeting	September 30th, 2019, 12:00 – 1:00 PM

Minutes Prepared by	Martin Battilana
Leader	Hin Yao Chow
Secretary	Martin Battilana
1.0 Attendees	
Martin Battilana Jacob Koo Hin Yao Chow Oliver Tian Devang Lamba	
2.0 Meeting Agenda	
1) Discuss the use of 3D sensors 2) Discuss software to convert camera data and get quantitative values in order to detect defects 3) Discuss how to turn an image into computer data to detect defects (ImageJ and Open CV) 4) Discuss speckle data for enhanced resolution 5) Discuss an x-y plane laser scanner and refraction laser sensors in terms of quantitative results 6) Go over action items and questions from Week 4 Formal Meeting Minutes 7) Discuss next steps in order to continue project progression 8) Distribute tasks for work to be done this week 9) Discuss status update for Formal Meeting	
3.0 Notes from Meeting	
1) ImageJ may not be the correct solution to use, lots of problems with it 2) MATLAB might be able to do real time imaging without addons 3) 3D scanning uses lasers to scan a part and produces an STL file. 4) Qlone is a 3D scanning application for your phone 5) For a live monitoring system, 3D scanning is slow 6) Ciclop 3D scanners use 2 cameras to get 2 images 7) When using MATLAB to convert an image to binary, it can be very challenging to determine where the boundaries of the printed part is versus where free space is 8) Need to first isolate the image, then get RBG profile 9) MATLAB has a 2D image pixel coordinate system which stores the values in a matrix 10) RGB profile could be overlaid onto the image and the 3D model could be segregated from the background 11) To reduce error, there could be a routine to check between 2 different images 12) For speckle pattern, sensors project an illuminous laser light as well as a reference laser light to acquire a face map of the amplitudes on the surface. It can then be processes through software such as MATLAB to get a 3D displacement matrix. Stress and strain could also be detected. 13) Potentially use CCD resolution cameras (risk that cost may be too high) 14) The plan is to move along with image photo comparison using MATLAB to develop a routine 15) Defects that we will focus on include: “spaghetti monster”, warping, and layer shifting 16) Sensor should be able to measure live feedback in the x-y plane at a specified z 17) For the formal meeting, start by discussing process that wont work and then discuss parts that worked well 18) Our camera sensors should not stop the printer from printing 19) The goal is to create a set up to take 3D images from side views 20) The limit of MATLAB is 524288 elements	

4.0 Action Items for Next Week
1) Look more into MATLAB code 2) Look into slicer settings 3) Figure out a routine that can detect defects within 3 to 4 minutes 4) Create a short list of cameras as potential solutions for sensors 5) Look into real time image uploading 6) Hin Yao Chow and Devang Lamba will look into image detection (live image uploading system), types of cameras/camera systems and will look at exploring cctv systems 7) Martin Battilana will look into how to get measurement data from an optical sensor and what this data looks like (matrix of RGB and x, y positions) 8) Jacob Koo will be looking at how to isolate the print from the background in an image as well as how to obtain reference points. 9) Kevin and Oliver will work on how to create an error routine assuming the sensor data is imported as a matrix
5.0 Questions
1) How do we compare the x-y distance at each layer for 3D sensors? 2) How do we create an image capturing and uploading routine? 3) How do we obtain a matrix of useful information from the sensor and what will this matrix include? 4) Car reverse camera has lines overlaid on it, could this be applicable to our solution? 5) From our uploaded image, how can we measure distance for each height and convert it into a matrix?

Group Meeting 2	Week 5
Location	Frank Forward Computer Lab
Date and Time of Meeting	October 4th, 2019, 11:30 – 12:45 PM
Minutes Prepared by	Martin Battilana
Leader	Martin Battilana
Secretary	Martin Battilana
1.0 Attendees	
Martin Battilana Jacob Koo Hin Yao Chow Oliver Tian Devang Lamba Kevin Zhu	
2.0 Meeting Agenda	
1) Discuss how to compare x-y distance at each layer for 3D sensors 2) Discuss various methods for creating an image capturing and uploading routine 3) Discuss how to obtain data from sensors 4) Discuss our current design 5) Explain and clarify research conducted by each member 6) Prepare for the formal meeting 7) Go over our presentation for formal meeting 8) Go over our design for the formal meeting	

3.0 Notes from Meeting
1) Speckle pattern is an unlikely solution that we will use 2) Need more clarification on how laser scanners and 3D sensors work 3) Can mount a camera on top of the 3D printer to take x-y plane picture after each layer 4) Can use a line laser and SSD camera on a track above the 3D printer to detect elevation changes in the surface. This method would detect our defects forming in the z-direction 5) Need to be more prepared for presentation questions
4.0 Action Items for Next Week
1) Look into how laser scanners and 3D sensors collect data and how they operate 2) Be prepared to answer any questions about the slides you present on quickly 3) Discuss our current design idea with our sponsors
5.0 Questions
1) Can we use a computer or laptop for our solution? 2) Do we need to include a computer or laptop in our cost analysis? 3) How do we connect our optical sensor to the 3D printer if we want to have the g-code control the camera? Do we want the g-code to control the camera? If not how to we know when a layer is finished in order to take a picture? 4) How are we going to send the data from our optical sensor to our MATLAB program?