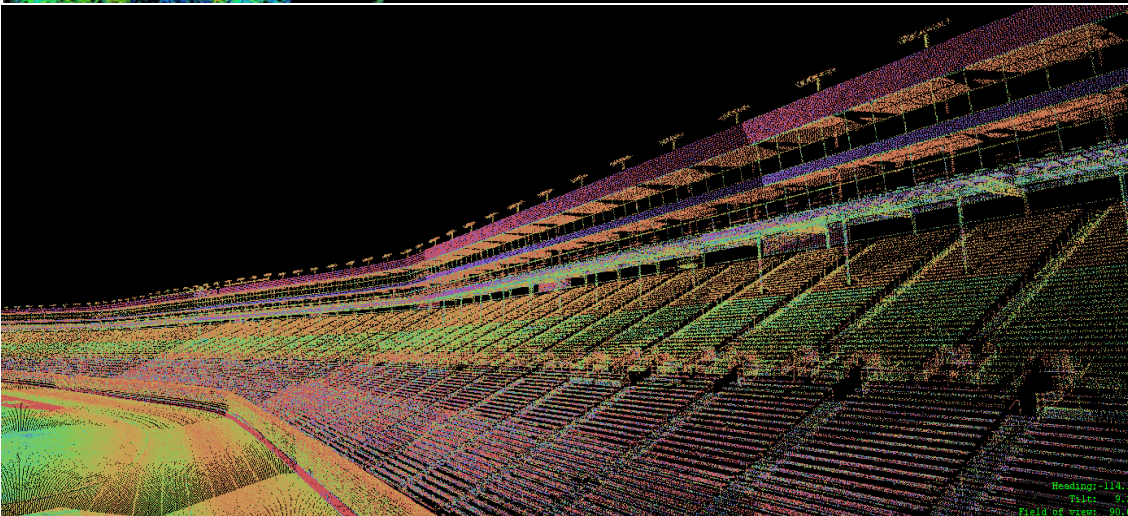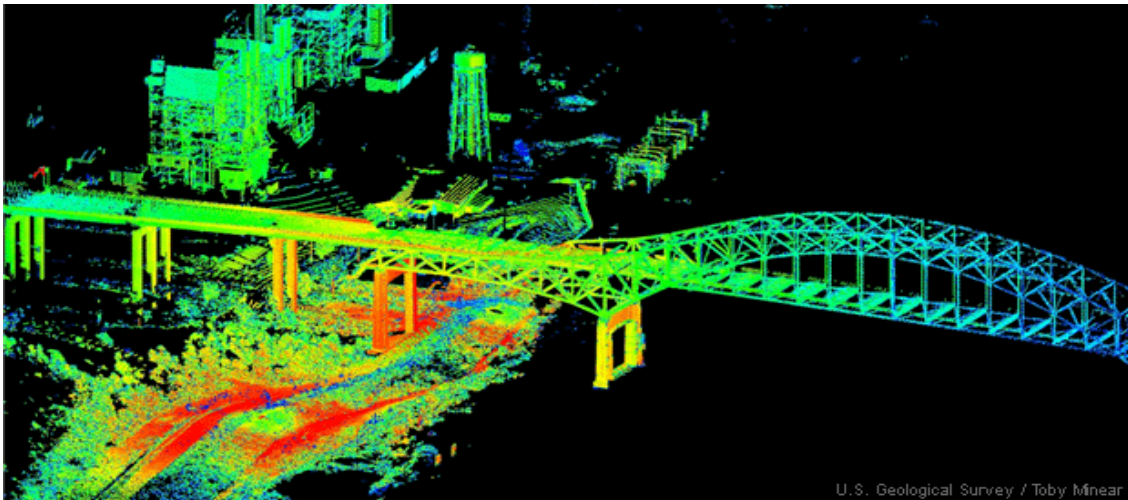# 3D DATA CAPTURE AND GROUND LIDAR

Final Project Report

This report gives a brief overview of collecting our own data and processing it for the generation of LIDAR and Photogrammetry models using various softwares.

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Contents

1. INTRODUCTION

1.1 Overview:

This report provides a brief overview and serves as a reference manual for all the projects that were done in the class namely generating a 3D Lidar Model, Photogrammetry model using various technical softwares. The main objectives of this project is

- To generate a model using our own collection of data rather than depending on a third party ready-made data which will cut down the time in generation.
- The methodology, process and techniques used for creating the models is emphasized more rather than looking for a perfect and best quality model.
- To know how the field data acquisition is done in a practical course like this and to learn finding inferences from them.

1.2 Field Work and Data Capture:

The field work was done on November 5th 2017, in the location Preston Canyon in Dallas TX. I have chosen this specific location over the Oklahoma location because of its accessibility from my home and it the field work could be done in a single day without spending much time in travelling, staying.

November 5th, when we carried out the field work, it was a sunny day .The entire field work was carried out in a couple of teams on a rotational basis for various works. Some teams worked on Lidar Data first, some worked on collection of GPS data on where the tripods were setup and finally there was an individual task of taking photographs for generating a photogrammetry model. Initially, the tripods were setup on the terrain where we are interested in capturing the 3D data model. Each tripod is aligned and setup by using the bubble center approach. It means whenever we are erecting a tripod we made sure that its position is intact without any sliding and we can know its accuracy by checking if the bubble is centered or not. The control used for both was USA_Local_Composite

Sequence of Tasks performed:

1. Arrangement of the Tripods and reflectors in the field so that a better model can be obtained.
2. Collection of GPS data was done using Trimble 7X at all the reflector positions.
3. Then Photographs were taken for generating a photogrammetry model where there is atleast 50%-60% overlap between the consecutive photos.
4. Last task was performed as a team, where VZ-400 scanner was used for scanning the reflector positions and collecting the 3D Lidar data.

1.3 Area of Mapping from Google Earth:

1.4 Google Street View of the study area:

2. POST PROCESSING OF MODELS:

2.1 Lidar Model Post Processing:

The Lidar model post processing usually consists of work both in RiSCAN Pro and also Polyworks.

Initial generation of a colorized model is done in RiSCAN Pro and then the final TIN mesh generation is carried out in Polyworks.

2.1.1   RiScan Pro Processing:

After the acquisition of field data it was saved and uploaded to the google drive from where we downloaded the data for post processing. Then a copy of acquired data was made and stored into the local computer so that we can keep the original data safeguarded and untampered. Some of the important aspects carried out in RiScan Pro are as follows.

After importing the data into RiScan Pro we get the detailer information popped out like Calibrations, Collections, Scans, Views, Objects , TPL (socs)

Below is the option panel and also the camera calibration we get after importing the data into RiSCAN Pro.
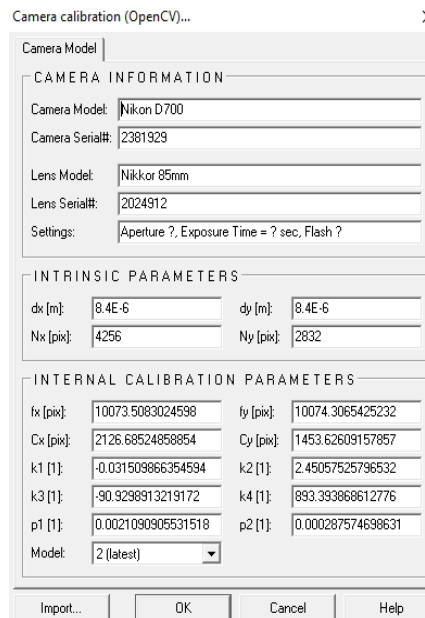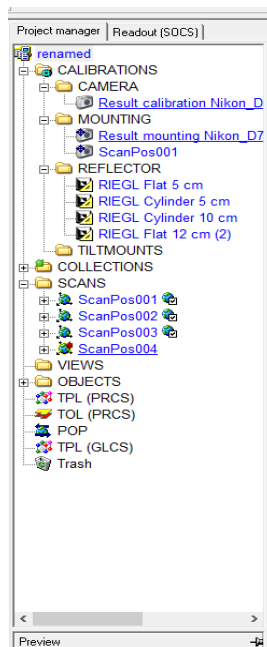
Once the data is correctly imported then the process of registration is carried out. The registration process is like referencing one scan position with respect to others.
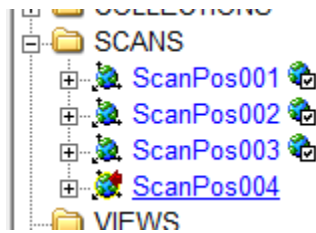
Here the globe symbol beside the scan position means that they are registered. For our project we have taken ScanPos001 as the base and tried to reference all other scan positions with respect to that. Since, there was an issue with the data collection with the imaging scanner at ScanPos004 it was not at all taken into consideration in our complete project.

At each scan position there were approximately 27 images that were taken by the scanner. In each of the images of every scan position, if we have the tie points link them with the PRCS which is Projected Coordinate System in this case. If we do not find any tie point in the image then we skip that particular image. This process is done for all the images in the scan positions till they are linked and referenced.
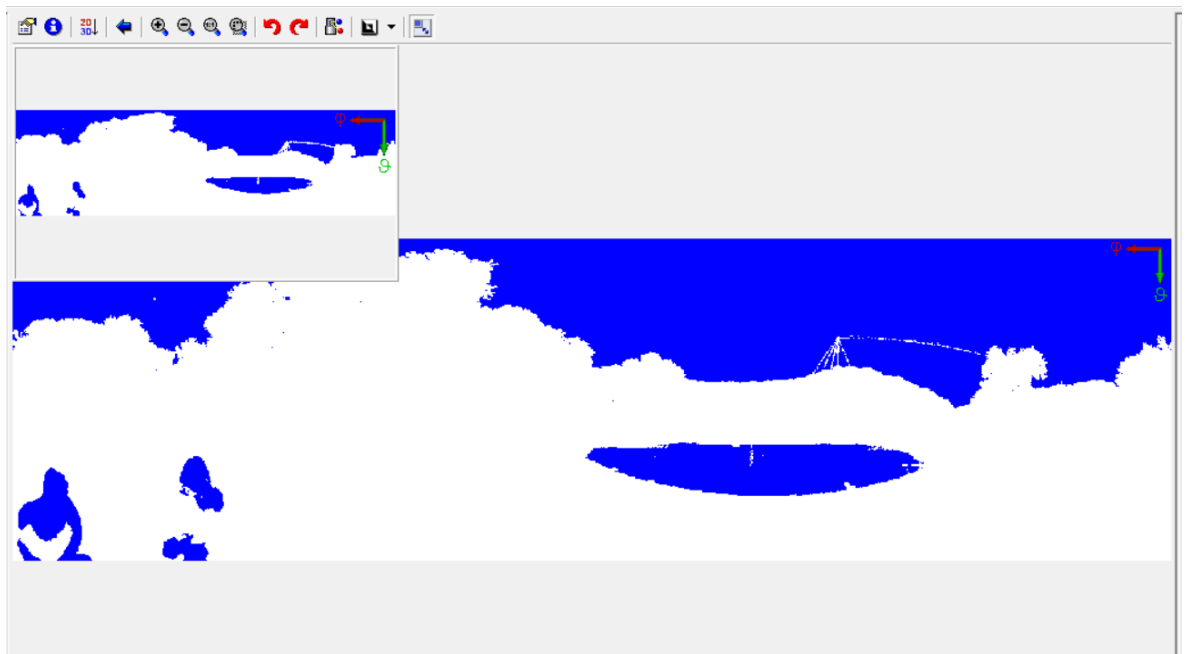
Panoramic View before colorizing the model in a 2D View

For viewing a 3D model we just need to change the settings to 3D. But in order to colorize the model we have a separate process that needs to be followed.

Before colorizing the model, we have to align the scans to the images that were taken at the scan positions and perform a new mounting calibration. In addition, the tie points should be manually added to the center of the reflectors which can be linked to the PRCS points.

In our case, since the camera was removed and mounted back at each and every scan position, we have the import the mounting calibration settings of the camera. Initially, we export the exiting mounting calibration into a text file. Then it is imported later into the settings again by creating a new mount calibration position. Once the new mount calibration is obtained we rename that to ScanPos001 since that was chosen as reference. Then we end up assigning the same calibration to all the images.

2.1.2 Colorizing the Scans:

In case of colorizing the scans we should make sure we follow a systematic process to do that. Navigate to the Panorama scan and right click in order to view the "Color from images" option where the colorization process begins. Then we get an option to choose the images that we need to color. We can use all the images that we want except for the ones which are distorted and those we do not want to take into consideration.
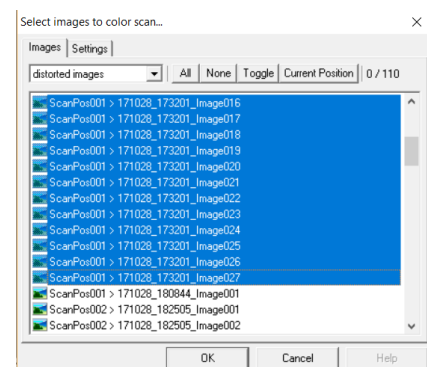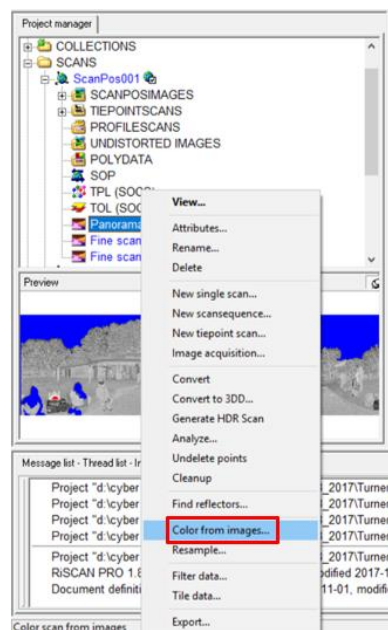
Below are the two views that are obtained for the Scan position 1 after colorzing the images. One is panaromic view and the other one is fine scan view. Our interest is majorly with respect to the fine scans.

Once we colorzie and obtain all the fine scans its required to clean up the data as appropriately as possible within the RiScan Pro so that it would be easy when we export the point clouds into polyworks and generate the TIN mesh from the data.

For cleaning up the data it is technically better to select a subset of the area and then clean up the unwanted points that not required. Once the points are selected they turn into red color and which can be deleted from them as shown below.
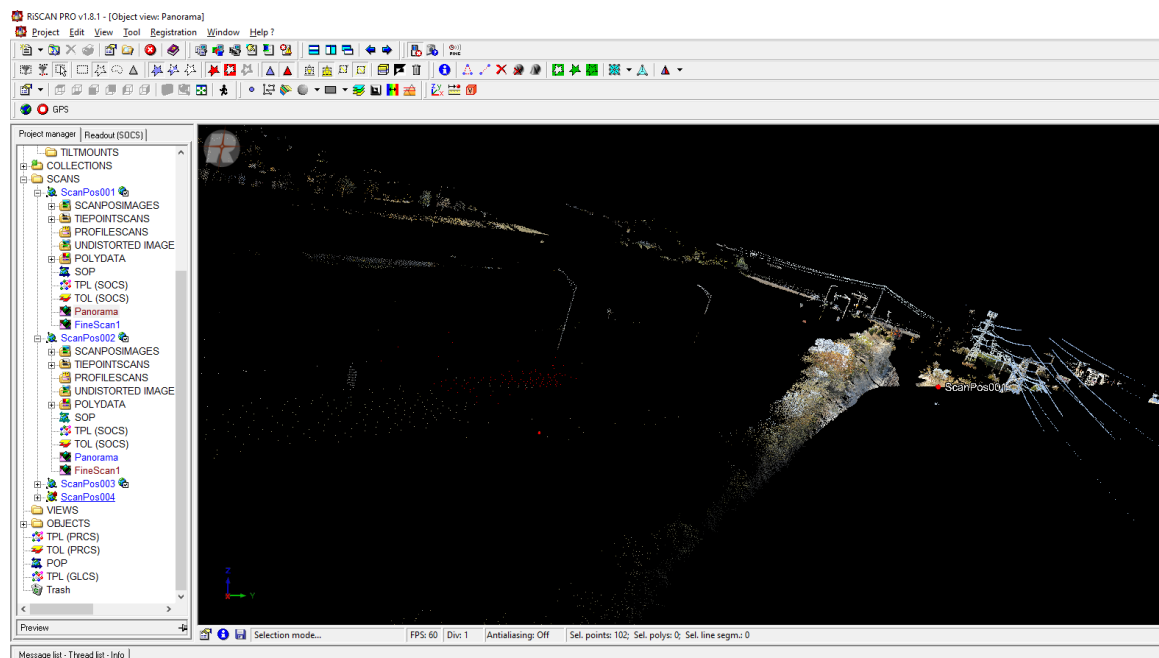
In our LIDAR model analysis we do not vegetation in our model because our main focus is given to the outcrop for displaying.

This process of cleaning up the data should be done as much as possible so that the cleaning process in Polyworks gets minimized. In order to have a fine clean select a sub area and zoom into that particular region, select the unwanted points highlight and delete them.
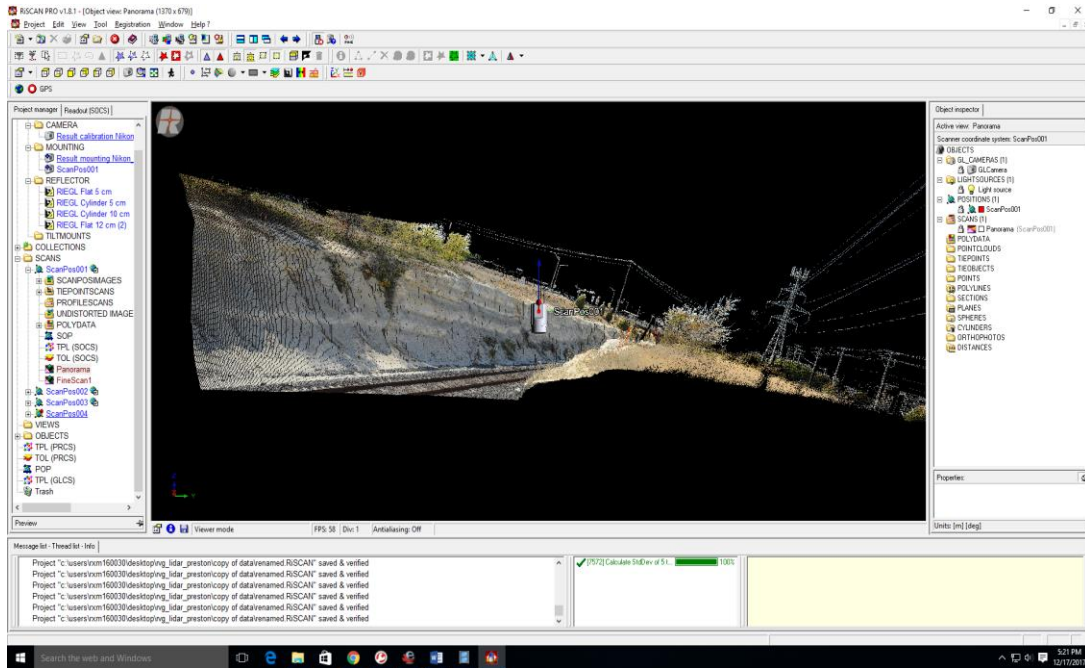
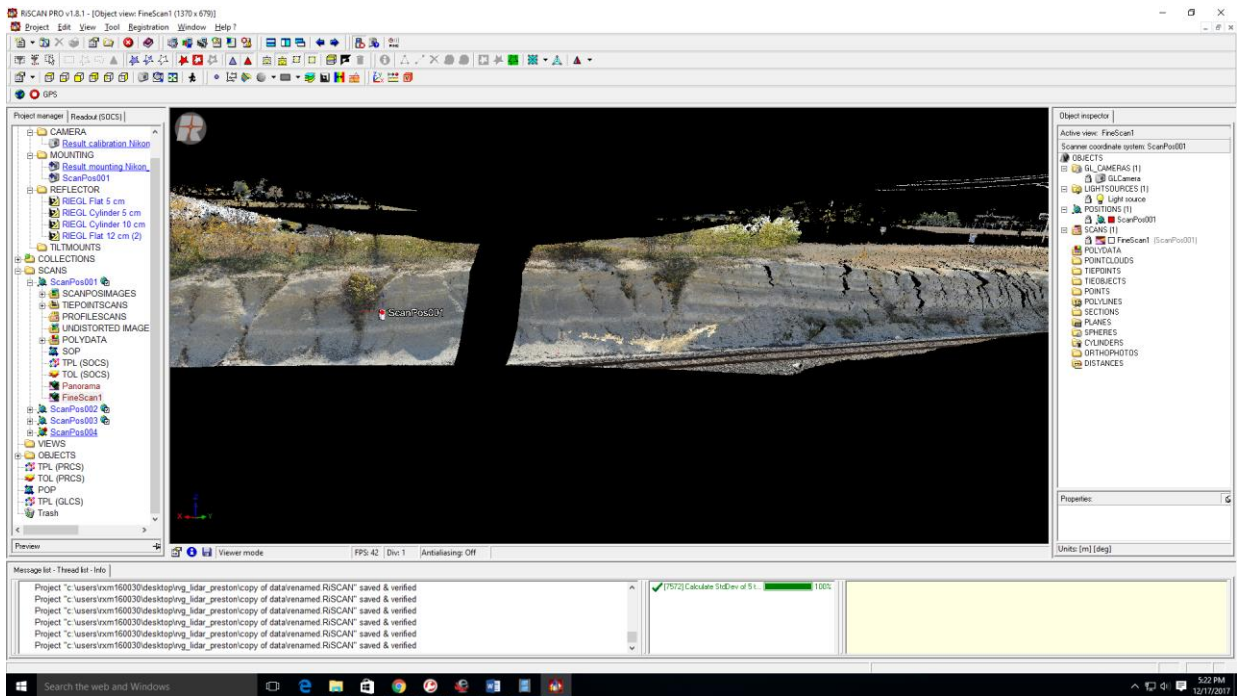Figure showing the panoramic View at Scan Position 001 (after colorizing)

Figure showing Fine Scan at Scan Pos 001 after colorizing

The difference between both of these views is panorama given an overall view of the imaged area. In the case of Fine scan, the name itself indicates that is very particular and limited to a particular area and also subset of the panoramic view. Ultimately we need this Fine Scans at all the scan positions for generating the final model. Now, the GPS coordinates are imported in order to link them with tiepoints and they are appropriately paired with lat,long,height with x, y and z and the corresponding points are found out so that a minimized standard deviation is obtained.

Once all these steps are completed, we can export the point cloud as an ASCII file for further analysis in Polyworks (where meshing is done). The below settings need to made while saving each of the point cloud as an ASCII file.
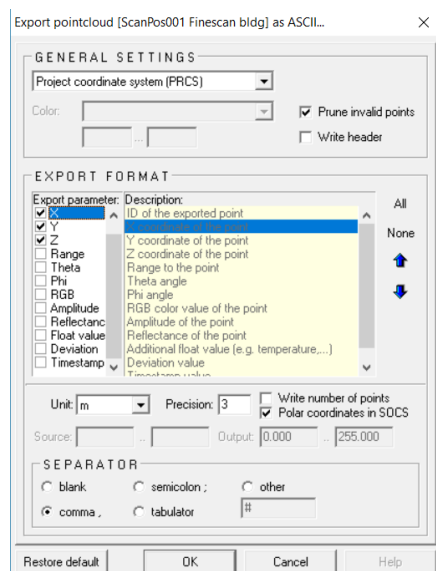

2.2 Polyworks processing:

Polyworks is a software suite from Innovmetric that maximizes the productivity, quality and profitability while integrating the 3D measurement technologies into an industrial manufacturing process. It can be also used for working on the 3D Terrain Analysis in a conceptual way which provides us a useful path for understanding the dimensional aspects of the lidar processing that we are going to do.

In order to get a better hands on experience with Polyworks, its better to have that on a machine which has a greater capacity of RAM like 16 or 32 GB.

Initially when we open the Polyworks a project needs to be created and saved. In that a workspace need to be created for our point cloud analysis and saved. Once a workspace is created, we can try importing the point clouds for starting our process of interpolation.

Each and every scan positon ASCII file should be imported in a sequence one at a time in order to carry out the interpolation. First we import the scan position 1 and we should be displaying it in a position which is suitable for interpolation. In order to do this there is an option of clipping plane which is provided so that it should be arranged parallel to the point cloud surface but perpendicular to our view. There is an option called as Anchor which always rotates the plane by 90 degrees when clicked upon. So an intelligent guesswork is needed to know how the plane can be arranged parallel to the surface and perpendicular to the viewer.

This needs to be taken care, because interpolation is one of the crucial process which gets us better results. Below is a screenshot
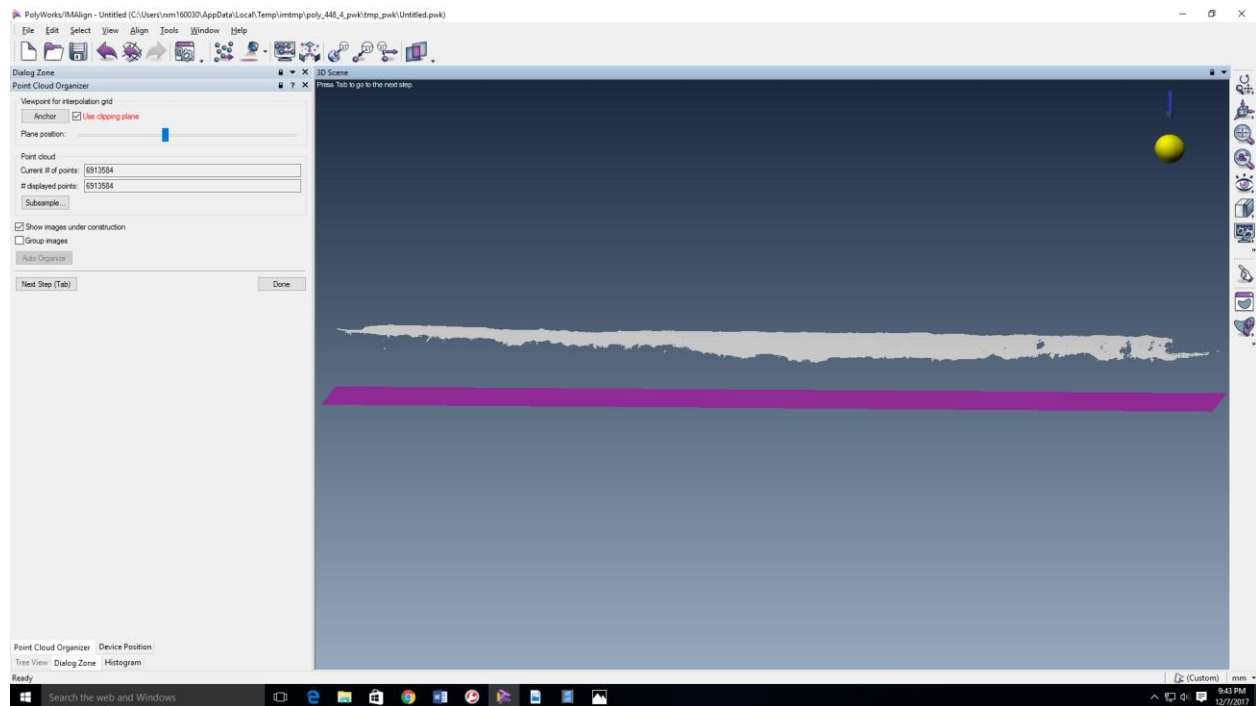

Similarly it can be repeated for other scan positions also so that we can begin the interpolation. During the process of interpolation it will ask us to provide the max edge length, interpolation step (1/10th of max edge always) and max angle.
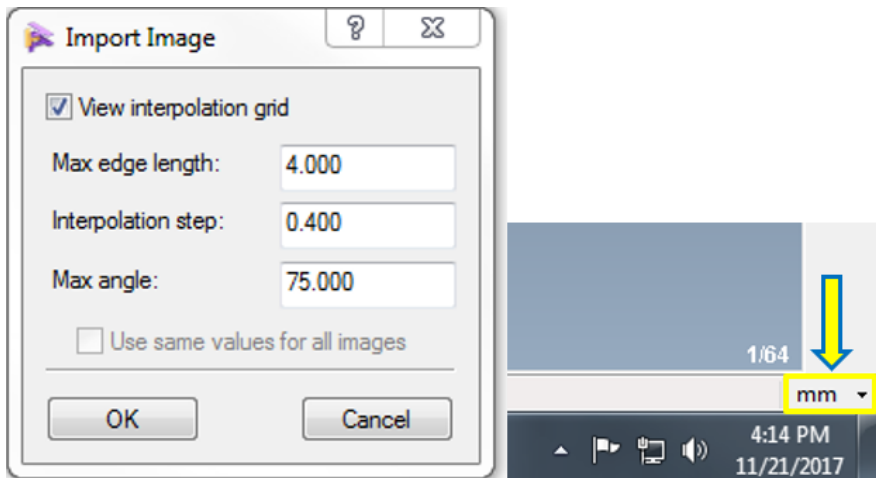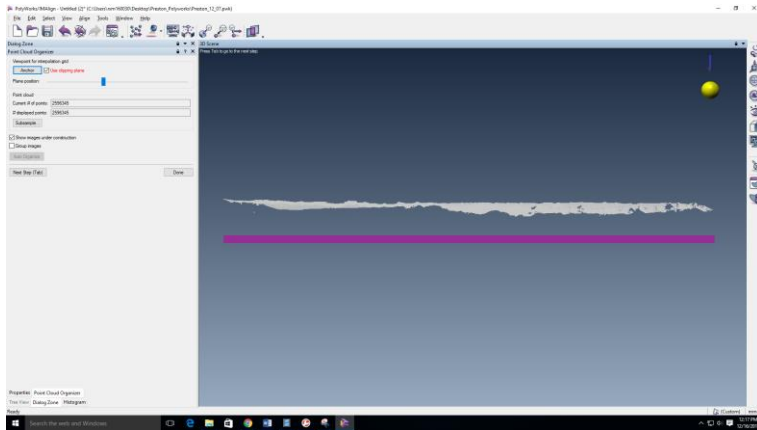
These values were the default values, but the values that were taken for this model were 100, 10 and 75 for Max edge length, Interpolation step and Max angle respectively.

2.1.2   Merging after Interpolation in Polyworks

Once the interpolation is carried out for all the point clouds in consideration a .pf image is created for each of the point clouds. We need to merge these point clouds and clean them up for final TIN mesh generation.
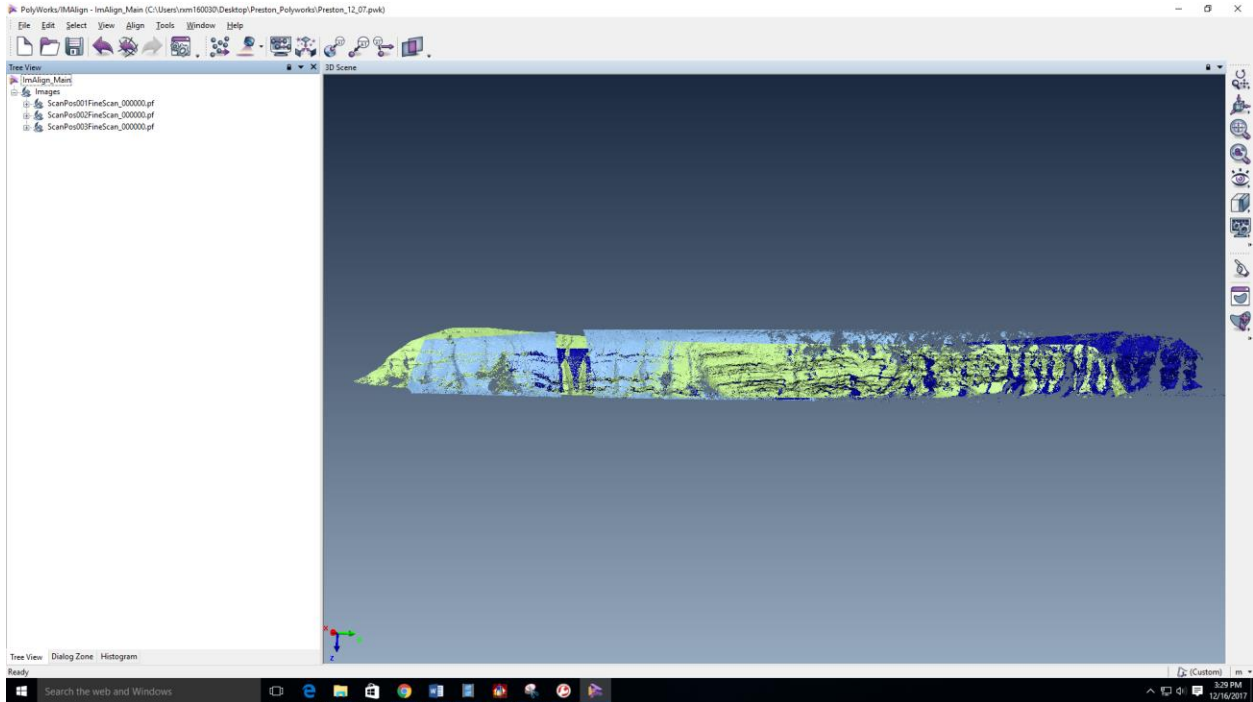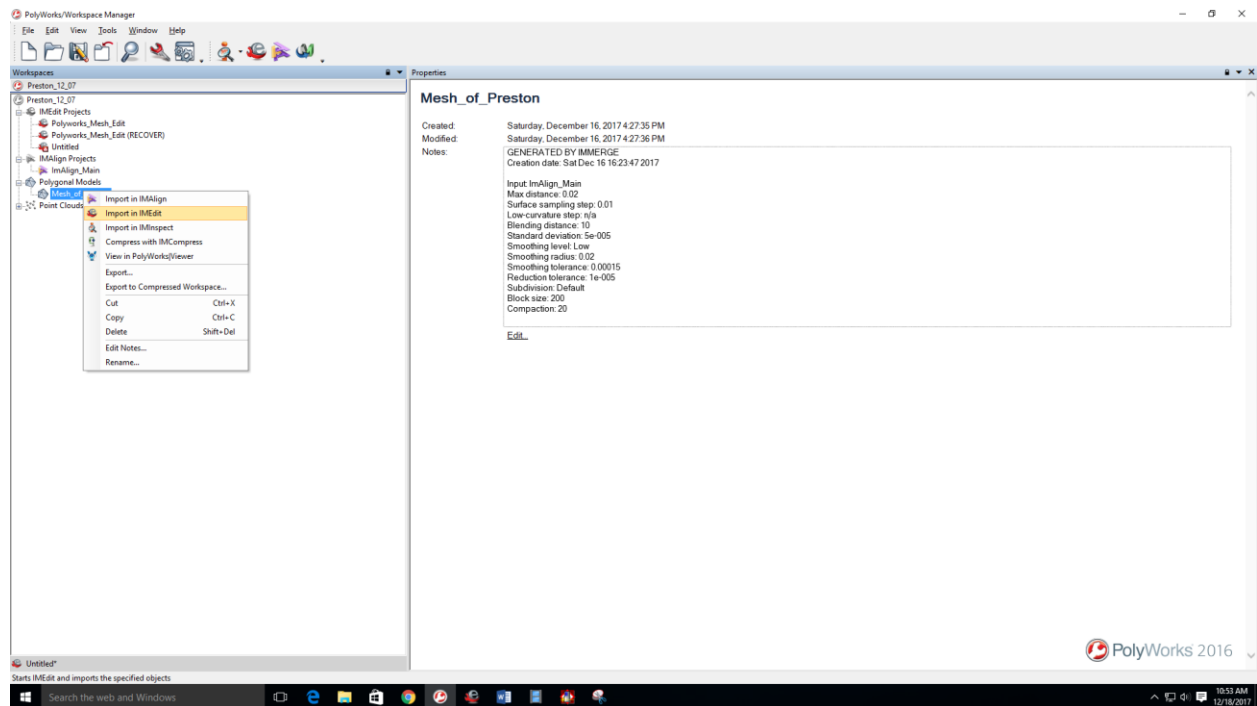
From the above screen shot we can see there are three fine scans that were obtained after interpolating. We need to merge them in IM merge in Polyworks. The settings that were used during this process were default.
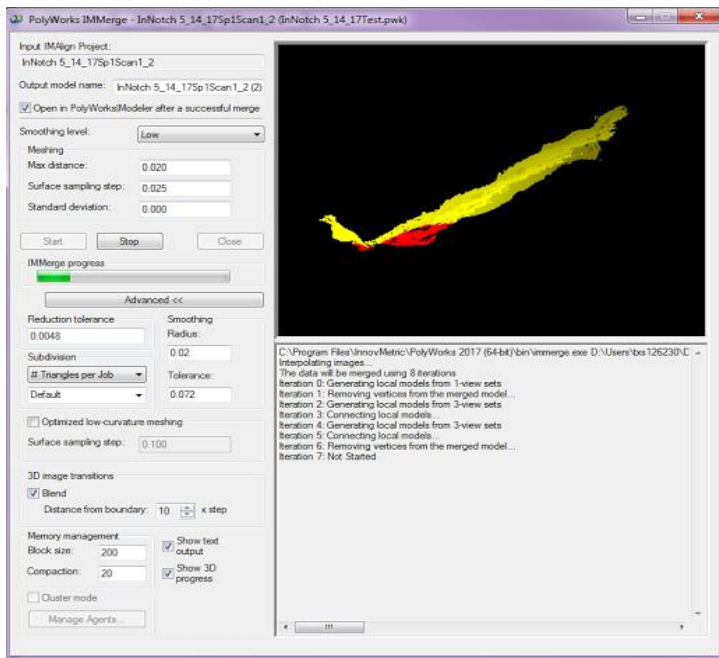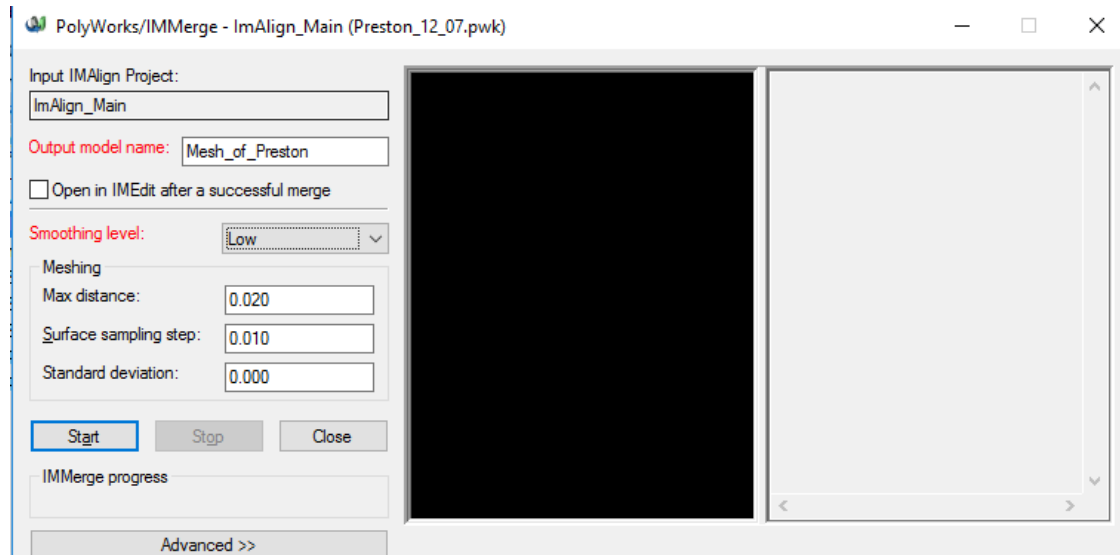
Once the merge process is completed, the resultant mesh is opened in IMEdit in the newer version of polyworks for cleaning the TIN mesh.

2.2.2 TIN mesh cleaning:

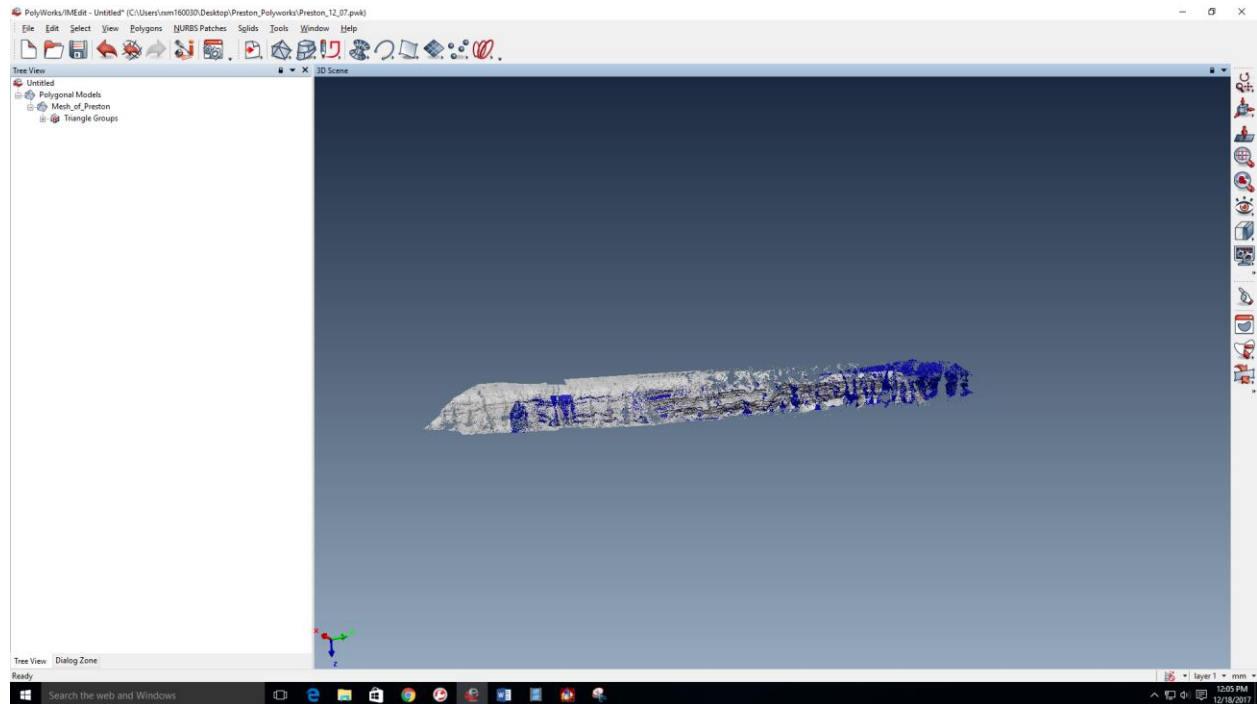Some of the methods that I used for cleaning up the mesh obtained are

Deleting the shell triangles.

Deleting the intersecting triangles.

Deleting the triangles with dihedral angle less than or equal to 70 degrees

Interactive hole filling was performed wherever necessary.

After all the cleaning operations are done, the model turns out to be like below.

In practice, the grey color should represent the front of the obtained 3D TIN mesh model and blue indicates the back of the TIN mesh model. However, here there is a mixed proportion because of the interpolation issue we had during the post processing in Polyworks. The procedure for obtaining the 3D mesh remains the same.

2.3 Photogrammetry model processing:

The generation of photogrammetry model requires us to take photographs with a camera of decent quality for the area we wanted to generate the model for.

The photographs should be taken in such a way that there will be atleast 50% to 60% overlap between the consecutive photos that were taken.

For the photogrammetry model, the photographs were taken using Motorola G4 which is an Android Smart Phone. The resolution of the camera was 8 MP. Most of the photos were taken in a HDR mode to get a better view of the terrain that I am going to work with.

2.3.1   AgiSoft PhotoScan Pro Processing:

Initially all the photos that were taken using the mobile camera were stored downloaded from the google photos and exported to a folder called as Photogrammtery_Project.zip.

Below is a screen shot showing the properties of the photos that were taken in the field.
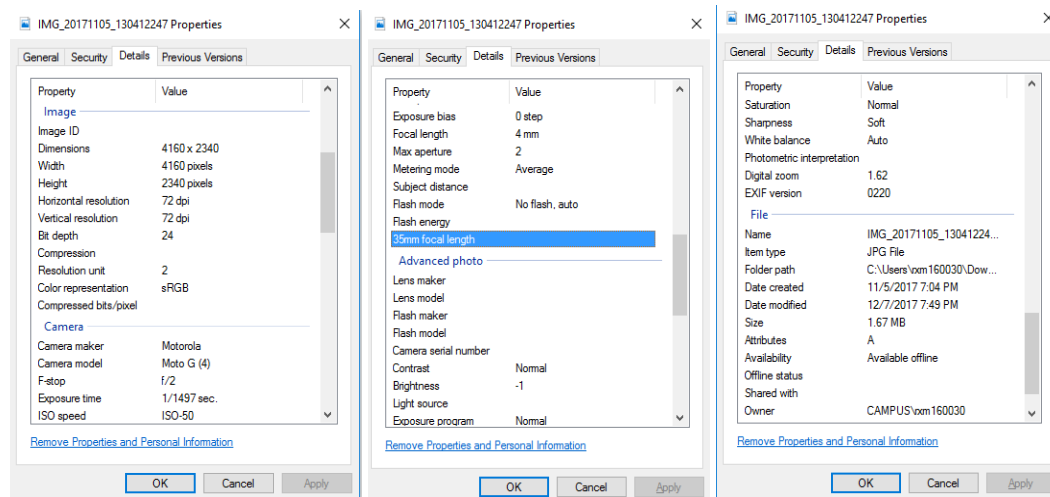
The initial step was to make sure that there are no GPS coordinates tagged for the photos as we do not want to use them, but would like import the tie points coordinates which were already measured and stored in an excel file.

The process starts once we have the necessary information to start with like the Photos, Cross Hair point information and any other Meta data

**Camera Calibration details from AgiSoft:**
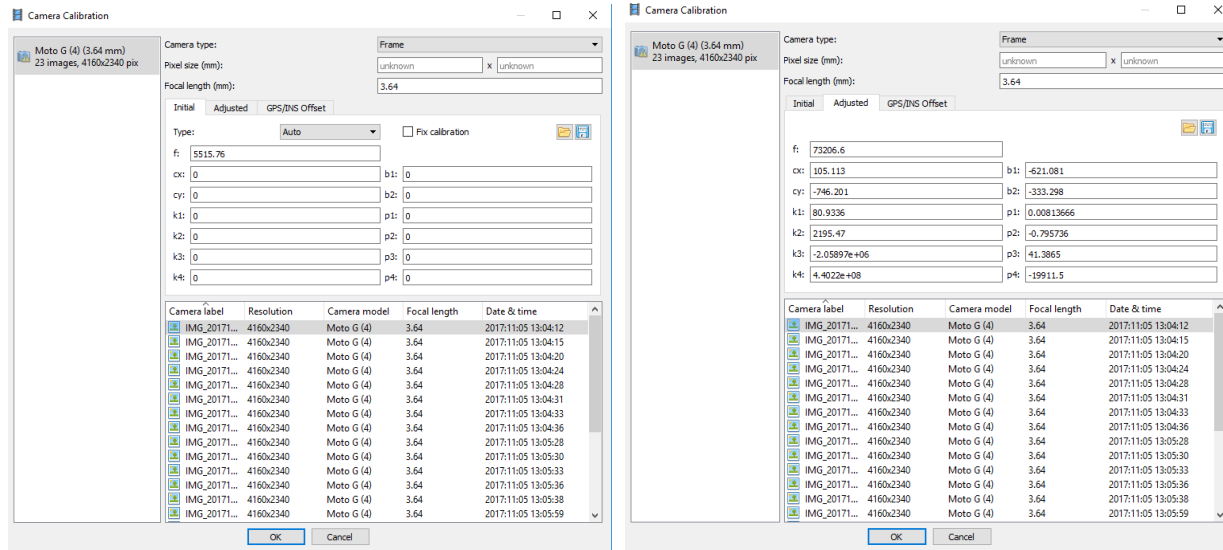
Aligning the Photos:

Aligning the photos is one of the major step if we use the camera GPS for our project, but as we are externally importing the tie points GPS from an excel file its not required.
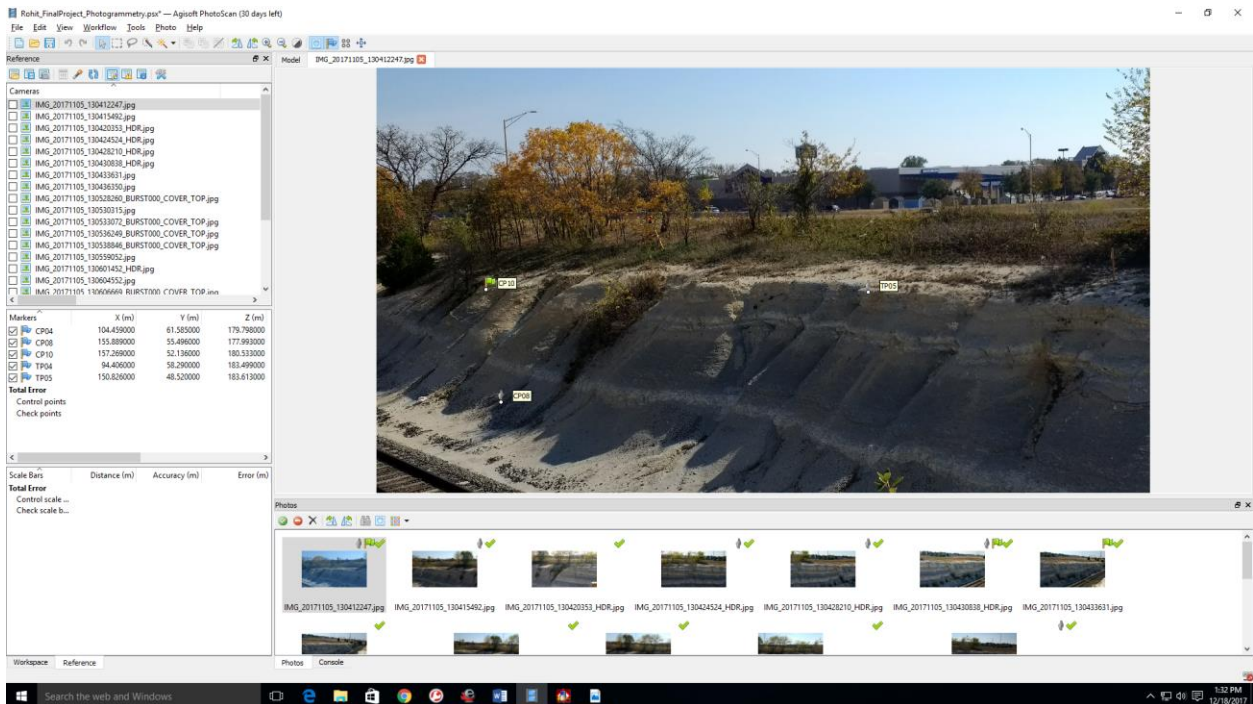
Creating Tie Points:

In this process we have to create the Tie points on the points using the cross hair photos as a reference. We should be creating a tie point on one photo and then navigate to other photo where the other photo has this point and place a marker and name them appropriately. The commonality of the points is found out in the consecutive photos because of the fact about the overlap (50% - 60%). Once all the Tie points were entered we import the XYZ coordinates for the tie points. The format will be like Name of Tie point, X (Latitude), Y (Longitude), Z (Altitude)
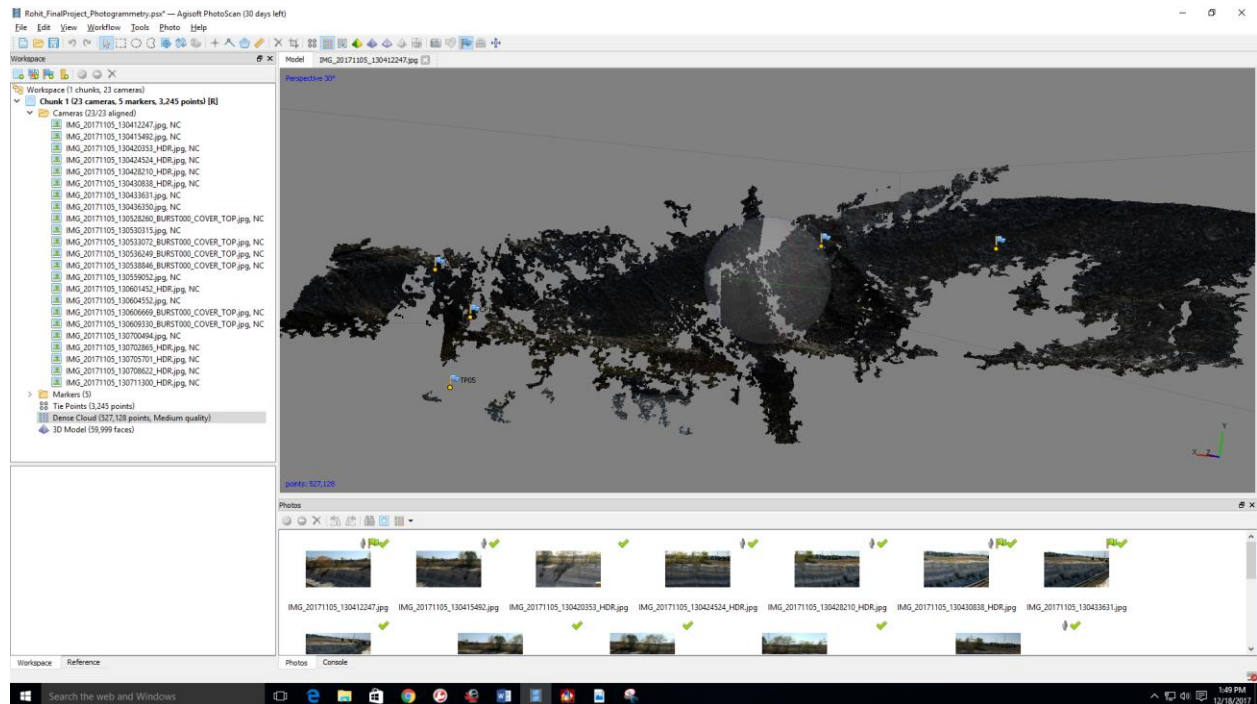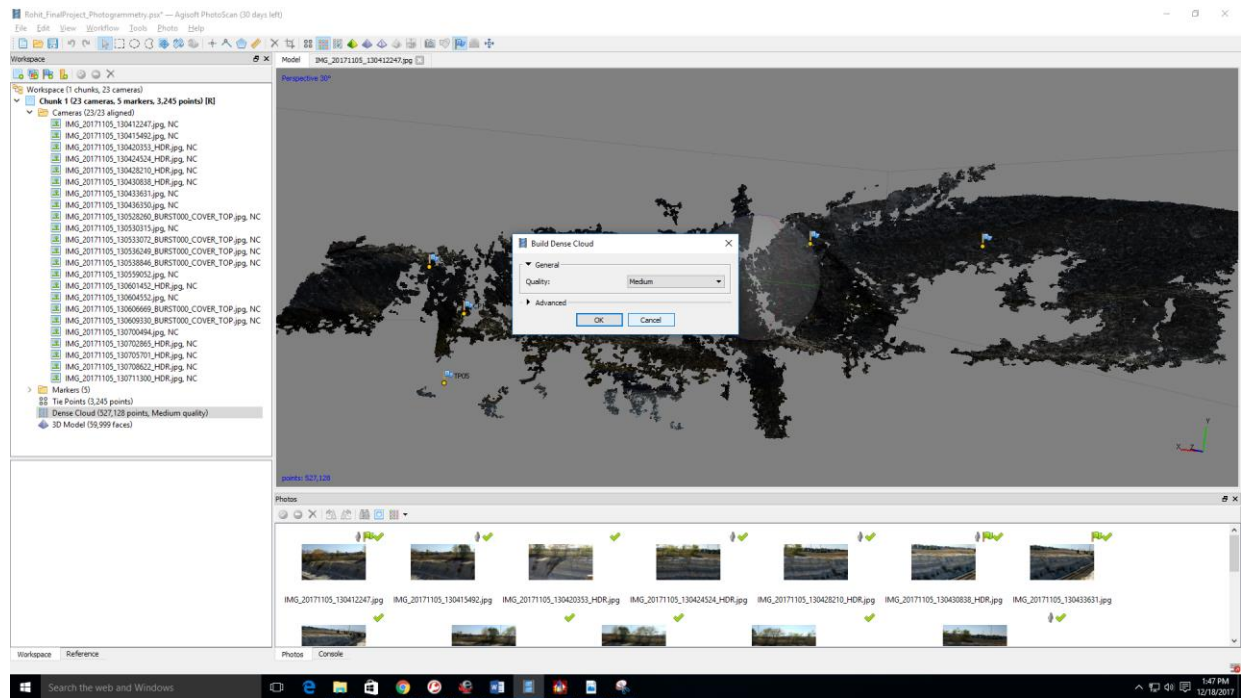
Camera optimization:
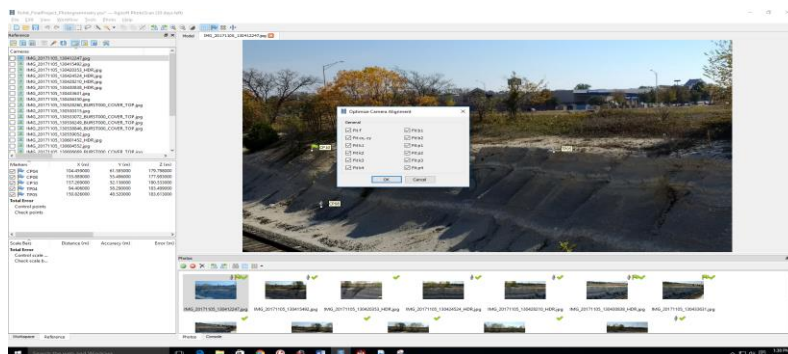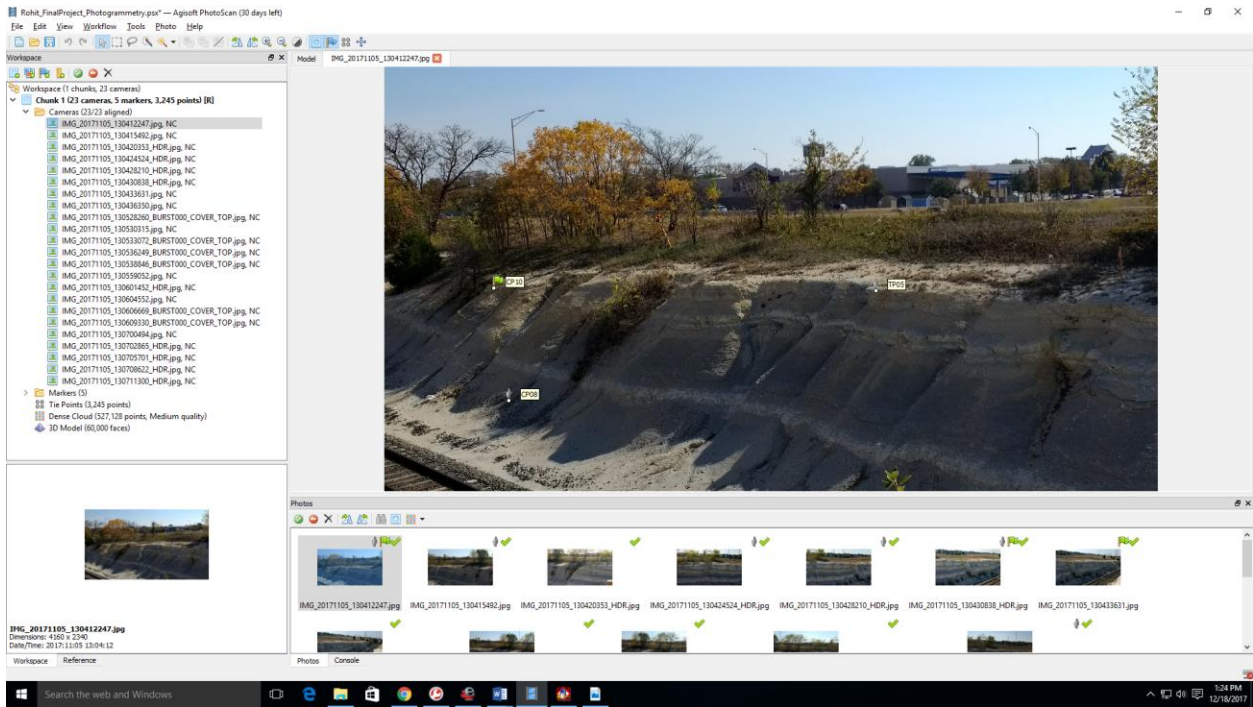
(Screenshot taken after aligning and Tie point generation)

*(Screenshot showing the reference tab having Tie Point Details)*

Now after this proceed towards building the point dense cloud using the tie points. Now navigate to workflow and go to Build Point Dense Cloud.

Point Dense Cloud

We usually choose to build the point dense cloud with medium quality so that it does not take long time for processing the model and getting the result. In addition, the storage size also gets reduced.

Once we obtain the point dense cloud, it's the time to generate a Mesh. Go to Workflow and click on Build Mesh.
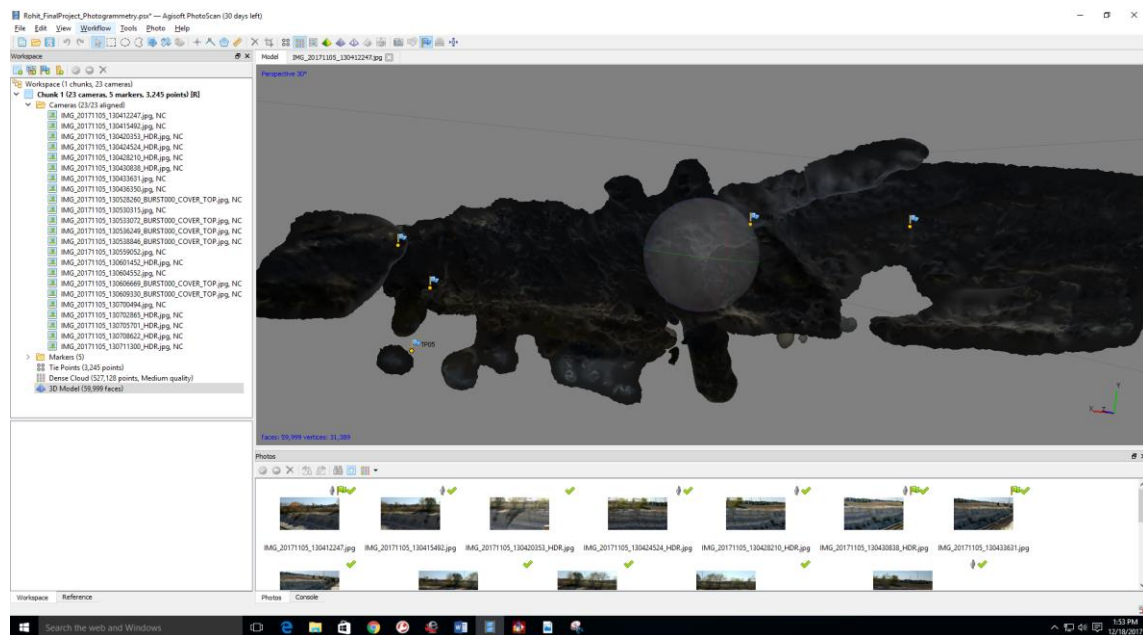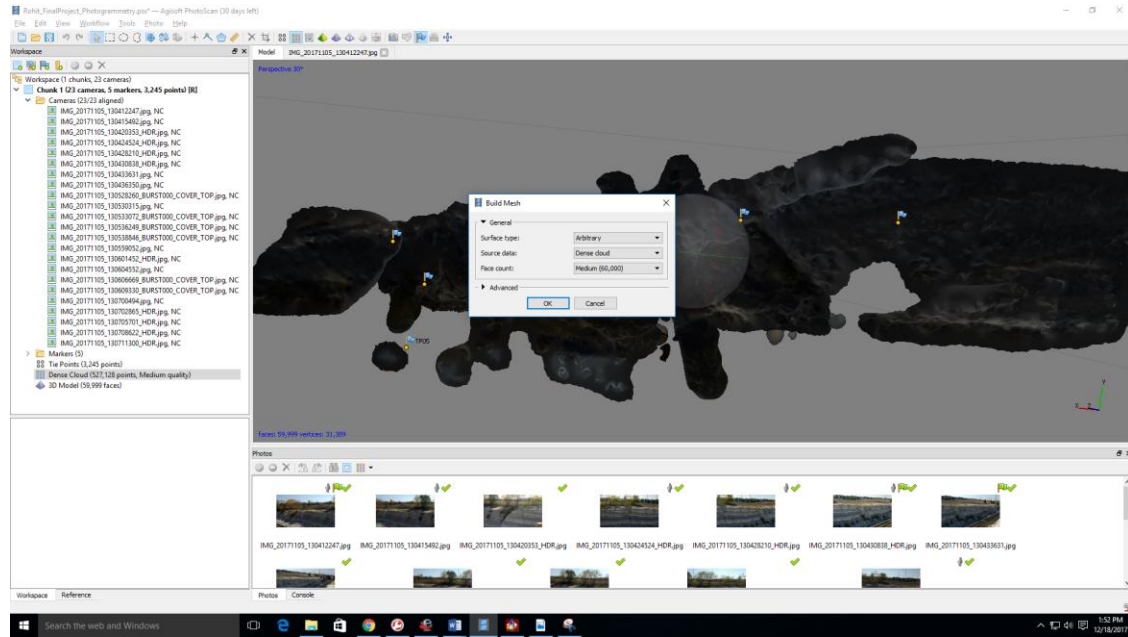
(3D model generated after building the mesh)

Now since the mesh is not that good quality we need to make sure that we clean up. We can View

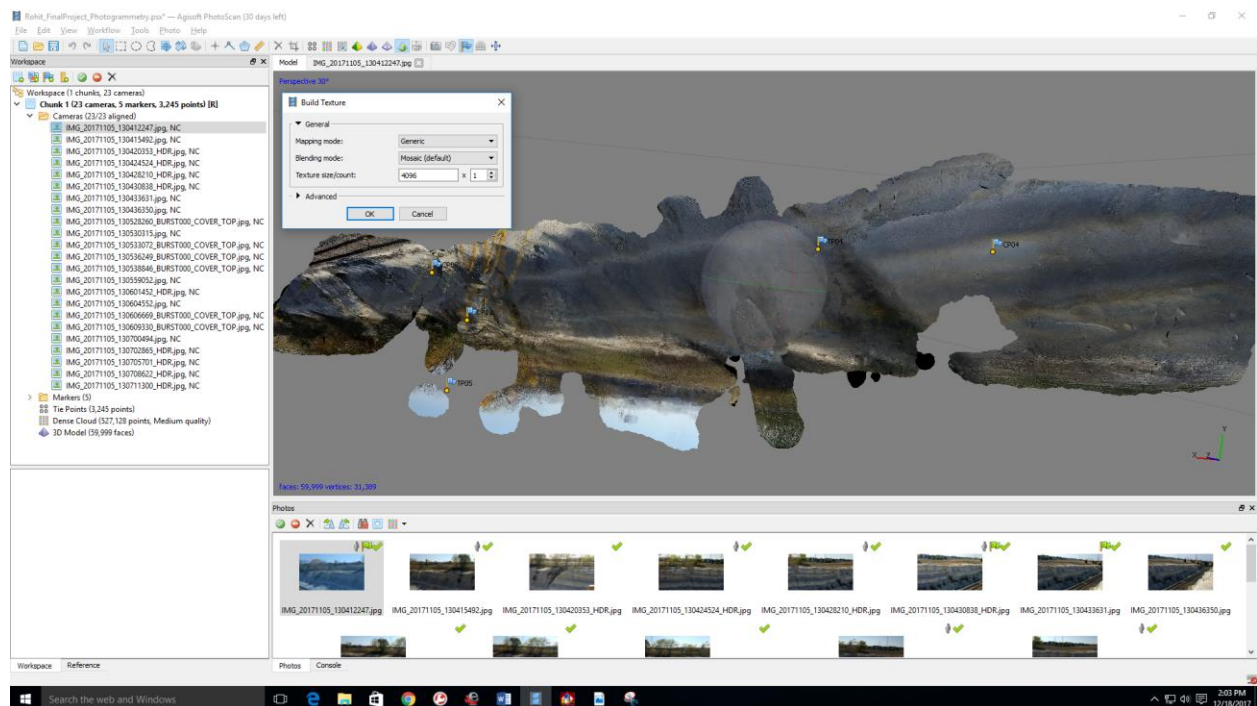Mesh statistics and clean up any topology errors by click on "Fix Topology"

Mesh smoothing can also be done like below.
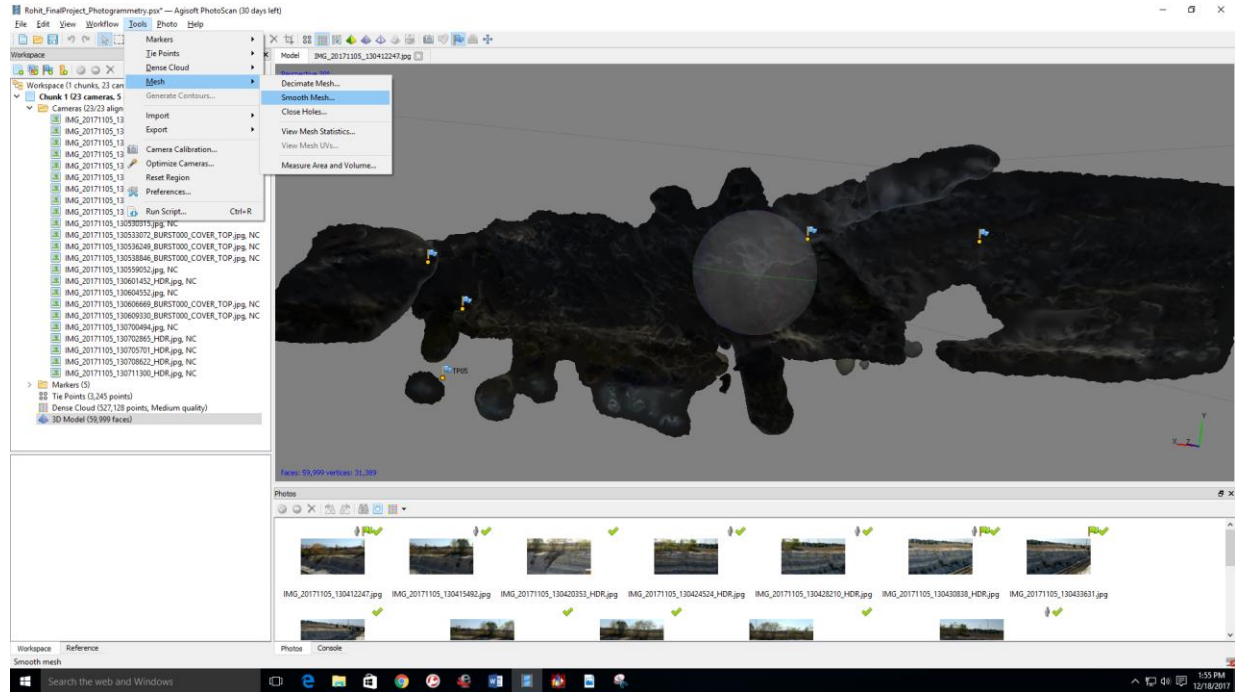
Now we can build a texture for the cleaned up mesh like below.

2.3.2   Results, Anomalies and Explanations:

From the obtained model above, we can conclude some of the following aspects which resulted in the anomalies that were observed from the model. These are explained below in a detailed manner.

Most of the photos that were taken was using HDR setting in the camera. Let's take a look actually what this HDR photos actually mean.

HDR photos usually captures a dynamic range between the lightest and darkest of an image than the normal photography. HDR photos therefore can provide an impression that we get usually more than a single photograph. Basically if we have a bright sky and a dark ground we will see more of each than in any single photo which happened in our case. On the day the images were pictured, the sky was very bright and there was a bit dark ground which provided us a greater reflection of the images that were obtained.

The biggest problem with the HDR photos it does not spit out photos with the correct "EXIF" information (a format used by the cameras, scanners). But we need EXIF information for photogrammetry. Hence it's a difficult task of messing with lot of parameters with regards to hue, tone and photogrammetry may not work because the matching points were not found. Some cameras have a built-in HDR mode, which creates images from usually three shots. If we use a tripod the motion between the shots will be minimal, thus there will be no large crop and practically no loss of sharpness, and the photos can be used for photogrammetry.

Most of the HDR photos do not vary the exposure time but ISO. There will be lots of noise which ends up in the final photo which has led to the anomaly in our obtained 3D model. In addition, the blended images may be crispier and may not contribute for generating a perfect model. It's all about experimenting with the camera for taking photographs. Once we process the data we can know which camera settings and format led to a quality model and which did not. In this case, with the HDR setting that I used, the model didn't turn out to be that great because of the issue we had with the reflectivity of the EMR radiation emitted by the Sun and also the reflective radiation from the area that we are imaging.

3. FIELD NOTES:
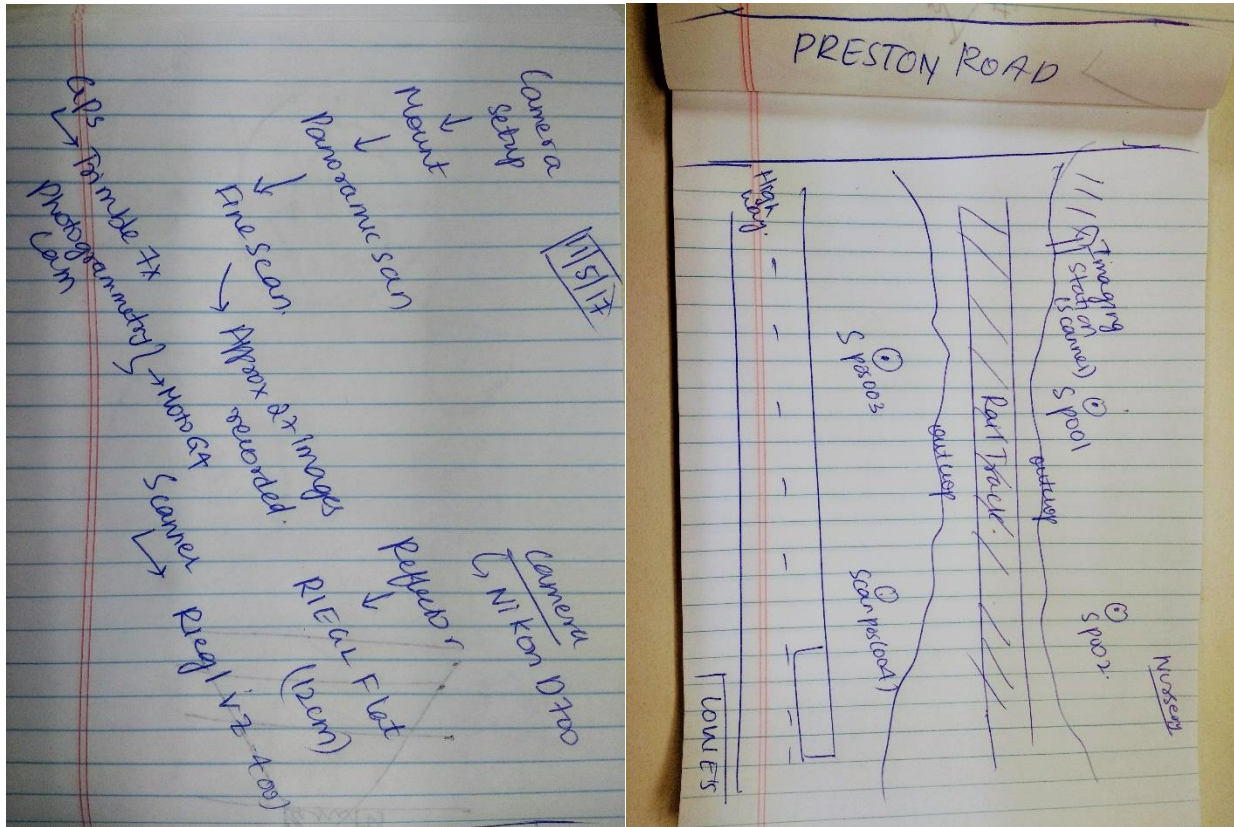
4. SUMMARY, CONCLUSIONS AND LEARNINGS

This entire project is based on self-experience and the motive of working with our own data rather than working on the provided data. From this I can infer that the collection of data requires a lot of care and practice which may lead to the accuracy level of our final output.

The LIDAR model which was obtained took a considerable amount of time for post processing because of its complexity in nature and multi-processing in various softwares like RiScan Pro and Polyworks. The preparation of the data for analysis is very vital in obtaining a model which is of considerable. As per our understanding, there is no perfect model which has 100% accuracy. It's all about how you put your efforts in minimizing the errors that are obtained and provide a decent quality model for analysis.

5. REFERENCES

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