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CRIME SCENE RECONSTRUCTION BASED ON A SUITABLE SOFTWARE: A COMPARISON STUDY

VINESH THIRUCHELVAM*, JULIA JUREMI,
RESHIWARAN JEGATHESWARAN, HAIDHAR A. M. PUAT

Asia Pacific University of Technology and Innovation,
Technology Park Malaysia, Bukit Jalil, Kuala Lumpur 57000, Malaysia
*Corresponding Author: dr.vinesh@apu.edu.my

Abstract

Crime scene animation has been a topic discussed by many authorities from various countries. Implementing the crime scene animation in solving the crime that took place in Malaysia would be more helpful. It is beneficial because it would present the case to those who have little or no understanding of it or the crime. With the help of an Unmanned aerial vehicle (UAV), those in the courtroom would be able to revisit the crime scene without physically attending the scene. With the help of software, the crime scene animation would be much appreciated by the courtroom member. This paper will conduct a practical demonstration to display three different software picked to reconstruct the crime scene. This demonstration would allow the reader to determine the proper software and add an appropriate crime scene reconstruction.

Keywords: 360 Degree View, 3D-Scenario, Agisoft metashape, Lidar, Photogrammetry, Pix4D, Sirv, Simulation.

1. Introduction

With the help of the drone, the crime scene will be photographically recorded, which may then be used in scene development. It is crucial to choose a suitable software to begin the operation. There are many kinds of software out there in the internet world, from over hundreds of the software Pix4D, Agisoft Metashape, and Sirv. In this paper, a demonstration will be conduct. This demonstration will be more understanding for the readers on how to use the three different software.

The scenario was set up with a dummy, and the images were taken with a drone. Those images are being used in the three different software. The reader will determine which software would be more suitable for developing an animation crime scene at the end of this paper. The process of stitching the images is being studied in each software.

2. PIX4D

2.1. Background

The Pix4D is well recognized as a pioneer in the development of 3D model creation and image mapping. Pix4Dmapper can offer a precise and accurate rendering of the crime scene to the court [1]. Adds details, lighting, and motion aspects using third-party software to enhance the courtroom presentation using Pix4D-generated point cloud and orthographic imagery displayed through Virtual Reality [2]. There are two types of access for the program: the free trial version and the premium paid version. So, after subscribing to the software, further testing is being conducted to determine if the output was more trustworthy.

A demonstrate were done on how to apply the Pix4d to observe the step-by-step process for creating a visualized image. By breaking the task down into simple steps, readers will learn and comprehend how to use the program. The entire procedure included several phases, each required to be completed before Photogrammetry is done.

2.2. Step for process

First, Start Pix4Dmapper is required. Click Project on New. The project and Wizard of New Project will come up in the menu bar. We need to enter a project name that could be your desired name. (Optional) Click "Browse" in Create in on the pop-up Choose Project Location, select the folder where the project and results are kept, and then click Select Folder as seen in Fig. 1.

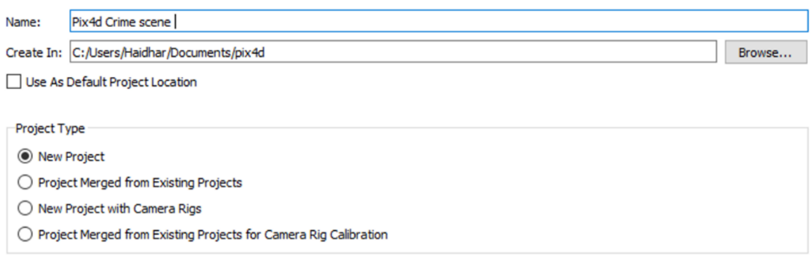

Fig. 1. Creating a new project.

Pressing "next" initiates the process with the insertion of images. This is where the image acquired by the drone in the application was uploaded. Figure 2 shown how to insert the images into the application. This technique is more likely to be called importing software images. The user may add either folder, photo, video and frames. The user would only click on the image, such that the window pops up to select the location of the image to be imported into the software. This would be the quickest approach because it takes much longer to load pictures into the application.

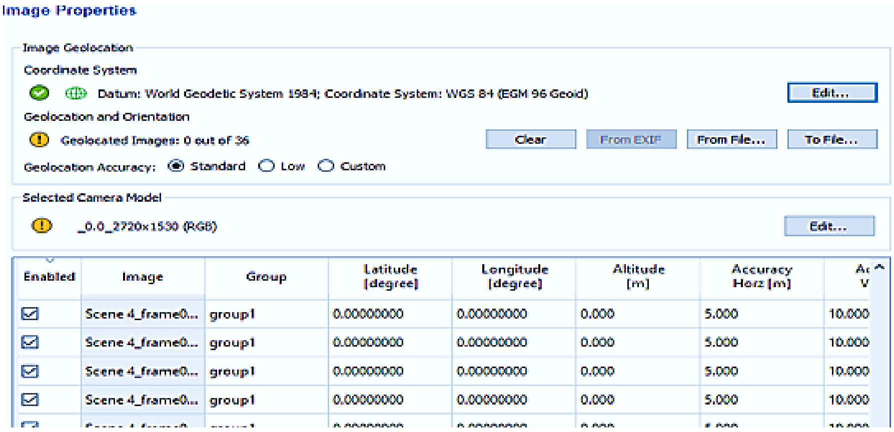

Fig. 2. Selecting image properties.

As shown in Fig. 2, the New Project Wizard offers three parts of the image properties window:

- Image Geolocation:
  - Sets the coordinate system referred to by the photo geolocation.
  - Import/export coordinates and, optionally, picture orientation and coordinate accuracy.
  - Access the geological of the image.
- Selected camera model: Sets and configures the image-associated camera model.
- Images table: Displays the photos selected and the group, location, position preciseness and orientation of each image and whether the image is enabled (an enabled image will be considered for processing).

After the photo has been added or imported, the user will need to start by selecting the processing options wizard template "3D models" in our instance as shown in Fig. 3. The processing options templates will be grouped into three categories within the Processing Options Template: Standard, Rapid and Advanced. Once chosen the processing option, the user can select the box "Start Processing Now" to start the processing automatically by Clicking the Finish icon to close the wizard and start the project.

In the process, a variety of obligatory procedures are required. Figure 4 shows three different types of functions that need to be performed to generate a 3D model. These processes are "Initial Processing," "Point cloud & Mesh," and "DSM, Orthomosaic &Index".

Depending on the quality of the result, each procedure would require a given time. Regarding quality, they are most likely to have a low, medium, and high level of 3, as seen by Fig. 5. The higher the rate, the longer the time is required. Not only would the quality of the number of imported photos play a significant influence on the time necessary to finish each stage. Sometimes, it could take around 24 hours if the image imported is more powerful and chosen a high option. If you look after the process in our instance, it took longer than expected because it relies on the output quality and the number of photos entered in the software.

When the initial processing starts, Pix4Dmapper calculates critical points on the pictures initially. They utilize these key points to match the images. The software performs automatic aerial triangulation (AAT) and bundles block adjustment of these initial matches (BBA).

In brief, the procedure starts with the alignment of the photos imported. This is the phase in which the software starts to sort the images imported. This method allows the picture to be sorted according to the position of the image. It is crucial as the photos must be sorted according to the scene's orientation to generate a photogrammetric. Referring Fig. 6 shows pix4d calculating the key points.

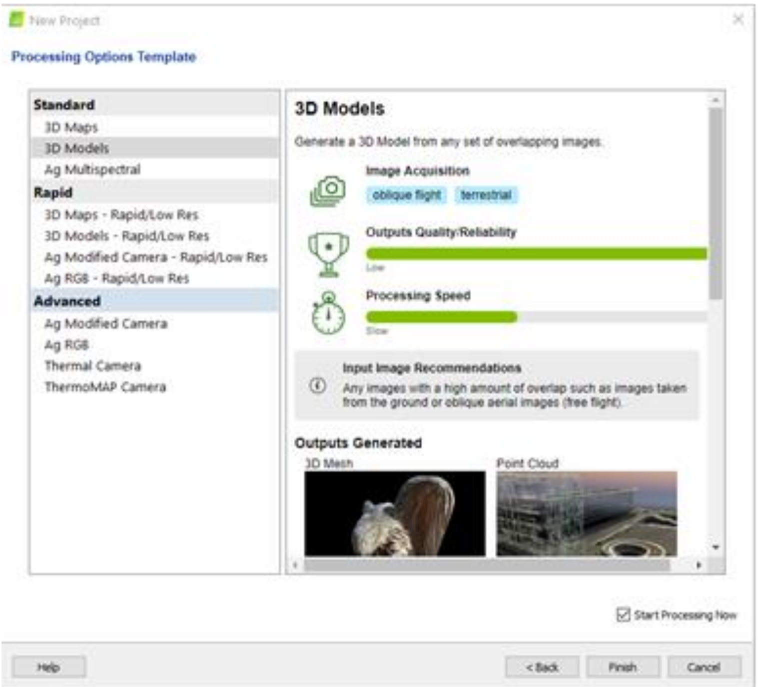

Fig. 3. Selecting 3D models.

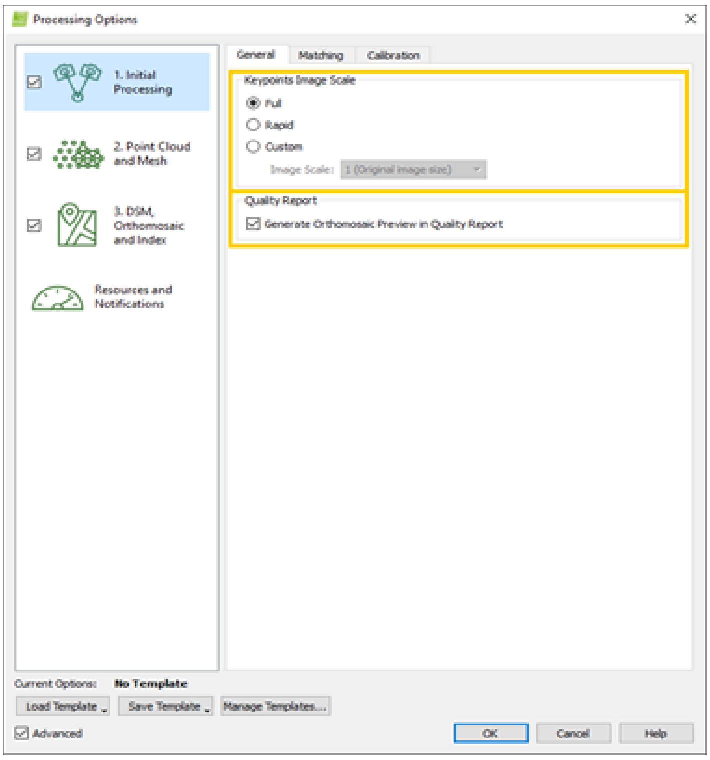

Fig. 4. Step of process.

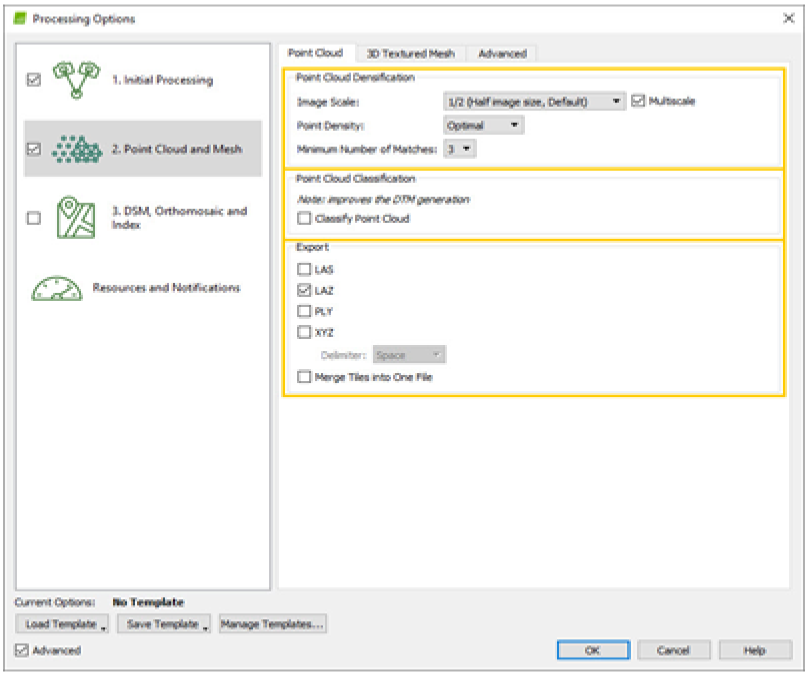

Fig. 5. Level of quality High – Low.

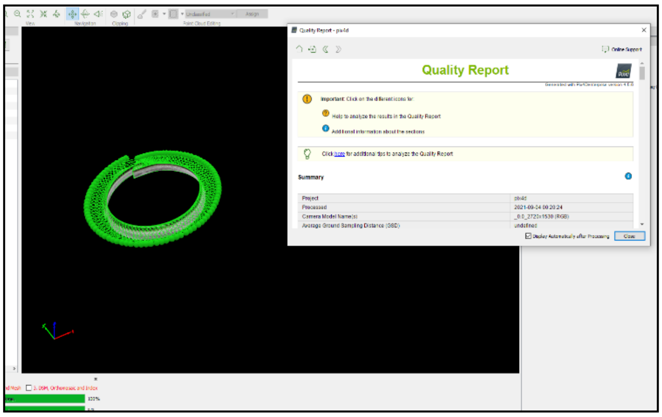

Fig. 6. Initial processing.

The procedure starts with developing a cloud point and mesh based on the uploaded image or video. The densified point cloud is a series of 3D attributes to reconstruct the model. The X, Y, Z position and colour information was recorded for each point cloud point. The densified point cloud is calculated using step 1 Automatic tie points (ATPs). The initial processing offers a highly precise baseline for measuring distance, surface, and volume. The 3d mesh is executed once Point Cloud is generated. The 3D textured mesh illustrates the model's form consisting of the projected photos' vertices, edges, faces, and texture. It is designed to appear attractive rather than accurate.

Figure 7 shows the procedure starts with DSM, Orthomosaic, and Index map generation. DSM (Digital Surface Model) is a digital topographic model that depicts surface relief and the situation. It comprises a digital terrain model that shows the surface of the earth and all its items. The creation of orthomosaic (real orthophoto) is based on orthorescence. This approach eliminates the aberrations of perspective from the photographs using the DSM.

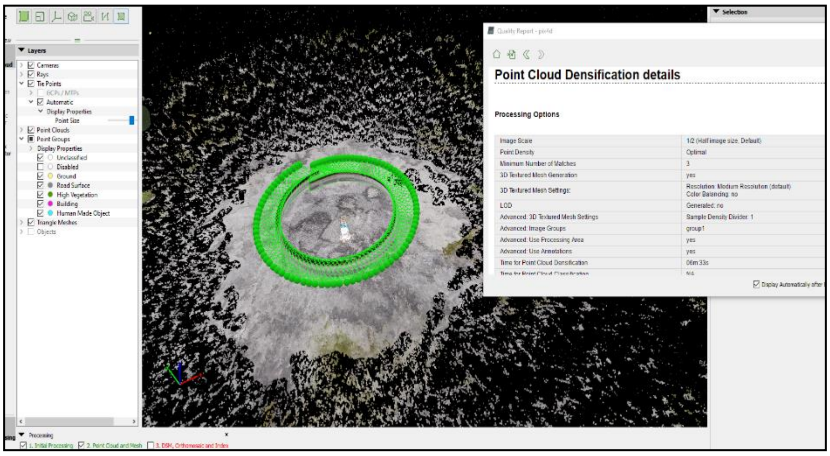

Fig. 7. Point cloud and mesh.

The model needs a high number of matches/key points (above 1000) [3]. This technique covers all terrain types and big datasets. Distance is retained, and orthomosaic for measurements may thus be exploited. Each index is linked to an index map. The pixel value is generated from the related maps for each pixel on this map.

Figure 8 shows the option of viewing the camera angle. The green figure in the circle lets users view the position, such as the drone or camera. The process is 360 degrees altogether to form a 3D model. The user will use this figure to determine if they require the capture procedure to be redone or presented. As illustrated in Fig. 9, is the final 3D model outcome of the crime scene.

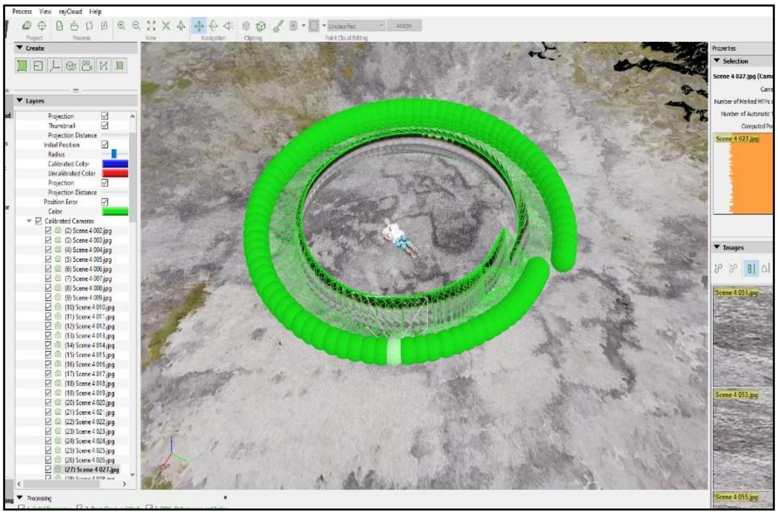

Fig. 8. DSM, orthomosaic, and index.

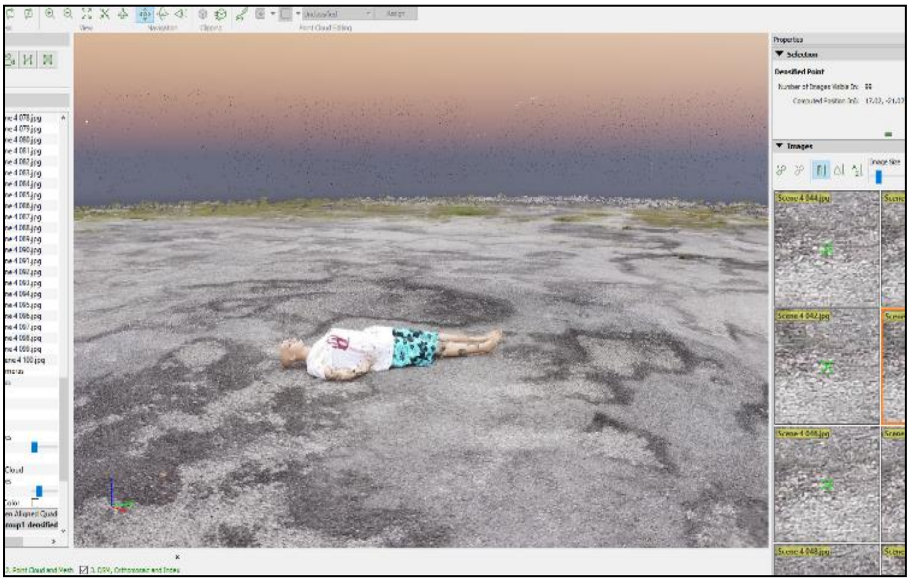

Fig. 9. 3D models.

3. Agisoft Metashape

3.1. Background

Redeveloping the crime scene is essential, as this process shall provide a clear view of how the crime took place. With the help of the drone, the crime scene images will be taken automatically, and they can be moved on to the next step, which is developing the scene. To get the process, proper software is needed to be picked. There is plenty of software in the internet world, but now all are suitable to be used [4]. Agisoft Metashape is being chosen to play a vital role in developing the 3D scene and image mapping.

Agisoft Metashape is stand-alone software that performs photogrammetric processing and generates 3D spatial data [5]. There are more other software users, but the important thing is that they have the important use of the photogrammetric process. There are two versions of the software: the free version and the paid version, as we can say firmly that the paid version would have more other features than the free version.

It is free to download the software but to use it, they either have a free trial or the paid version. As of knowing free trial, they would have certain restrictions. In the beginning, I have used the trial version, and the outcome was not reliable. Software is being subscribed to see if the output would be more reliable.

3.2. Step for process

The process begins with inserting images. This is where the process of inputting the image that has been captured by the drone in the software—referring to Fig. 10. The steps on inserting the photos into the software. This process is more likely known as importing the images in software. Just by right-clicking on the chunk, there will be a drop out that will allow the user to add either folder, photo, video, and frames.

The user would simply click the picture, and the window will pop up to pick the image's location that needs to be imported into the software. This would be the fastest process as it does not take much longer to import the photos into the software. Likewise, the steps after this would most likely consume more time to complete the process.

After adding or importing the picture, the user will need to begin the process. Under the process, there are a few compulsory procedures that will need to be taken. The process would start with aligning the imported images. This is the process where the software will begin to arrange the imported images. This process will allow the image to be place according to the image position. This is important to develop a photogrammetric, and the photos will need to be set according to the position of the scene. Figure 11 shows the image of the process that needed to be done to complete the procedure.

From Fig. 11, we can say about five procedures need to be completed to process. Each process would take a certain amount of time, depending on the quality of the output. The rate is most likely to have three levels: low, medium, and high. The better the quality, the longer the time taken. The quality and the number of imported images also would play a vital role in the time taken for each process to complete. Sometimes, importing more than 200 images and placing a higher quality would roughly take 16 to 17 hours [6]. Looking at the time to complete the process, they might take a long time to complete as it depends on the output quality and the number of images that have been imported into the software.

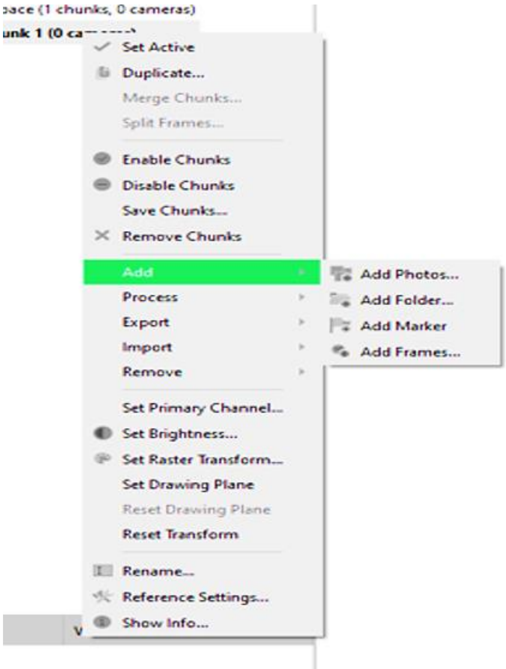

Fig. 10. The step of inserting images.

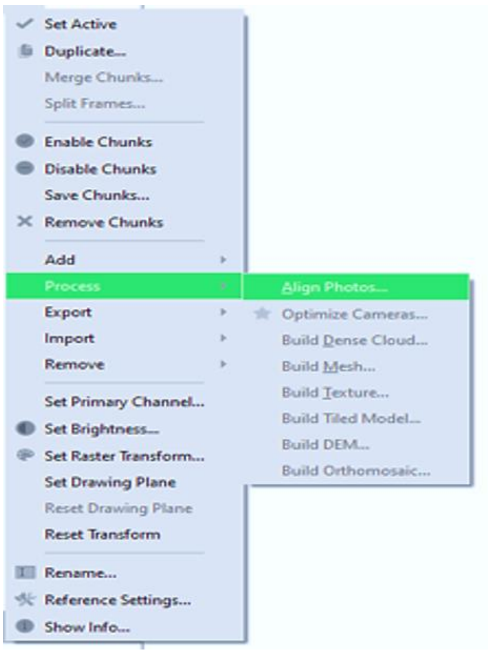

Fig. 11. The process in developing a 3D photogrammetric.

In Fig. 12, we can see that the process of aligning the image has been completed. The software will arrange the image according to the position, and the blue stains in the figure represent the position of the camera being place. After aligning, the process will need to go like in Fig. 12. Upon completing all the functions in Fig. 13, the outcome will be Fig. 13. Figure 13 is a completed sample. To gain the result in Fig. 14, the user will simply need to follow all the procedures one by one, and in the end, they shall receive the product, something like in Fig. 13.

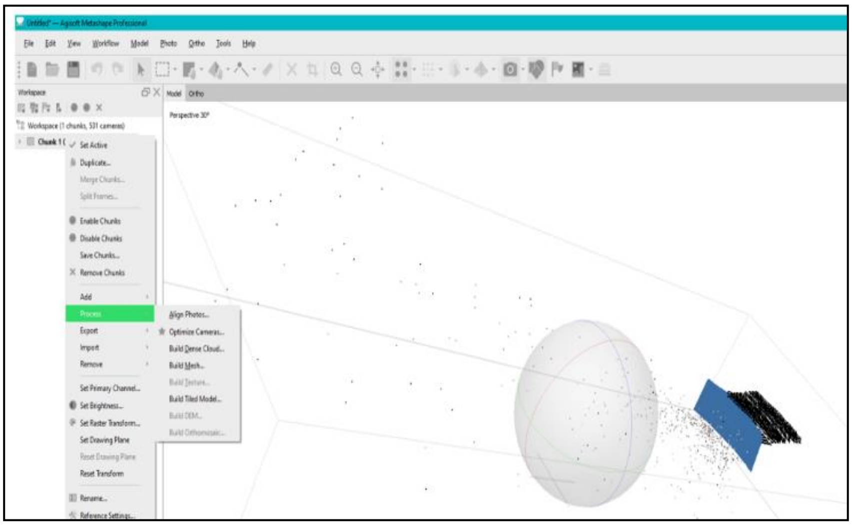

Fig. 12. The completion of align process.

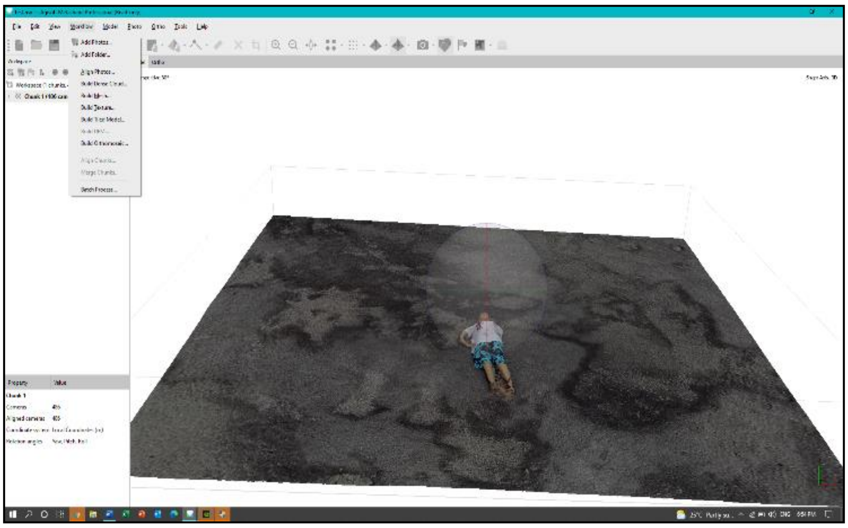

Fig. 13. The completion of photogrammetry.

Figure 14 demonstrates the option to view the camera position as the blue figure that goes in circular allows the users to see the device's function, such as drone, camera, and more. The circular shows the perfect 360 degrees. The users will also consider if they need to redo the capturing processor to present it from this figure.

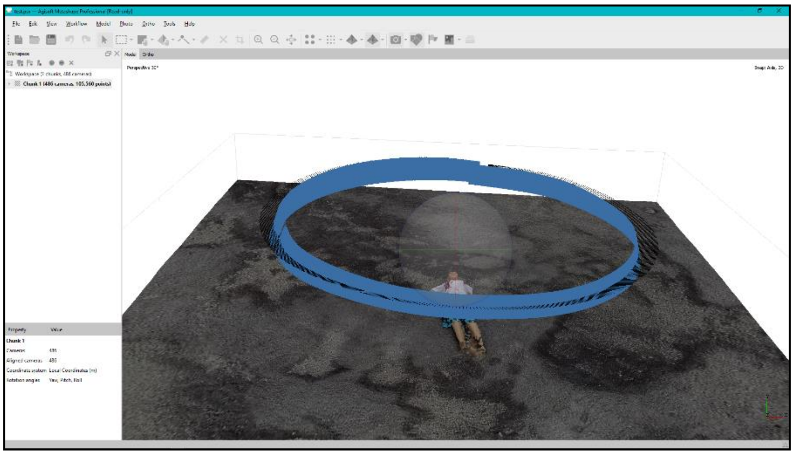

Fig. 14. The camera position.

3.3. Issues

Upon completing all the steps in the Agisoft Metashape software, the user will view the outcome. Figure 15 below shows the sample outcome. Looking at the figure, we can see a base with the object, but there is no background. This was an issue that could not be resolved as with the drone, we have captured a 360-degree video, and later that video was converted into jpeg whereby every single frame in the video is being stored as a jpeg. Looking from the restored image, they do cover a background, but in the outcome for the 360 photogrammetric, there is no background. Figure 15 would display the issue that is being discussed above. Looking at Fig. 15, the process of photogrammetry is a success, but no location was provided.

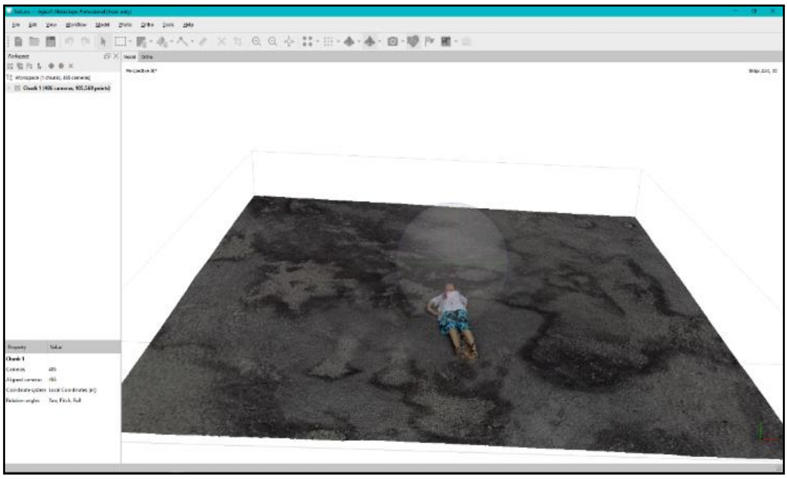

Fig. 15. The background.

This is one of the issues that we face. Other than that, aligning the image is another issue that a user would face. Aligning those images is essential as they will need to align correctly before the process begins. Without a successful alignment, the process of Photogrammetry would not be successful. This would also lead to a failed outcome and uncompleted. There could be many issues, but other users would face them differently, but the background is the main issue that would need more attention.

4. SIRV

4.1. Background

Sirv is a host that processes and optimizes images [7]. This is where they provide service on processing and optimizing the ideas that the user provides. This Sirv is website-based. The Agisoft Metashape is a software application, and this Sirv is website-based. The Sirv is much easier to use and does not consume space in the user's machine. The Sirv has many kinds of services, but the service that could help us on this project is their 360 spins, including Image Zoom.

As of the trial, the user can try out the free version. The free version would allow the user to use the Sirv, just that the users were given 0.5 GB storage. If the user wishes to upgrade, they shall subscribe to it. By subscribing to it, they would get 5 GB storage, converting video into a spin, and more [8].

4.2. Step of process

Figure 16 shows the page of the Sirv. We can add folders to it. The first thing the user will need to do is to import the images that are being capture, and once the import is completed, the Sirv will begin to upload it to the cloud. The photos will be saved in the server for the Sirv to start uploading to the cloud.

Fig. 16. The infrastructure of Sirv.

To import and upload the images, the users will need to click the upload. In Fig. 17, there is an option for upload, and when clicking the upload, it will provide two different opportunities: Files or Folder. This means the Sirv is allowing the user to upload files or in a folder. It will be better and more accessible for the user to pick the folder, and a window pop-up will appear to allow the user to determine the folder containing the images. By searching it and clicking it, the process of uploading will begin, and the time taken for the uploading would be dependent on the internet speed and the number of images that the folder contains.

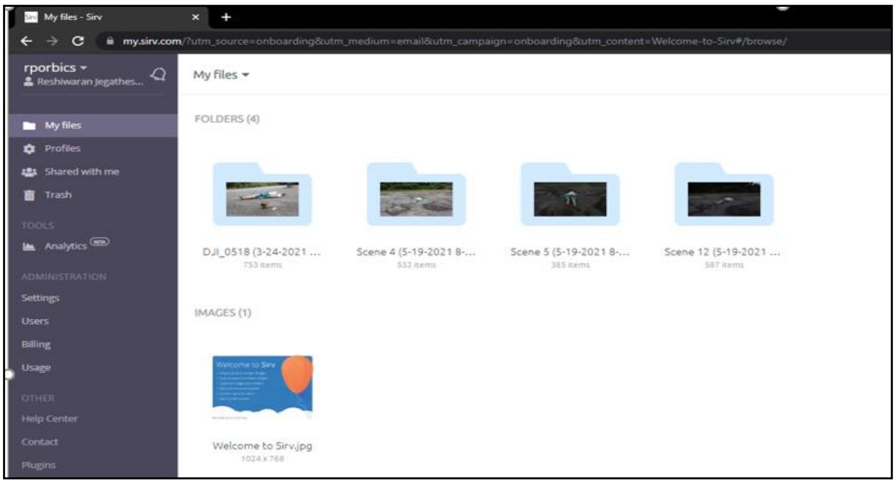

Fig. 17. The upload.

Upon completing uploading without further time waste, the Sirv will automatically begin developing the 360 spins. This is where the system will arrange the image, stitch them, and create it. There is not any human movement that is needed. In Agisoft Metashape, the user will need to click one by one step, but in this Sirv, the system will complete it all, and within 5 minutes, the 360 spins will be completed ready to be viewed. Figure 18 below is a simple display of how the uploading process on the cloud will take place.

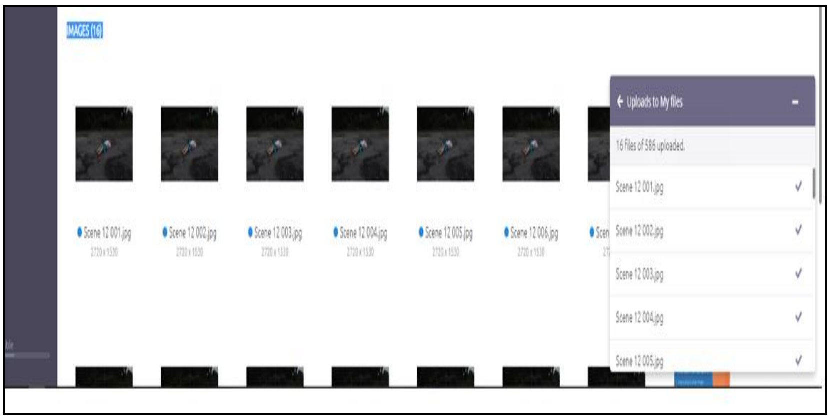

Fig. 18. Uploading.

As it been said above, upon the completion of uploading, the Sirv will begin the process of developing the 360 spins. When the process is completed, a file will be created, and, in that file, there will be two types of items whereby there will be the jpeg images that are being uploaded, and then there will be the 360 spins. Figure 19 shows the content of a file in the Sirv. We can see the jpeg and the 360 spins are being separated.

Fig. 19. The file.

When the 360 spin develops, the user can view it, and Fig. 20 would be the sample example of the 360 spins. There is code below for the user to make some changes in the output.

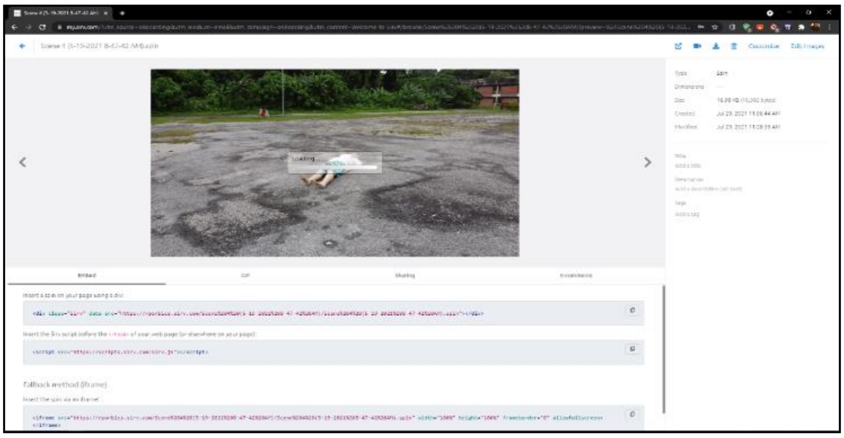

Fig. 20. 360 spins.

For this project, there we two scenarios being developed. Both the scenario was taken outdoor, and both where a simple scenario whereby there would be a dead body. Figure 21 is to display both scenarios. On the left side of the figure, the plan was taken during the moody cloud, and the lighting did not play any role as the Sirv would just replicate the 360 Spin no matter what they get. On the other hand, the scene on the right was developed during a sunny day and this time the background has a few objects, and the images were taken closely.

Fig. 21. Scenarios.

5. Future Studies

5.1. Background

To overcome the issue in the background, we feel that lidar would resolve the issue. Lidar here would not be the only device, but they could add the lidar as a secondary device. For instance, we can use the drone as the primary and the lidar devices as the secondary devices. By doing this, the drone would be use to capture the scene, and the lidar could be used as a backup that includes the background and location.

LIDAR, also known as 3D laser scanning, is an abbreviation for light detection and ranging. LIDAR (light detection and ranging) has been in use since the 1960s [9]. It used for detecting distances using laser light. It relies on a laser light being shined on a target item or area, and then the amount of time required for the laser light to return to the sensor is recorded to precisely measure distances.

According to Pix4D, many businesses currently utilize 3D laser scanning, which has applications in various areas, from mobile to aerial and terrestrial data-collecting initiatives [10]. Laser scanning precisely calculates distance, which allows it to recreate detailed 3D digital images of various areas, objects, and landscapes. There is no comparison between this technique and Photogrammetry, as they produce accurate, completely digital results. The LiDAR technique produces a 3D point cloud that is geo-referenced and non-coloured, as shown in Fig. 22. In this thick point cloud, photogrammetry may have trouble recognizing smaller objects, such as cables or wires. Unfortunately, a professional scanning firm needs to perform laser scanning, which can be pricey.

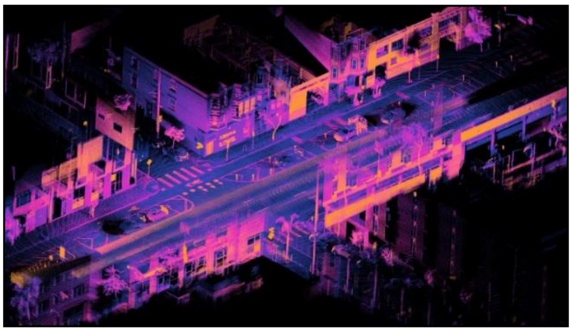

Fig. 22. A detailed LiDAR's point cloud.

5.2. What is the difference between LiDar and Photogrammetry

The main benefit of LiDAR over Photogrammetry is that it can create light. In short, it indicates that photogrammetry drone data gathering is not influenced by meteorological circumstances, such as cloud cover and changing illumination conditions. Both terrestrial and aerial 3D laser scanning benefit from this, whereas Photogrammetry using drones or handheld cameras does suffer in poor lighting.

Then, LiDAR can penetrate greenery that is composed of several discrete pieces and retrieve the minor details. The laser pulse will detect the inter-leaf spaces and tell you how close you are to the tree root or the ground underneath the tree. At the same time, Photogrammetry simply takes photographs and then applies image-processing techniques to reconstruct what is visible on the surface.

Also, as seen in Fig. 23, LiDAR in that region was able to identify a much higher number of points in the forest and cable densely packed area. This can be problematic for Photogrammetry in Fig. 24 because many minor issues cannot be distinguished.

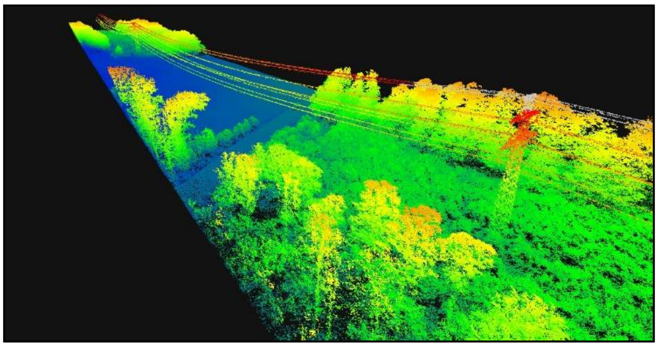

Fig. 23. LiDAR.

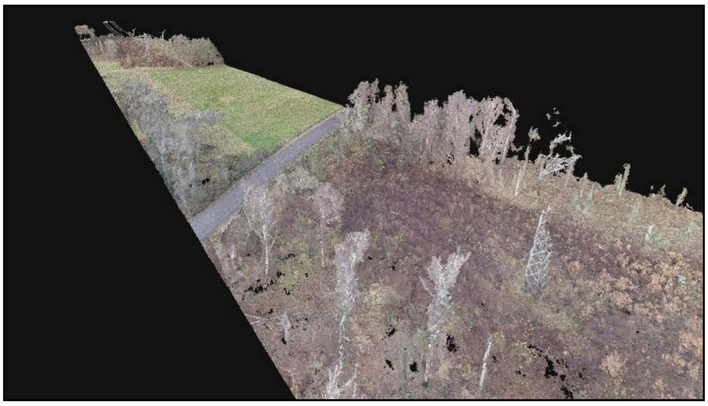

Fig. 24. Photogrammetry.

On the other hand, LiDAR tends to be rather costly [11]. Despite the growing array of consumer-level cameras, Photogrammetry may be carried out using any camera, including those designed for the consumer market. Photogrammetry also benefits from colourized point clouds, textured meshes, and orthomosaic, whereas LiDAR gives you a point cloud alone.

5.3. How can Photogrammetry and LiDAR work together?

LiDAR can be exploited to do comparable photogrammetry operations and therefore can enhance its outcomes. Using these two methods in conjunction, LiDAR can provide information, mainly terrestrial laser scanning, that aerial photogrammetry data may have failed. When LiDAR and Photogrammetry are integrated, they thereby offer greater detail in a project that individually has still not achieved.

According to Pix4D, it was demonstrated by the new vectorization program Pix4Dsurvey that overcomes the gap between photogrammetry and CAD [10]. This allows users to integrate point cloud photogrammetry with point cloud data collected from other techniques, such as LiDAR.

By providing access to both the original images and the point cloud, the vectorization and extraction of points, polylines, polygons, and catenaries is made more precise and quicker. For complex tasks such as thin objects such as overhead power lines, LiDAR can assist bridge gaps in data gathering methods for Photogrammetry. Photogrammetry data can used in conjunction with terrestrial laser scanning. Vectorizing a region splits it into polylines and polygons to specify geometry points. The final vector files produced from Photogrammetry and LiDAR large-point cloud data was engineer as shown in Fig. 25.

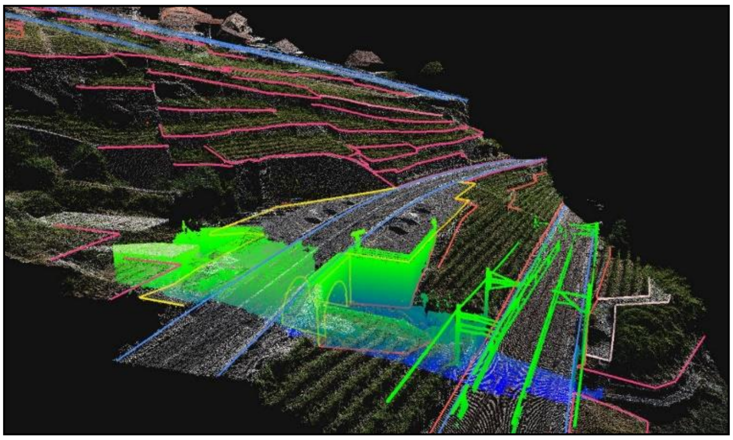

Fig. 25. Pix4Dsurvey combining both LiDAR and photogrammetry data [10].

6. Conclusions

Briefly, with a various number of software out there in the internet world, the Pix4D, Agisoft Metashape, and Sirv are the software that is user friendly, and the process of image processing is much understandable for the users. Although many people recommend Pix4D and Agisoft Metashape, we suggest that Sirv would be more acceptable and reliable for developing the image stitching process.

Sirv seems to complete the process with what they have been feed. Compared with the other two software, the Sirv would construct the image processing in minutes. They seem not to have any weakness on image stitching as the other two software would want to need more images to get the image stitching acceptable. On the other hand, the other two software would take more time to give the outcome, and sometimes, the result would not be as expected, which will lead to a rerun of the software, and more time would be wasted. Being on the first stage, this viewing of the 360 spins would be more reliable and realistic to be use and, they would be appropriately used to serve their purpose.

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