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Satellite Image Stitcher using ORB

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Abstract:- Satellite Image Stitcher is a smart system which will carry out Image stitching and 3D Texture Mapping. In this module, overlapping areas in the photos, resulting in photographs with accurate information. When two images overlap, a portion of the earlier image is duplicated in the present image. If the image cannot be divided entirely, the degree of overlap on the boundary images is increased until they can. The preceding module's divided photos with overlapping regions are patched together to create an improved overall image. We are integrating many photographs with overlapping fields of vision in this module to create segmented panoramas or high-resolution photos. To achieve accurate results, this method of image stitching needs virtually perfect overlaps between photos and identical exposures. This module sets up the virtual display, creates the sphere on which the stitched image will be generated, maps the texture images to the sphere, then exports the file as a 3D viewable HTML file. In this procedure, a three-dimensional (3-D) object is wrapped in a two-dimensional (2-D) surface known as a texture map. As a result, the surface texture of the 3-D item resembles that of a 2-D surface.After executing all the phases, we get a 3D Viewable HTML File, where we can view the planet 3 Dimensionally.

I. INTRODUCTION

Nowadays, the development of cameras and multimedia technology is accelerating quickly. Also, there is a dramatic increase in the use of huge images and videos among people. Smart cameras used in recent time in a wide range, smart cameras are a combination of three parts in one package (cameras, computer vision programs, and image processing). Smart cameras also called intelligent cameras used to hand the users for processing the images by providing microprocessors that control the camera instead of using a separate processor or PC [3]. The field of computer vision has increased drastically, with the introduction of a variety of techniques to perform such tasks [2]. These tasks include motion analysis, reconstruction of the scene, image restore, and image matching [4]. This study focused on various image matching techniques and feature detection algorithms [7]. We compared how well they performed and how that impacted the stitching process' precision [5]. Some algorithms/techniques might work better with certain data sets, whereas others do not analyze the same datasets as efficiently. Therefore, some algorithms are useful for a particular application, whereas others have different applications in image processing and computer vision applications.

The method of integrating many photographs with overlapping fields of view to create an Elongated Image or high-resolution image is known as image stitching or photo stitching. The majority of methods for image stitching, which are frequently carried out through the use of computer software, call for virtually precise overlaps between images and equal exposures in order to achieve seamless results. "Stitching" refers to the process of utilizing a computer to combine small images into a larger one, ideally without leaving any trace that the generated image was produced by a machine [1].

II. MATERIALS & METHODS

The project's core idea or mode of operation is relatively straight forward. The image processing technology is used throughout the project. The project is made up of both static and non-static modules. The system may separate the images with overlapping sections, resulting in a higher-resolution image. Using texture mapping, a

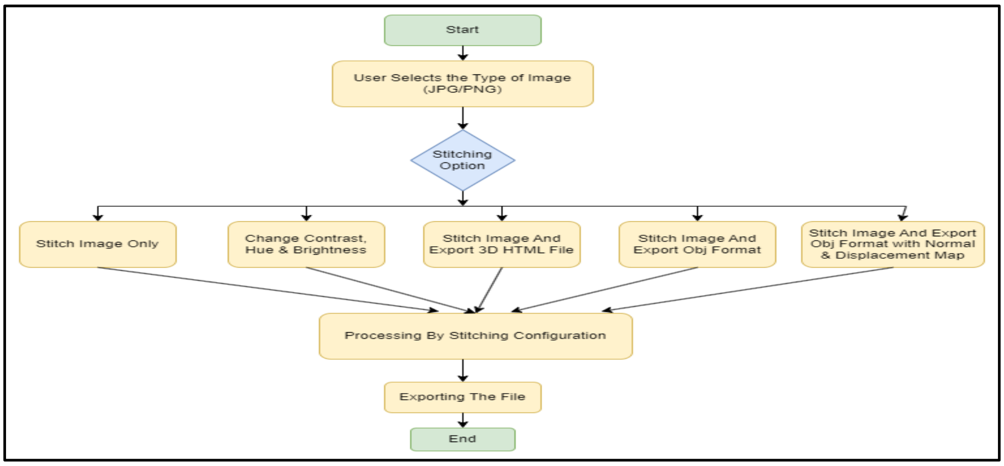

Fig. 1: Flow Diagram of Proposed System

Stitched 2-Dimensional image will be transformed into a 3-Dimensional texture map model.

This system uses the ORB algorithm.

A. ORB :

ORB builds on the FAST keypoint detector and the BRIEF descriptor Algorithm. Both of these algorithms are attractive because of their good performance and low cost.

ORB's main contributions are as follows:

- The addition of a fast and accurate orientation component to FAST
- The efficient computation of oriented BRIEF features
- Analysis of variance and correlation of oriented BRIEF features
- A learning method for decorrelating BRIEF features under rotational invariance,leading to better Performance in nearest-neighbor applications.

B. FAST :

A feature detection technique called Features from accelerated segment test (FAST) is used to extract feature points from an image. The FAST feature detector has the advantage of being computationally efficient. Superior performance in terms of computing time and resources can be attained when machine learning techniques are used. Due to its quick performance, the FAST feature detector is ideal for real-time video processing applications.

Fig. 2: Features of Binary Vector

C. BRIEF :

After detecting keypoint we go on to cipher a descriptor for every one of them. point descriptors render intriguing information into a series of figures and act as a kind of numerical " point " that can be used to separate one point from another. The defined neighborhood around pixel(keypoint) is known as a patch, which is a forecourt of some pixel range and height. Image patches could be effectively classified on the base of a fairly small number of pairwise intensity comparisons. detail convert image patches into a double point vector so that together they can represent an object. A double features vector also known as double point descriptor is a point vector that only contains 1 and 0. In brief, each keypoint is described by a point vector which is 128 – 512 bits string.

The Flow Of the ORB Algorithm is as follows :

- The Input Image Is Given.
- FAST(Feature From Accelerated Segment Test) Detects the key points of the image.
- Then, The Best points are selected from the key points.
- BRIEF(Binary Robust Independent Elementary Feature) Extracts the Image with patch and then it generates Binary Feature Vector.
- After that the final Output Image is Produced.

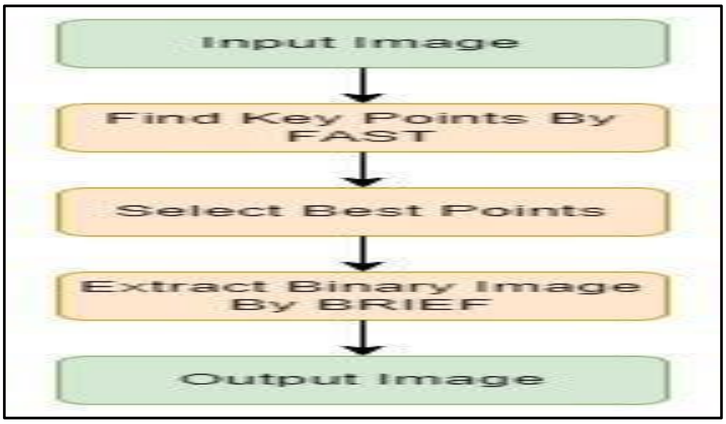

Fig. 3: Flow Diagram of ORB Algorithm

III. RESULTS AND DISCUSSION

A. Image Stitching

The photos with overlapping regions are patched together to create an improved overall image. We are integrating many photographs with overlapping fields of vision in this module to create segmented panoramas or high-resolution photos. To achieve accurate results, this method of image stitching needs virtually perfect overlaps between photos and identical exposures.

B. 3D SPHERE CREATION & TEXTURE MAPPING

This module sets up the virtual display, creates the sphere on which the stitched image will be generated, maps the texture images to the sphere, then exports the file as a 3D viewable HTML file. In this procedure, a three-dimensional (3-D) object is wrapped in a two-dimensional (2-D) surface known as a texture map. As a result, the surface texture of the 3-D item resembles that of a 2-D surface.

- *Heterogeneous Images With Overlapping Parts:*

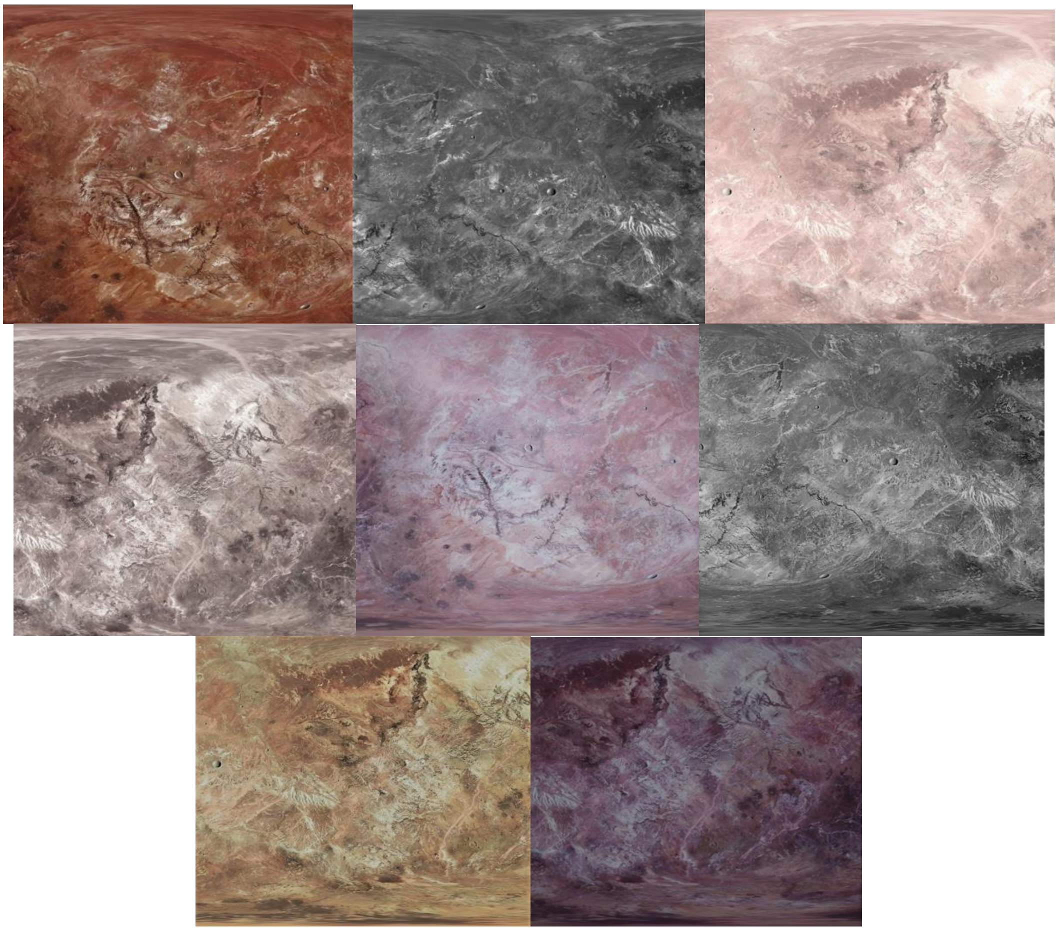

Fig. 4: Images With Overlapping Parts

- *The Stitched Image :*

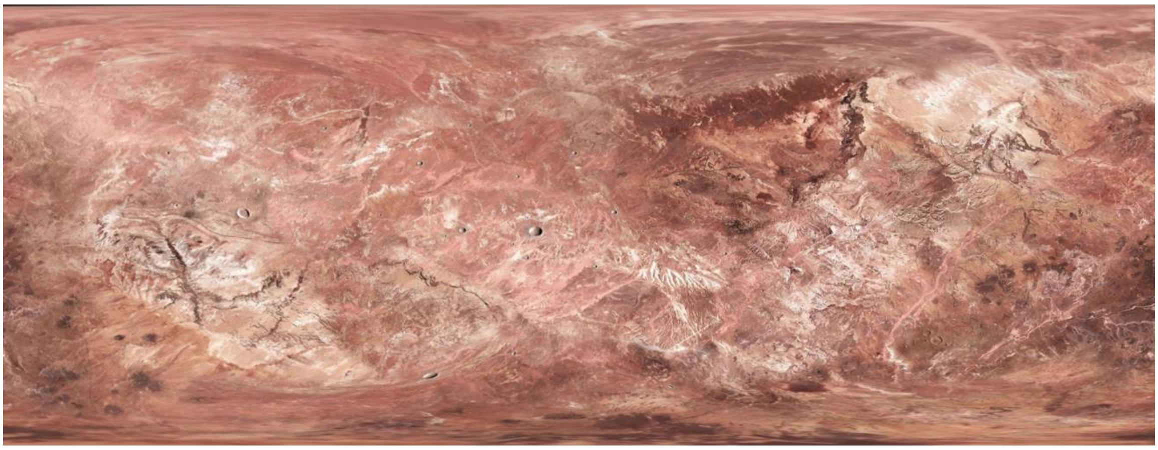

Fig. 5: Stitched Image

➢ *The Stitched Image Mapped on Sphere:*

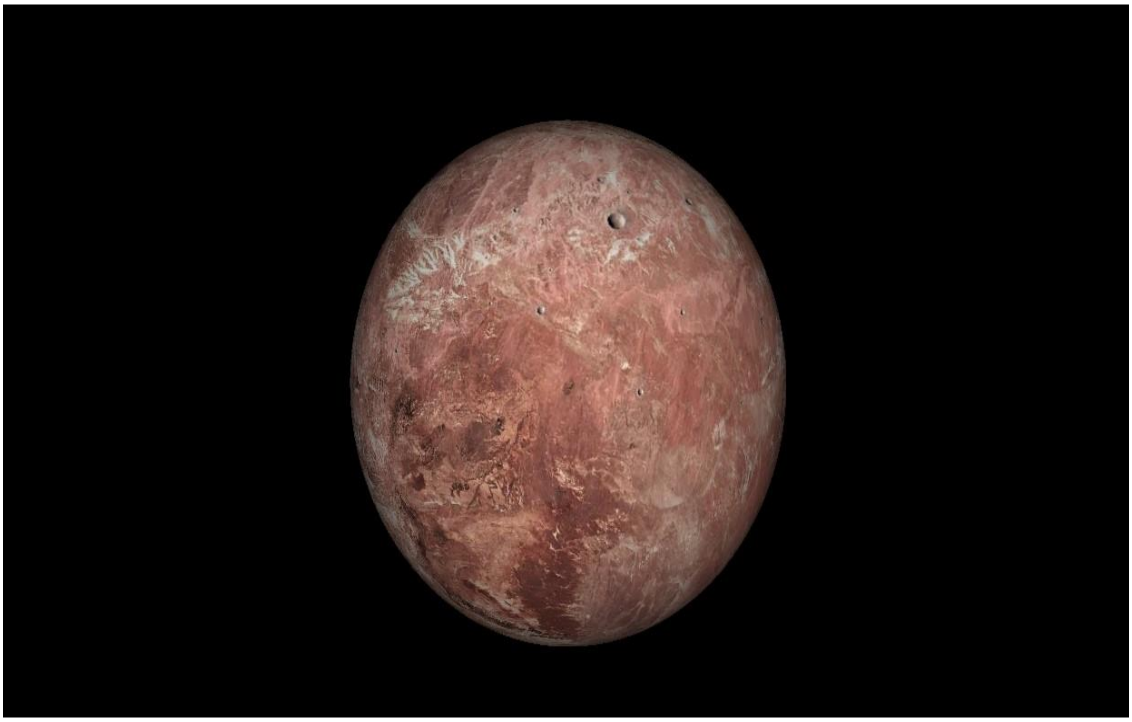

Fig. 6: Mapped 3-D Image

➢ *Heterogenous Stitched Image :*

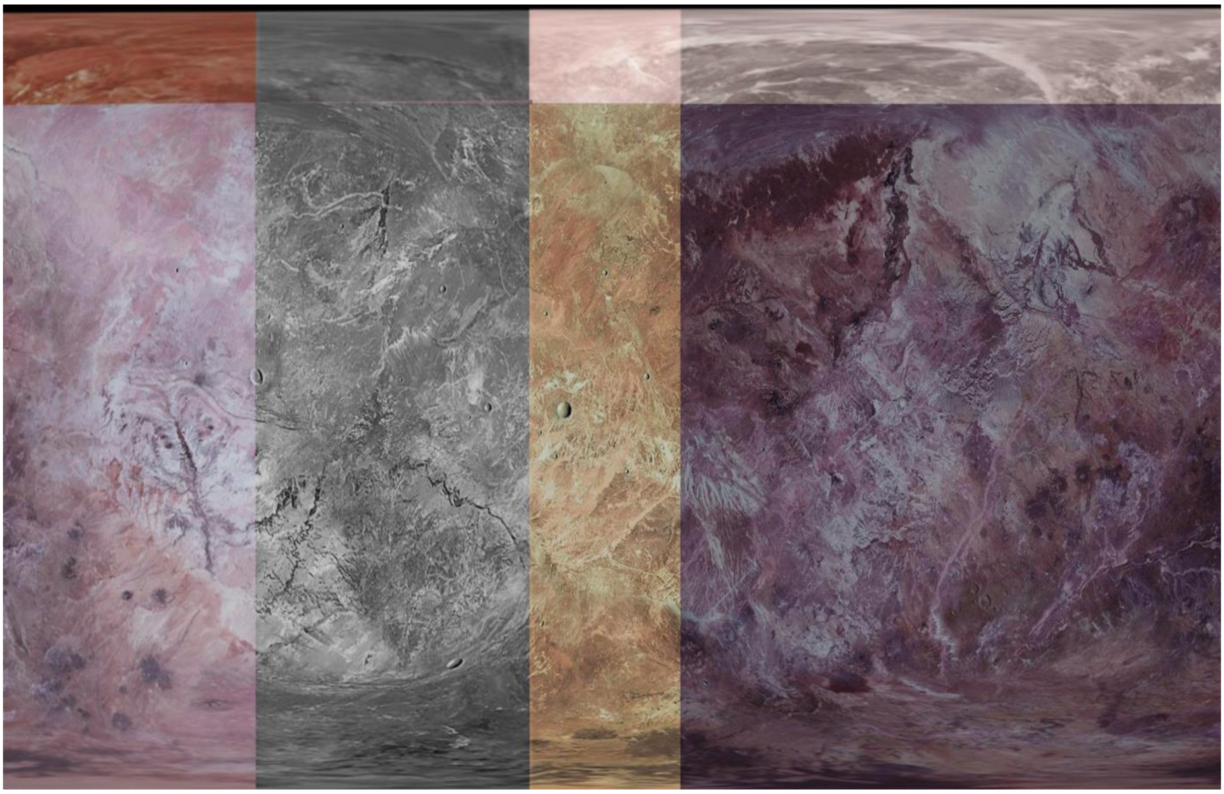

Fig. 7: Heterogenous Image After Stitching

Original Image : Hue And Contrast Image :

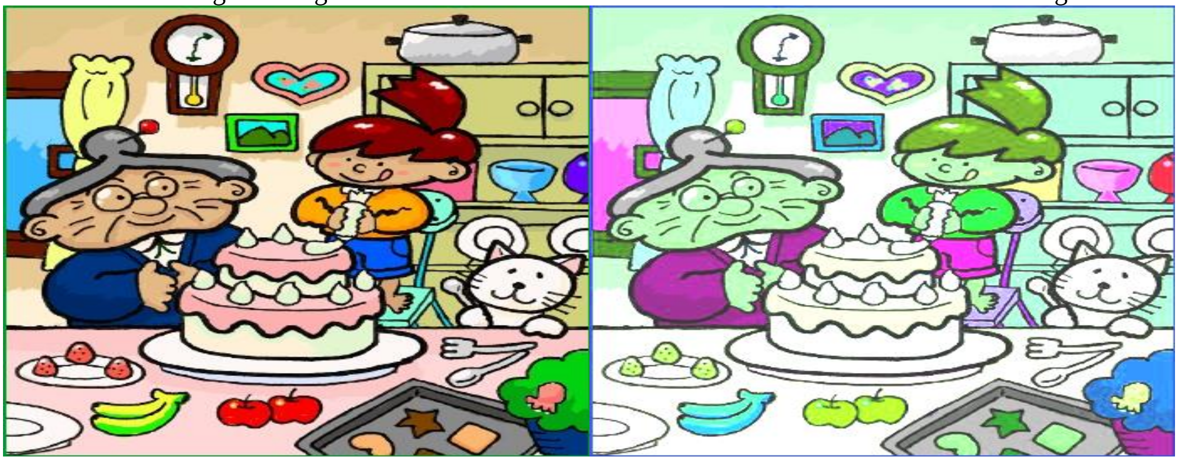

Fig. 8: Comparison of Original and Hue & Contrast Image

- *Displacement Map :*

Fig. 9: Displacement Map of Stitched Image

- *Normal Map :*

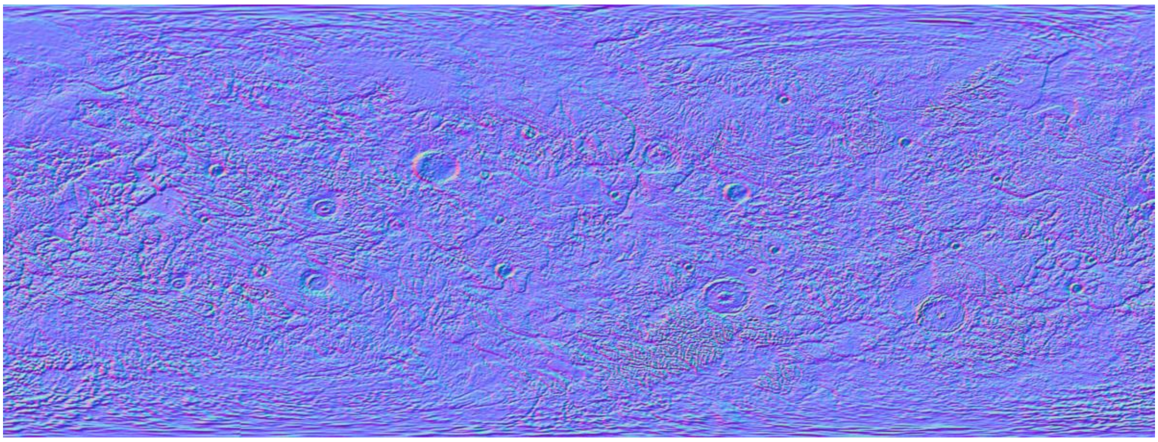

Fig. 10: Normal Map of Stitched Image

C. ORB Algorithm :

The ORB (Oriented FAST and Rotated BRIEF) algorithm is a feature detection and description algorithm used in image processing and computer vision.The algorithm combines two popular methods for feature detection and description: FAST (Features from Accelerated Segment Test) and BRIEF (Binary Robust Independent Elementary Features).FAST is a corner detection algorithm that identifies corners in an image by finding pixels whose intensities change rapidly in all directions. BRIEF is a feature description algorithm that generates a binary string for each feature based on a comparison of pixel intensities in a small patch around the feature.

The ORB algorithm improves upon these methods by introducing orientation information for each feature. This is done by computing the intensity centroid of the feature patch and calculating the direction of the gradient at this point. The orientation is then used to rotate the patch before computing the feature descriptor using BRIEF.The resulting feature descriptors are binary strings that are invariant to changes in illumination and scale, and can be efficiently matched across images using techniques such as the Hamming distance. The ORB algorithm is also computationally efficient, making it suitable for real-time applications such as object recognition and tracking.

D. Why ORB instead of SIFT

Both the ORB and SIFT (Scale-Invariant Feature Transform) algorithms are widely used methods for feature detection and description in image processing and computer vision. However, there are some key differences between the two that may make ORB a better choice in certain situations.One advantage of the ORB algorithm is its computational efficiency. ORB is faster than SIFT because it uses binary feature descriptors that can be compared using bitwise operations, while SIFT uses floating-point descriptors that require more complex computations. This makes ORB more suitable for real-time applications such as object recognition and tracking.Another advantage of ORB is its ability to handle occlusion and clutter in images. SIFT features are scale-invariant, but they are not always robust to changes in orientation or occlusion. ORB, on the other hand, computes the orientation of each feature and can handle partial occlusion by using multiple oriented patches.

Finally, ORB is a patented algorithm that is freely available for use, while SIFT is a patented algorithm that requires a license for commercial use. This makes ORB more accessible for developers and researchers.That being said, there are also situations where SIFT may be a better choice, such as when dealing with highly textured images or when extremely high accuracy is required.

E. 3D Sphere creation & Texture mapping

Mapping an image onto a sphere is a common technique used in computer graphics and computer vision applications. This process is also known as texture mapping, and it involves wrapping a 2D image onto a 3D sphere to create a textured surface.

Here are the general steps for mapping an image onto a sphere:

- **Define the 3D sphere:** First, a 3D sphere needs to be defined with a certain radius and center. This can be done using 3D modeling software or by programmatically generating a sphere mesh.
- **Generate UV coordinates:** Next, UV coordinates need to be generated for each vertex of the sphere mesh. UV coordinates are 2D coordinates that represent the position of each point on the 3D surface of the sphere. UV coordinates are typically normalized to a range of 0 to 1.
- **Map the Image:** The image is then mapped onto the sphere using the UV coordinates. Each vertex on the sphere mesh is assigned a corresponding UV coordinate, which is used to sample the corresponding pixel in the image. This pixel value is then applied as a texture to the surface of the sphere.
- **Apply texture Filtering:** To create a smooth texture on the sphere surface, texture filtering is often applied to the image. This can involve techniques such as bilinear or trilinear filtering to smooth out pixelation or other artifacts.

Once the image has been mapped onto the sphere, the resulting texture can be rendered using a 3D graphics engine or used in other applications such as virtual reality, augmented reality, or panoramic photography.

IV. CONCLUSION

Image stitching is a research area in active development, with many distinct algorithms for detecting and describing characteristics. This research provides a features-based image stitching system using the rotation- and scale invariant SIFT method, which requires lengthy computation. The ORB algorithm has a faster execution time and is rotation and scale invariant. In the future, a variety of attributes will be used to provide a thorough inspection of the stitched and mapped 3-D Model.

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