3D Reconstruction Methodologies: a Review

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ABSTRACT -Usually underwater images will have a less visibility conditions, for which the 3D reconstruction for these images has become a challenging tasks. This is because of problems like harsh environmental conditions (black smoke, white smoke) or may be of infraction by floating partials and aquatic animals. The other problem that arises like light propagation in underwater which affects the image color, and the problem in visualization of small objects is poor.to overcome these problems in this paper, we did the detailed survey on different technique of 3D reconstruction of underwater objects.

Keywords- SFM, Speeded Up Robust Feature, CLAHE, SIFT, Delaunay Triangulation.

I. INTRODUCTION

In computer vision, 3D object reconstruction is a process to recreate the shapes and appearances of original objects. 3D reconstruction can be performed by Active method and Passive method. The active method reconstructs the 3D objects either by using a mechanical method or a radiometric method. Passive method don't interfere with the reconstruction technique, as it uses sensors to estimate the radiance released by surface of objects to infer its 3D modal. After the revolutionary contributions in medical practices and many other fields, 3D imaging system is used in more and more applications such as video surveillances, in the survey of underwater objects like biological species, ancient shipwrecks and coral reefs etc., video simulation and mapping. Now a days underwater imaging (marine science and technology) has become a very interesting topic for researchers.

Underwater imaging will have a poor visibility conditions. This is because of challenging environmental conditions (black smoke, white smoke) or may be violated by fish, floating particles and aquatic animals. Another challenge that arises on image color when light propagation occurs in underwater. Another challenge is the visibility of small objects is not good or hidden when the underwater image is captured. To overcome these problems in this paper, we did the detailed survey on different technique of 3D reconstruction of underwater object.

II. LITERATURE OVERVIEW

Luca Mazzei et al.[1] the proposed work presents an autonomous, small sized, low cost device for underwater imaging. The low cost system is used to analyze marine organism (macro, mega zooplankton and benthos) through reconstructing 3D models. The system is designed completely autonomous, low cost and small in size, in order to deploy easily on any underwater vehicle and is also used in the fixed area as a stand-alone mode to monitor the benthos growth for long time, and because of its flexibility it is used in many underwater investigation approach even in harsh environment. The system is capable of reaching deep-sea depth because of its autonomous functionality, without the support of any divers. The image acquisition task is completely autonomous and it is designed to be fully programmable in camera parameter and performs in real time. Then the 3D reconstruction is performed by using metadata and the information collected during the image acquisition process.

Adrian Bodenmann et al.[2] the proposed work demonstrate that the underwater imaging system can generate the high resolution 3D color reconstruction of the seafloor, from the range of up to 13m. Visual mapping is used in the applications like survey of underwater archeology, survey of marine organism, to inspect man-made structures etc. Usually the attenuation of light in water is more than in air, so to obtain the colored underwater images it is required to be within 2-3m from the seafloor. In such low altitude, the underwater vehicle can acquire a limited area in each image of the seafloor, which is time consuming for the survey of large area. To overcome this problem, 3D mapping device –SeaXerocks‖ has been developed to increase the efficiency of acquiring large area of the seafloor images, also obtain high quality of color images from the high altitude of up to 13m. The algorithm uses these images to automatically process the data it obtains.

Dr. Ramakanth Kumar P et al.[3] proposed a 3D object reconstruction system using a feature detection technique called Speeded Up Robust Feature(SURF) is a robust feature detector and is used in 3D reconstruction problem and object recognition problem. Speeded up robust feature points and are matched between the pair of underwater images. The unwanted feature points are removed using epipolar geometry and derive the geometrical relation. Then the 3D points are computed using linear triangulation. These 3D point clouds are then used for 3D reconstruction and texture mapping.

Pulung Nurtantio Andono et al.[4] proposed a Contrast Limited Adaptive Histogram Equalization(CLAHE) enhancement technique for 3D surface reconstruction of underwater coral reef. Underwater images will have a less quality of visibility because of absorption and scattering of light, which affects the image color. To enhance the quality of the images for underwater image CLAHE algorithm is used in preprocessing area. The image pairs of the seafloor were manually extracted from the video footages, to develop a 3D representation of a seafloor. The SIFT (Scale Invariant Feature Transform) image matching algorithm is used to automatically extract the corresponding points between the image pairs. The performance of the Scale Invariant Feature Transform with CLAHE is computed using the number of matching points. Thus the combination of CLAHE and outlier removal provides a better enhancement technique to improve the quality of the image.

Alessandro Gallo et al.[5] proposed work presents the analysis made on small specimens, using a multiview stereo technique to reconstruct the 3D object. The analysis in the field of cultural heritage is gaining importance for

restoration, duplication and maintenance of ancient specimens. The 3D reconstruction technique is used to determine the characteristics of a particular species. The problem rose due to use of macro lenses, such as small depth and loss of sharpness because of diffraction. To overcome this problem, every image in the sequence is acquired by merging all the images captured at different focus plane using image fusion algorithm. This results in obtaining the object with high quality textured 3D modal that ranges from some millimeter to centimeter.

Prabhakar C J et al.[6] the proposed work presents the reconstruction of 3D surface for the underwater objects. The surface reconstruction of 3D underwater image is a very challenging task, because of the poor visibility of underwater image. There are many reasons for the poor visibility of underwater image such as illumination of light propagation, scattering and floating particles that produce noise in the captured image. The preprocessing is applied for the degraded images by using wavelet denoising, anisotropic filtering and homomorphic. To rectify the preprocessed image uncalibrated rectification technique is applied. Then the graph cut method is used to find the corresponding points from the rectified image, which is the used to estimate depth of the image by applying triangulation method.

Pulung Nurtiantio Andono et al.[7] the proposed work presents the 3D reconstruction of coral reef images using lowcost underwater camera. A footages of the seafloor is collected from the multiview underwater cameras in linear transects. The image pairs of the seafloor were manually extracted from the video footages, to develop a 3D representation of a seafloor. The SIFT (Scale Invariant Feature Transform) image matching algorithm is used to automatically extract the corresponding points between the image pairs. Based on the result obtained by the corresponding points of the image pair the 3D position of the coral reef can be determined by using triangulation technique and the surface reconstruction is processed using Delaunay triangulation.

Georgios Papadopoulos et al.[8] proposed, SCOUT autonomous surface vehicle which is used to determine the above part and below part of the underwater structure. The autonomous surface vehicle is designed which is equipped with sonar and laser scanner, which is capable of scanning the above and below part of the underwater structure. To construct 3D models of the above part, scan matching technique is used. The 2D sonar data of the below part is then used by the transformation of the above part to construct a 3D modal. Then the above and below part of the 3D modal is combined to construct an entire 3D modal of the partially immersed underwater structure. Two types of maps are constructed: low quality map- constructed online which is used for navigation, and high quality map-constructed offline which is used for inspection.

Chris Beall et al.[9] the proposed work presents the 3D reconstruction of dense objects using smoothing and mapping techniques. There are technique which gives high quality 3D reconstruction for large structure, but the 3D reconstruction for small underwater objects is not satisfied because of the challenging environment. The dense object modal is built from the synchronized high definition video. The SURF is used to detect features, the camera trajectory and the 3D points are estimated, and are fed as the input to mapping and smoothing techniques for optimization. These 3D modals provides accuracy for quantitative measurements of drown structures.

Anne Sedlazeck et al.[10] proposed SFM (structure from motion) system allowing to compute detailed 3D reconstructions from underwater objects or scenes. The underwater video of deep seafloor structure from ROV Kiel 6000 is used for 3D reconstruction. The SFM (structure from motion) is used to provide a good imaging condition, because of which the camera is not required to follow the specialized trajectory. It adapts a special filtering to remove the noisy background and floating particles from the underwater images, which in turn is used to predict a camera pose and spare 3D points. Based on the camera path estimation, the dense depth is computed for each image, which enables to generate 3D surface modal. Once the 3D surface modal is generated, color correction is made by using physical modal for underwater light propagation, this allows to view the object without the effect of attenuation and scattering due to water.

V Brandou et al.[11] proposed work is to improve the 3D reconstruction method for small scale by image acquisition method for quantitative measurements. The camera parameter should be known, from which the image sequences are captured, and is used to compute the 3D modal for metric measure. The acquisition method is used to compute the extrinsic camera parameter by using camera trajectory. The procedure of 3D reconstruction is reduced and improved by capturing images in regular intervals. 3D reconstruction of the objects is performed using different techniques, then the texture map is applied to the dense 3D modal.

Oscar Pizarro et al.[12] proposed work presents when camera moves over a non-planer surface, recovering 3D structure to provide a global view for an area of interest, this is a local to global approach. This can be achieved by applying structure from motion with some additional requirements. These techniques are complex than mosaicking. Navigation sensors are used in vehicles which is used to generate 3D sub map, which in turn used for bundle adjustment for 3D structure.

Nathalie Pessel Ifremer et al.[13] proposed a self-calibration technique for a camera mounted on an underwater vehicle, that is used to perform the 3D reconstruction of underwater scenes. Underwater vision is a necessary element in subsea operations. The self-calibration technique is used for a camera mounted in a fixed position on an underwater vehicle. The main goal is to identify the intrinsic parameters of the camera. The navigation sensors are used to measure the motion of the vehicle, which in turn is used to estimate the extrinsic parameter. The moving camera will not affect the applications that uses stereoscopic method, nevertheless it enables robust algorithm that is used for point matching. Robust parameter is used to estimate the analysis of the number of point matches accurately.

III. CONCLUSION

3D reconstruction helps to recover correct shape and size of the objects. It helps to enhance the quality of underwater

image. The extensive literature survey shows many methods are existing for 3D underwater reconstruction. The different methodologies, advantages and disadvantages have been severed and listed. This helps to implement 3D reconstruction technique efficiently. This paper gives detail survey of algorithms used for 3D reconstruction of underwater images and their advantages and disadvantages.

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