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Quality Assessment of Stereoscopic 3D Image Compression by Binocular Integration Behaviors

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Abstract: The objective approaches of 3D image quality assessment play a key role for the development of compression standards and various 3D multimedia applications. The quality assessment of 3D images faces more new challenges, such asymmetric stereo compression, depth perception, and virtual view synthesis, than its 2D counterparts. In addition, the widely used 2D image quality metrics (e.g., PSNR and SSIM) cannot be directly applied to deal with these newly introduced challenges. This statement can be verified by the low correlation between the computed objective measures and the subjectively measured mean opinion scores (MOSs), when 3D images are the tested targets. In order to meet these newly introduced challenges, in this paper, besides traditional 2D image metrics, the binocular integration behaviors—the binocular combination and the binocular frequency integration, are utilized as the bases for measuring the quality of stereoscopic 3D images. The effectiveness of the proposed metrics is verified by conducting subjective evaluations on publicly available stereoscopic image databases. Experimental results show that significant consistency could be reached between the measured MOS and the proposed metrics, in which the correlation coefficient between them can go up to 0.88. Furthermore, we found that the proposed metrics can also address the quality assessment of the synthesized color-plusdepth 3D images well. Therefore, it is our belief that the binocular integration behaviors are important factors in the development of objective quality assessment for 3D images.

Keywords: STATCOM, PI Control, THD, DPFC, VSC.

I. INTRODUCTION

The idiom, "A picture is worth a thousand words", has demonstrated the importance of visual information for human perceptions. Most perceptible information is represented visually in our daily life (e.g. paintings, magazines, images, videos, and 3D graphics), which enables numerous visual applications. The evaluation of the quality of various visual applications has initiated the research of image quality assessment (IQA). Generally, IQA can be classified into the categories of subjective and objective quality assessments. Since human visual system (HVS) is the final receiver of the visual information, subjective IQA is the ultimate evaluation of an image. However, there are noticeable variations among people who have different physiological and psychological status. In order to achieve a reliable subjective evaluation, appropriate procedures of subjective quality assessment had been standardized in ITU-R BT.500. Although subjective IQA provides the ultimate perceptual quality evaluation, the associated high cost and complexity handicap its value in real applications. In order to address this issue, computational objective IQA has long been an active research area since the last decade. The most widely used objective quality metric is the mean-squared error (MSE), which in turn derived the major similarity evaluation criteria (i.e. PSNR) for the image/video compression standards.

However, there are lots of research work demonstrated that images with the same level MSE could have noticeable different visual perceptions. Therefore, numerous objective metrics have been studied to fill up the gaps between the objective metrics and the subjective evaluations. The study utilized multi-metric fusion approach to address the 2D image IQA and showed the state-of-the-art status obtainable so far. For further detail comparison and survey of objective IQA, the studies, the VQEG report and the references therein are highly recommended. Owing to the booming up of 3D movies and the advances in display devices, 3D image is becoming the new research target for IQA. The quality assessments of anaglyph 3D images were addressed in and the work dealt with the quality assessment of multi-camera applications (e.g. panorama images). One direct arisen question is the applicability of existing 2D objective metrics to the 3D images. Notice that the study [14] focused on the quality assessment of color-plus-depth 3D images. All these research work showed that 2D objective metrics can well predict the quality of 3D images (e.g. picture quality and depth quality) only when they are symmetric (that is, PSNR's of the two-eye images are nearly equal to each other). Compression plays a vital role for promoting the 3D image/ video since its huge data volume makes 3D image/video requiring more storage space and higher transmission bandwidth than that of its 2D counterpart. Fig. 1 illustrates that we can classify the types of stereo image compression according to the relation between the quantization parameters.

II. SYSTEM STUDY

A. Feasibility Study

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential. Three key considerations involved in the feasibility analysis are

- Economical Feasibility
- Technical Feasibility
- Social Feasibility

Economical Feasibility: This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

Technical Feasibility: This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

Social Feasibility: The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

III. IMPLEMENTATION

A. The Image Compering Method

In an image & a bounding box, a value is set to each pixel (lbp value first, and then i use a converting table from 255 options to 10).Then, a vector of 10 is saved, by counting how much of each value we got. And basically - this vector represent the property of the image and bounding box. The actual implementation is splitting the box to 4 equal parts, make 4vectors as above - one for each - and the concatenated vector of length 40 is the property we really use. And, in addition, in the 41 cell of the vector we also save the amount of pixels the box had (for the comparing part) Comparing of two property's is just an Euclid distance between the two vectors, when each cell is taken as the cell divided in the total amount (cell 41), to support comparing two images of different sizes.

B. The Model

The model is a set of property vectors. At the beginning, we add the property of the bounding box set by the user. And for each new property, if we decide it is close enough to the model - we add it.

C. The Threshold

Comparing two property's result in a distance, to decide if that distance is "close enough", we use a threshold. At the beginning, we assume all the first frames after the user set the object - still contain the object. And so we add them all to the model (we start with a high threshold to add everything). Then we calculate a new threshold, by taking sort of a mean over the previous distances we got. And from this point, we use the new threshold to decide if we have the object (and continue with short-term tracking), or if we lost the object, and in that case we use the detector part to re-find it.

D. The Detector

In order to find the object, we want to search around the frame for something that is close enough to the model, and if there are a few matching - we want to find the best one. the basic idea is to do a grid search all over the frame, but since this will take too much time, we start by searching close to where we last seen the object, and if we do not find it, then in the next frame we widen the search radios. After a few frames, if we reach the point where we search all of the frame, then there is a chance we do not find it because it is not visible (out of the frame or hidden behind something) and so in this point we use 3 methods to improve the speed:

- We don't search every frame, but "jump" a few frames each time.
- We do not search the entire frame, and in each coordinate we search in a certain chance (random).
- Instead of comparing the all box right away - we first compare one quarter to the same quarter in the model and only if it is good enough we compare the all box.

E. Pruning Events

Since the process is not perfect, the model might be added with property that does not really represent the object, and so we need a process which removes this property from the model: this are called "pruning events". The idea is to take the property from the model that gave "false positive" and remove them. "False positive" - is when we get a distance to the model that is lower than the threshold, but we get it from a coordinate which we later decide is not the object. In that case, we say that part of the model is contributing to the messing of the model – and so we remove it from the model.

Main Difficulties:

- Although I got good result for some example videos, in others, the property for the object was close (under the threshold) to parts of the image that didn't contain the object and so the bounding box stayed there and the tracking stopped being effective

- Setting the appropriate threshold, after the right amount of frames, is a difficult task to achieve for a video without any prior knowledge of the video's property.
- The 'affine function' (that i used to determine the new position of the box in the optical flow part) is giving false results in many cases.

F. Modules

1. Pathways of Binocular Visual System: There are two visual pathways for neural processing of visual information in visual cortex,

- Dorsal stream and ventral stream.
- Dorsal stream ("Where" pathway) the dorsal stream starts from (primary visual cortex), goes through area. The functions of dorsal stream are about visual information guided actions.
- Ventral stream ("What" pathway) the ventral stream begins from area goes through to area. The perception and recognition visual behaviors occur in ventral stream.
  - The visual response of two eyes,
  - The binocular combination behaviors in the early stage of visual pathway and
  - The visual information representations and integration.

2. Binocular Combination: In this behaviors of binocular brightness combination when the input brightness is asymmetric in both eyes (e.g. Fechner's paradox, cyclopean perception).

- Cyclopean perception means that we will have single perceptual image when we perceive 3D images/videos by two eyes. These behaviors play the role of constraints for selecting the plausible biological models of binocular combination.
- Fechner's Paradox This binocular combination behavior describes the phenomenon that a bright light to one eye may appear less bright when a dim light is shown to the other eye. Cyclopean Perception The cyclopean perception was suggested as a constraint in the research work [65] for modeling the binocular combination behavior.

3. Effect of DOG Bands: Each quality metric has its own specific visual properties and background assumptions, a quality metric could not perform well at DOG frequency bands which are far from the original usages in the regions with zero values and the original usage of VIF is for natural image only). The proposed DOG decomposition may be replaced by Gabor filter bank which is another popular physiological model and the corresponding performance evaluation will be one of our future works.

IV. SYSTEM DESIGN

A.Data Flow Diagram/Use Case Diagram / Flow Diagram

The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of the input data to the system, various processing carried out on these data, and the output data is generated by the system as shown in Figs.1 to 4.

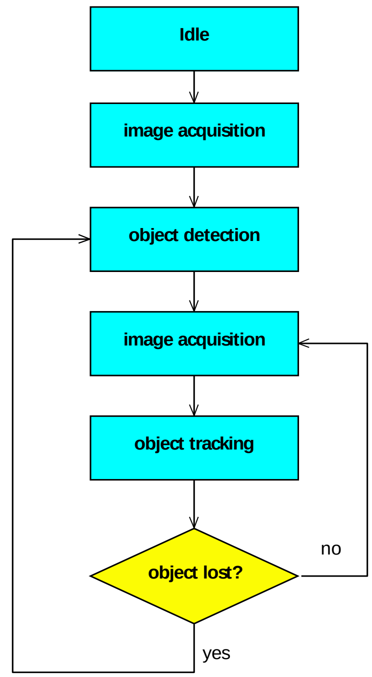

Fig.1. Flow Chart.

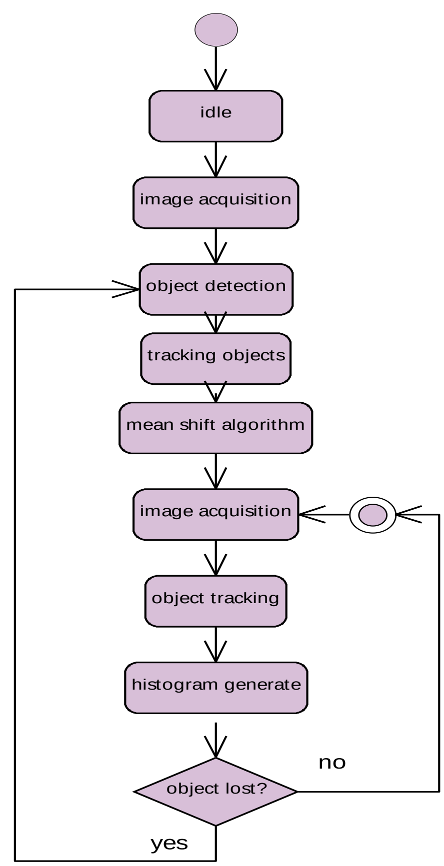

Fig.2. Activity Diagram.

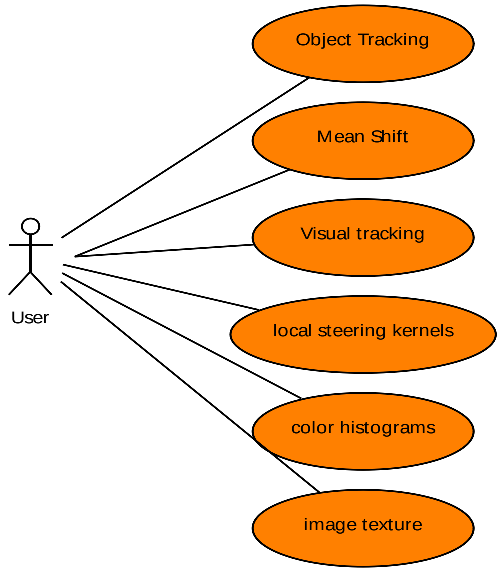

Fig.3. Use Case Diagram.

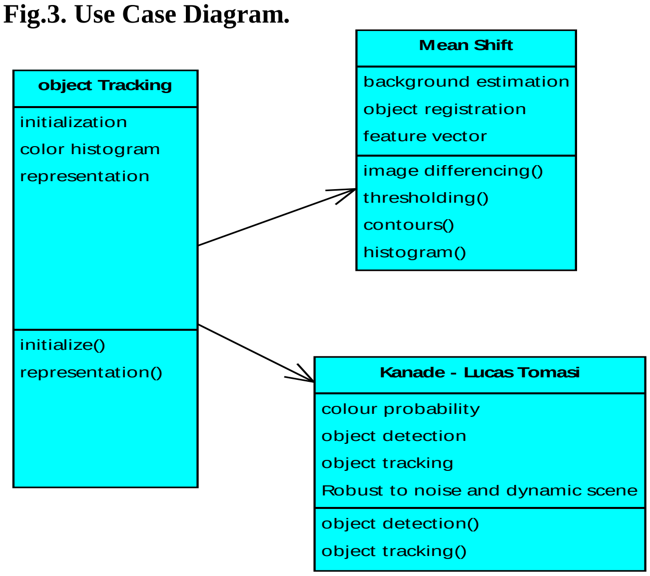

Fig.4. Class Diagram.

V. SCREEN SHOTS

Screen shots of this paper is as shown in bellow Figs5 to 11.

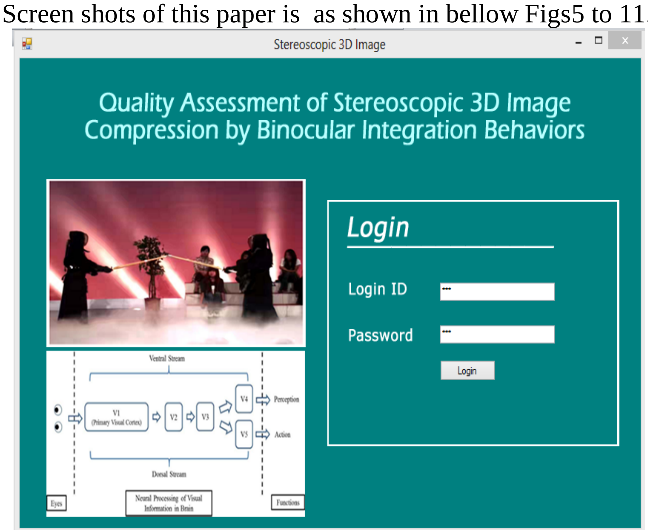

Fig.5. Main form.

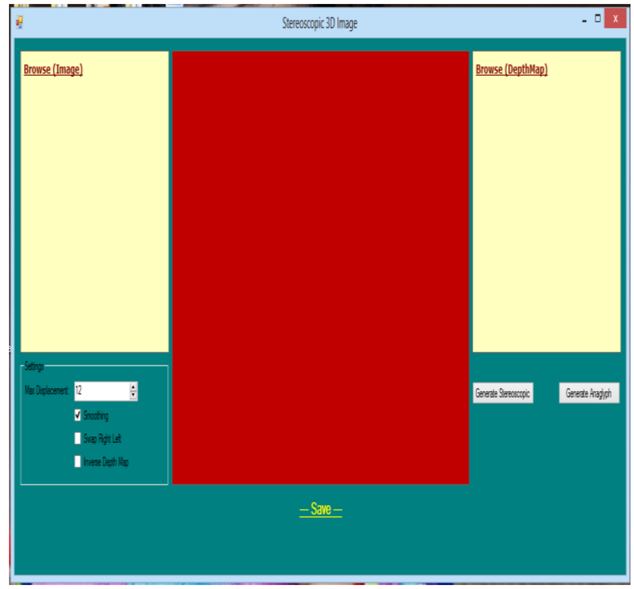

Fig.6. Second form.

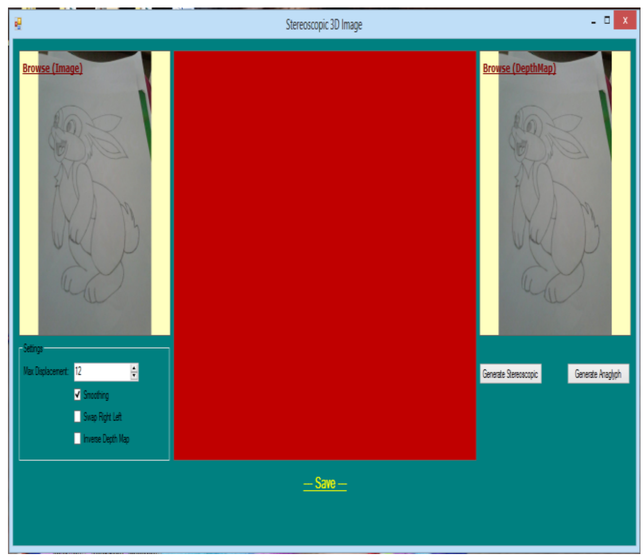

Fig.7. Browsing the image.

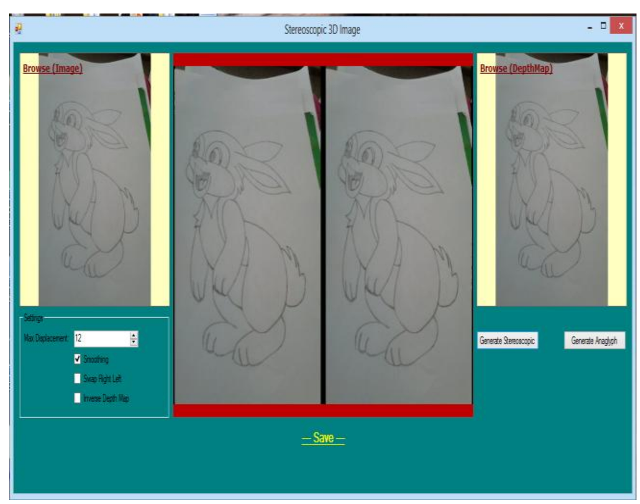

Fig.8. Max displacement, smoothing and generating Stereoscopic image.

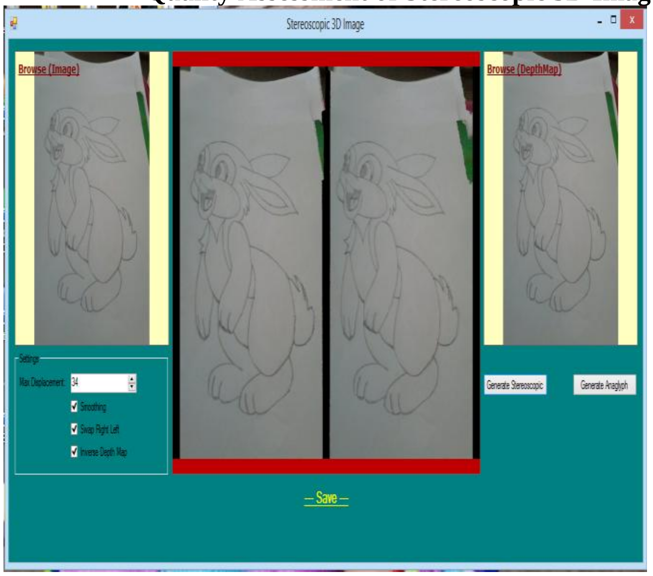

Fig.9. Swap Right Left and Inverse Depth Map and generating image.

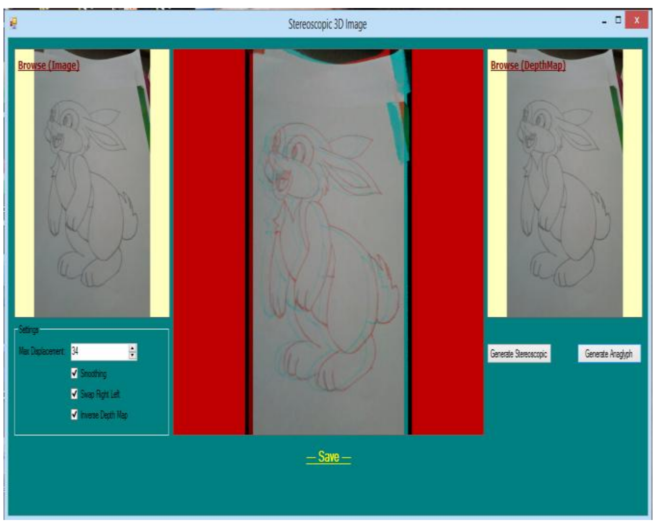

Fig.10. Generating Analgyph and getting 3D Stereoscopic image.

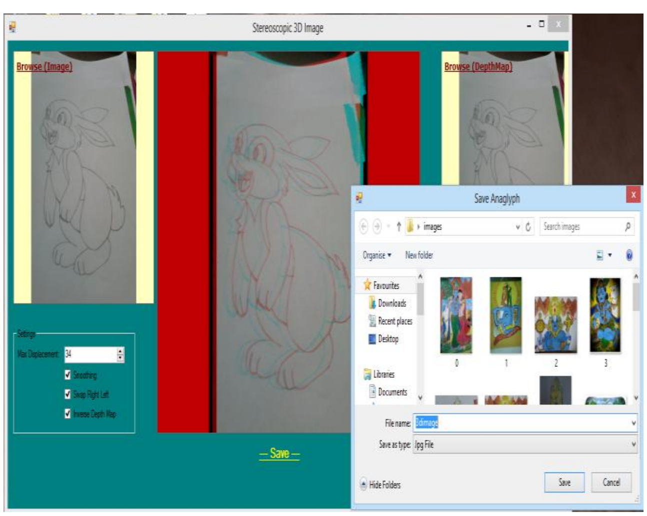

Fig.11. Saving the 3d image after anaglyph.

VI. SYSTEM ANALYSIS

A. Existing System

Image quality assessment IQA provides the ultimate perceptual quality evaluation; the associated high cost and complexity handicap its value in real applications. In order to address this issue, computational objective IQA has long been an active research area since the last decade. The booming up of 3D movies and the advances in display devices, 3D image is becoming the new research target for IQA. The quality assessment of anaglyph 3D images was addressed in and the work dealt with the quality assessment of multi-camera applications (e.g. panorama images). One direct arisen question is the applicability of existing 2D objective metrics to the 3D images. The existing 2D quality assessment metrics can predict well for the Symmetric-Stereo compression, however, the prediction results are not well addressed for the Asymmetric counterpart by the same metrics. This work aims to fill-up this gap by proposing a quality assessment metric which is applicable to both the Symmetric-Stereo and the Asymmetric-Stereo compressions.

B. Proposed System

There are numerous physiological discoveries of binocular vision where we focus on the binocular visual behaviors that describe the visual inputs integration process. For simplicity, these physiological discoveries of binocular vision are denoted as binocular integration behaviors which consist of binocular combination and binocular frequency integration behaviors. In order to overcome the challenges of 3D image IQA, we integrate the binocular integration behaviors into the existing 2D objective metrics for evaluating the quality of 3D images. We denote the integrated quality assessment metrics as the Frequency-Integrated metrics. The new challenges of 3D IQA come mainly from the interactions between the two eyes, a better understanding of the physiological studies of binocular vision is beneficial to the development of effective computational models for 3D images. We briefly revisit the findings of binocular vision.

VII. CONCLUSION

The objective quality assessment of stereo images plays a key role for the development of 3D image/video compression standards and the success in enriching various 3D visual applications. The traditional 2D objective metrics are suitable only for addressing the stereo images with Symmetric-Stereo compression. However, the perfect symmetric quality scenario is very unusual to be found in practical stereo images which makes the traditional 2D objective metrics do not work well in 3D IQA. This work revisits the physiological findings in HVS and proposes a binocular integration behavior based computational framework for dealing with the challenges arisen in 3D IQA. Experimental results demonstrate that significant improvement in performance consistencies between the proposed FI-metrics and the corresponding subjective MOS's can be achieved for both picture quality and depth quality assessments, even if the stereo images are synthesized from another stereo images. These binocular behaviors shed a light on a new paradigm for the developments of IQA on 3D images/videos. This also provides new opportunities to investigate the new quality metrics for 3D image/video IQA. To investigate the effects of different types of distortions and seek for a more powerful 3D IQA computational framework will, of course, be the possible directions of our future work.

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