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A ROBUST APPROACH FOR 2D TO 3D IMAGE CONVERSION USING MTF SQUEEZE WITH DEPTH INFORMATION

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Abstract— **The main objective of this paper is to develop a novel 2D-to-3D conversion method based on ROI boundary by MTF squeeze function and estimation of depth level through gradient map. The proposed algorithm utilizes contour information to group the image into coherent regions. Depth levels computed by MTF squeeze model are adopted here to assign the depth for each region and a cross bilateral filter is subsequently applied for removing the blocky artifacts. The proposed algorithm is quality-scalable as it depends on the block size. Smaller block size will result in better depth detail and that of the larger block size will have lower computational complexity. Capable of generating a comfortable 3D effect, this proposed algorithm is highly promising for 2D-to-3D conversion in case of 3D applications. To analyse the performance of the proposed method several performance metrics are used. This paper uses PSNR,SSIM, MSE and RMSE to analyses the performance. From the experimental results it is shown that the proposed method performs better than the other existing methods.**

Keywords— ***2D-to-3D conversion, depth boundaries, depthmap, nonlocal neighbors, MTF sqeeze, edge information.***

I. INTRODUCTION

3DTV is widely anticipated as the next revolution of television technology. '3D' (three dimensional) here means 'stereoscopic', which provides viewers with feeling of immersion. The promotion of 3DTV depends not only on technological advances in 3D displays, but also on availability of large amount of 3D content. However, it's both costly and time-consuming to make 3D content of high quality directly with stereoscopic cameras, so the shortage of 3D content becomes one of severe bottlenecks for 3D industry. Converting 2D images or videos to 3D is one way to alleviate the problem in the early stage of 3DTV development, because it not only can create 3D content with lower cost and less time, but also makes full use of large amount of existing 2D materials.

Generally, the existing 2D to 3D conversion approaches can be classified as two categories: human assisted conversion and automatic conversion. The human-assisted approach is to convert 2D images or videos to 3D with some corrections made "manually" by an operator [1]. Even though this approach has relatively better performance, it's still impractical in many scenarios. To convert the vast collection of available 2D material into 3D in an economic manner, an automatic approach is desired [2]. The automatic approach utilizes the depth cues in a single monocular image to generate another or more virtual views without any human assistance.

There is several research works are progressing on 2D to 3D conversion of images which shall be used in the motion pictures [4] and [5]. 3D imaging system has been incorporated in the televisions, cameras etc. In the health system the 3D body scanners help surgeons to determine the accurate status of various diseases. The 3D hardware is expensive compared with 2D hardware system. Therefore, it is necessary to develop a fast and accurate algorithm for converting 2D images to 3D images. In this research article, a new simple algorithm is proposed for converting 2D image to 3D image using image fusion. Xiaoyang Mao, lbsiyasu L. Kunii, Hierarchical was proposed G-octree as an extension of G-quadtree to 3D grey-scale images. They did the program in C on VAX 11/750. Application to the color coding of macro-auto-radiography images of rat brains demonstrated the advantages of the approach [6]. Chin-Tung Lin, Chiun-Li Chin, Kan-Wei Fan, and Chun-Yeon Lin was presented a 2D to 3D effect image conversion architecture integrated image segmentation system and depth estimation. They tested many 640*480 RGB format color images. They generated left view and right view image and displayed the 3D stereo image [7]. H. Murata, X Mori, S. Yamashita, A. Maenaka, S. Okada, K. Oyamada, and S. Kishimoto, proposed a system for converting all kinds of 2D images into 3D images. The method is used adaptively by computing the depth of each separated area of the 2D images with their contrast, sharpness, and chrominance [8]. Wa James Tam and Liang Zhang provided an overview of the fundamental principle of 2D to 3D conversion techniques, short note on approaches for depth extraction using a single image, and depth image based rendering [9]. Chao-Chung Cheng, Chung-Te Li, and Liang-Gee Chen presented an automatic system for converting 2D videos to 3D videos. They grouped the regions into blocks using the edge information and applied bilateral filter to generate depth map [10]. Zhebin Zhang, Yizhou Wang, Tingting Jiang, and Wen Gao described an approach which estimated a 2.5D depth map by leveraging motion cues and photometric cues in video frames [11]. Ching-Lung Su, Kang-Ning Pang, Tse-Min Chen, Guo-Syuan Wu, Chia-Ling Chiang, Hang-Rnei Wen, Lung-Sheng Huang,

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Ya-Hsin Hsueh, and Shau-Yin Tseng, presented an algorithm for conversion of 2D to 3D in real time. The 2D video accompanied with a depth image was stored to create 3D video [12]. Yeong-Kang Lai, Yu-Fan Lai, and Ying-Chang Chen proposed a hybrid algorithm for 2D to 3D conversion. They used motion information, linear perspective, and texture characteristic for depth estimation. They used bilateral filter for depth map smoothing and noise removal [13].

Two approaches to 2D to 3D conversion can be loosely defined: quality semiautomatic conversion for cinema and high quality 3DTV, and low-quality automatic conversion for cheap 3DTV, VOD and similar applications. [14] In semiautomatic conversion a skilled operator assigns depth to various parts of an image or video. Based on this sparse depth assignment, a computer algorithm estimates dense depth over the entire image or video sequence. In the case of automatic methods, no operator intervention is needed and a computer algorithm automatically estimates the depth for a single image or video. Automatic methods estimates shape from shading, structure from motion or depth from defocus. Electronics manufacturers use stronger assumptions to develop real-time 2D-to-3D converters. Such methods may work well in specific scenarios. But generally it is very difficult to construct heuristic assumptions that cover all possible background and foreground combinations. An important step in any 3D system is the 3D content generation. Several specialcameras have been designed to generate 3D model directly. For example, a stereoscopic dual-camera makes use of a co-planar configuration of two separate, monoscopiccameras, each capturing one eye's view, and depth information is computed usingbinocular disparity. A depth-range camera is another example. It is a conventional videocamera enhanced with an add-on laser element, which captures a normal two-dimensionalRGB image and a corresponding depth map. A depth map is a 2D function that gives thedepth (with respect to the viewpoint) of an object point as a function of the imagecoordinates. Usually, it is represented as a gray level image with the intensity of eachpixel registering its depth. The laser element emits a light wall towards the real worldscene, which hits the objects in the scene and reflected back. This is subsequentlyregistered and used for the construction of a depth map.All the techniques described above are used to directly generate 3D content, which certainly contribute to the prevalence of 3D-TV. However, the tremendous amount of current and past media data is in 2D format and should be possible to be viewed with a stereoscopic effect. This is where the 2D to 3D conversion method comes to rescue. This method recovers the depth information by analyzing and processing the 2D image structures.

In this paper a novel 2D-to-3D conversion method has presented based on ROI boundary by MTF squeeze function and estimation of depth level through gradient map. The proposed algorithm utilizes contour information to group the image into coherent regions. Depth levels computed by MTF squeeze model are adopted here to assign the depth for each region and a cross bilateral filter is subsequently applied for removing the blocky artifacts. The proposed algorithm is quality-scalable as it depends on the block size. Smaller block size will result in better depth detail and that of the larger block size will have lower computational complexity. Capable of generating a comfortable 3D effect, this proposed algorithm is highly promising for 2D-to-3D conversion in case of 3D applications.

The remainder of the paper is organized as follows: In Section II, the overview of proposed method is presented. In Section III, the proposed method is specifically depicted, including its design idea and practical implementation approach. In Section IV, the performance of the proposed method is evaluated. Finally, conclusions are made in Section V.

II. 2D TO 3D IMAGE CONVERSION USING EDGE INFORMATION

The overall block diagram of this approach is shwon in Fig.1. This work uses a novel 2D-to-3D conversion method based on ROI boundary by MTF squeeze function and estimation of depth level through gradient map. The proposed algorithm utilizes contour information to group the image into coherent regions. Depth levels computed by MTF squeeze model are adopted here to assign the depth for each region and a cross bilateral filter is subsequently applied for removing the blocky artifacts. The proposed algorithm is quality-scalable as it depends on the block size. Smaller block size will result in better depth detail and that of the larger block size will have lower computational complexity. Capable of generating a comfortable 3D effect, this proposed algorithm is highly promising for 2D-to-3D conversion in case of 3D applications. The further details of these modules are discussed below:

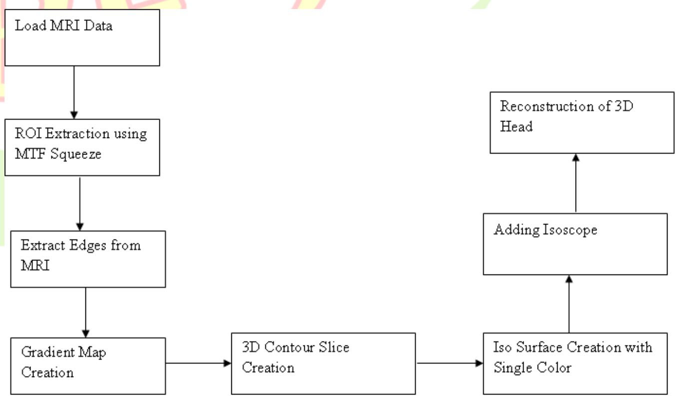

Fig. 1. Overall Block Diagram of Method1

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III. PROPOSED APPROACH

A. Load MRI Data

The first step is to upload the images into Matlab workspace, and to store them as .mat file. Then images had to be converted from grayscale to indexed ones. As code has the possibility to operate with 4D matrix, the whole set of 25 images was concatenated one on top of the other into a matrix. With this matrix the proposed method get an extra dimension derived from obsolete color maps. It can be eliminated using squeeze function, after which the proposed method get a 3D variable used in the rest of the algorithm.

B. ROI Extraction using MTF Squeeze Model

The proposed method employed k-means clustering using MATLAB k means function to group the pixels into four clusters, roughly corresponding to black, dark gray, light gray, and white in the original image. Also, the proposed method used the "city block" metric, which in MATLAB for 1-D data places the cluster centroids at the median value of the clusters, rather than the mean. The proposed method found that with this metric, the resulting images more closely resembled the originals. Note that the initial clusters are not randomized in any way, which means they might not converge to the global optimum. The proposed method chose to do this so that the results for each image would be exactly reproducible every time the procedure is run, and in any case the resulting centroids work well. Once the clusters have been obtained, the proposed method create a new image that condenses the intensity range down to the number of clusters.

C. Edge Extraction from MRI Images

The proposed method use the canny edge detection algorithm, available in MATLAB's Image Processing Toolbox, toward sectioning the image involves finding edges. Under the default threshold settings, use of this algorithm via the edge command easily identifies all of the major edges, which are of most interest to us, plus many minor edges that are potentially helpful.The algorithm finds the boundaries between the breast tissue and skin and between the breast tissue and chest wall, which are precisely the edges the proposed method need for creating the ROI boundary.

D. Gradient Map Creation in Depth Image and Apply Contour

The extraction of depth is the crucial one in our conversion process. Analysis results indicate that the most important mode in the real world is the bottom-up mode. If the linear perspective information fails to detect the scene mode, then the bottom-up mode is the default mode to be selected.

E. Creation of 3D Contour Slices

3D contour slices is found by using the filtered depth map. The filtered depth map has a comfortable visual quality because the cross bilateral filter generates a smooth depth map inside the smooth region with similar pixel values and preserves sharp depth discontinuity on the object boundary. Following filtering by the cross bilateral filter, the depth map is then used for the generation of the left/right or multi-view images using depth image-based rendering for3D visualization.

F. Creation of Isosurface with Single Color

An isosurface is a three-dimensional analog of an isoline. It is a surface that represents points of a constant value within a volume of space, in other words, it is a level set of a continuous function whose domain is 3Dspace.In medical imaging, isosurfaces may be used to represent regions of a particular density in a 3D CT scan, allowing the visualization of internal organs, bones, or other structures. The isonormals function to renders the isosurface using vertex normals obtained from the smoothed data, improving the quality of the isosurface. The isosurface uses a single color to represent its isovalue.

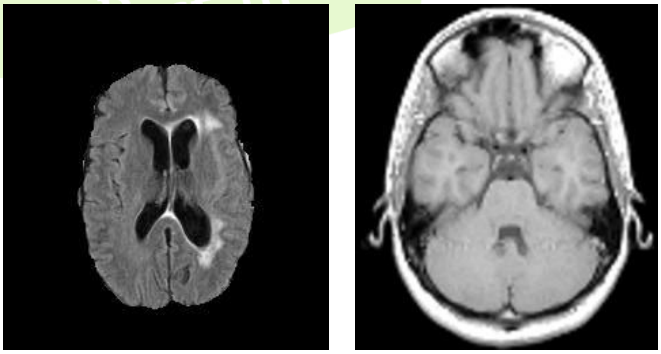
G. *Reconstruction of 3D Head Image*

The proposed method can use isocaps to calculate the data for another patch that is displayed at the same isovalue as the isosurface. The unsmoothed data is used to show details of the interior. The proposed method can see this as the sliced-away top of the head. The lower isocap is not visible in the final view. Adding lighting and recalculating the surface normals based on the gradient of the volume data produce smoother lighting. The isocaps can use interpolated face coloring, which means the figure colormap determines the coloring of the patch.

IV. PERFORMANCE ANALYSIS

A. *Expiremental Images*

Experiments were conducted on a group of MRI images to verify the effectiveness of the proposed scheme. For the experimental purpose several standard, MRI Brain Images are taken. Some of these images, are shown in Figure 2.



(a) (b)

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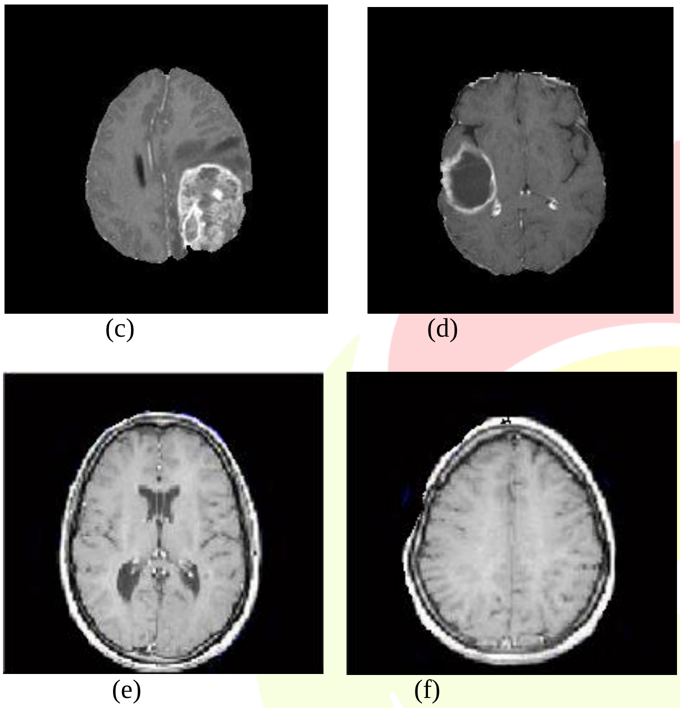


Fig. 2. Expiremental MRI Images

B. Performance Analysis

To evaluate the performance of the steganography techniques several performance metrics are available. This paper uses the PSNR,SSIM, MSE and RMSE to analyses the performance.

1. Peak Signal-to-Noise-Ratio

The peak signal-to-noise ratio (PSNR) is used to evaluate the quality between the 3D image and the original 2D image. The PSNR formula is defined as follows:

$$\mathrm{PSNR} = 10 \times \log 10 \frac{255 \times 255}{\frac{1}{\mathrm{H} \times \mathrm{W}} \sum_{x=0}^{H-1} \sum_{y=0}^{W-1} [f(x,y) - g(x,y)]^2} \mathrm{dB}$$

where H and W are the height and width of the image, respectively; and f(x,y) and g(x,y) are the grey levels located at coordinate (x,y) of the original image and attacked image, respectively.

2. Structural Similarity Index

The structural similarity index is a method for measuring the similarity between the 3D image and the original 2D image.

$$SSIM\,(y,\hat{y}) = \frac{\left(2_{\mu_y \mu_{\hat{y}}} + c_1\right)(2\sigma_{y\hat{y}} + c_2)}{(\mu_y^2 + \mu_{\hat{y}}^2 + c_1)(\sigma_y^2 + \sigma_{\hat{y}}^2 + c_2)}$$

where, $\hat{Y}$ is the 3D image, the Y is the original 2D image, μ is the mean and the is the variance.

3. Mean Square Error

The mean square error (MSE) is used to evaluate the difference between a 3D image and the original 2D image. The MSE can be calculated by,

$$\mathrm{MSE} = \frac{1}{n} \sum_{i=1}^{n} (\hat{Y}_i - Y_i)^2$$

where, $\hat{Y}$ is the 3D image and the Y is the original 2D image.

4. Root Mean Square Error

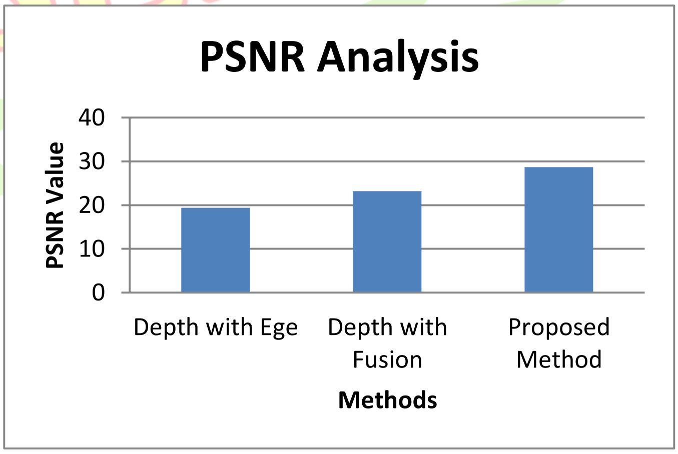
The Root Mean Square Error (RMSE) is a frequently used measure of the difference between 3D image values and the original 2D image values.

$$\mathrm{RMSE} = \sqrt{\frac{\sum_{i=1}^{n} (\hat{Y}_i - Y_i)^2}{n}}$$

where $\hat{Y}$ is 3D image and Y is original 2D image.

To analysis the performance of the three methods by using the performance metrics which are mentioned above. This is shown in the below tables and graphs

Methods	*PSNR*
Depth with Ege	19.4
Depth with Fusion	23.2
Proposed Method	28.7



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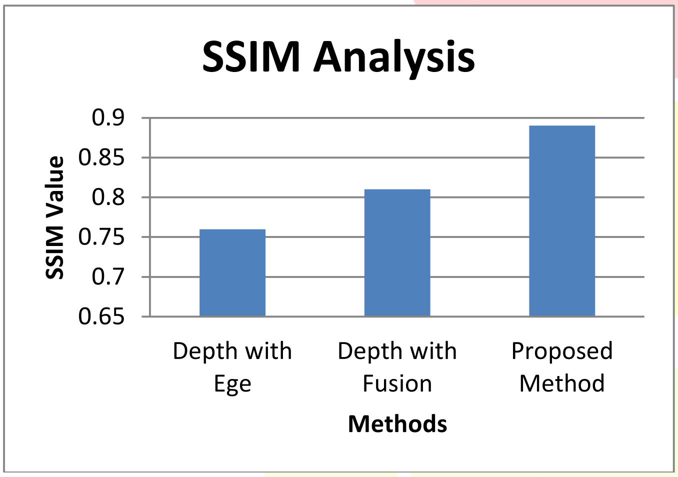
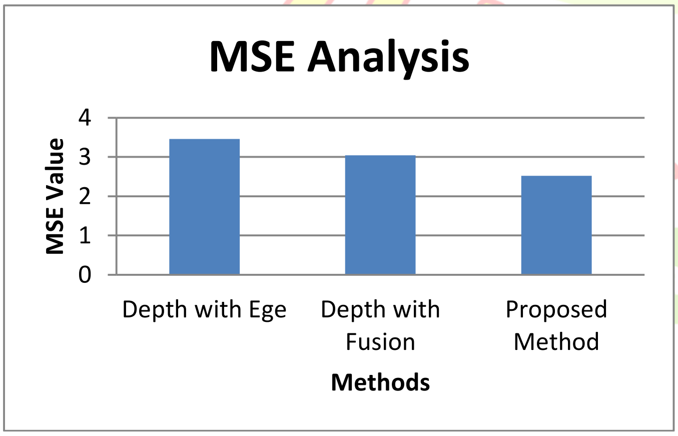
Methods	***SSIM***
Depth with Ege	0.76
Depth with Fusion	0.81
Proposed Method	0.89

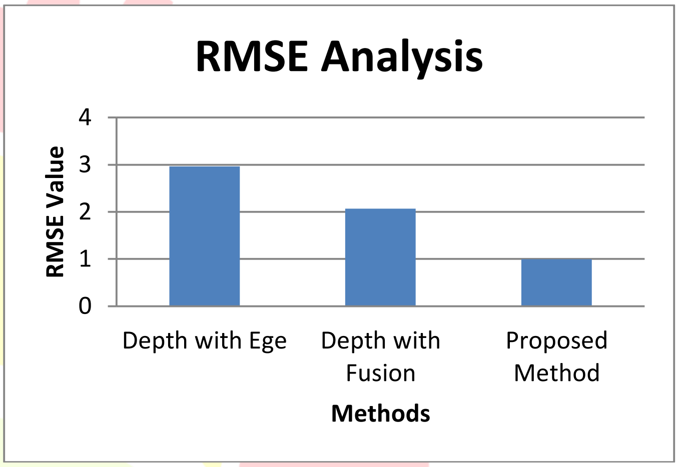


Methods	***MSE***
Depth with Ege	3.46
Depth with Fusion	3.04
Proposed Method	2.52



Methods	***RMSE***
Depth with Ege	2.962

Methods	***RMSE***
Depth with Fusion	2.064
Proposed Method	0.994



V. CONCLUSION

This paper has presented a novel 2D-to-3D conversion method based on ROI boundary by MTF squeeze function and estimation of depth level through gradient map. The proposed algorithm utilizes contour information to group the image into coherent regions. Depth levels computed by MTF squeeze model are adopted here to assign the depth for each region and a cross bilateral filter is subsequently applied for removing the blocky artifacts. The proposed algorithm is quality-scalable as it depends on the block size. Smaller block size will result in better depth detail and that of the larger block size will have lower computational complexity. Capable of generating a comfortable 3D effect, this proposed algorithm is highly promising for 2D-to-3D conversion in case of 3D applications. To analyse the performance of these method several performance metrics are used. This paper uses PSNR,SSIM, MSE and RMSE to analyses the performance. From the experimental results it is shown that the proposed method performs better than the other two methods..

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