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2D to 3D Video Conversion

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***Abstract*: 3D video applications becoming popular in our daily life, especially at home entertainment. Although more and more 3D movies are being made, 3D video content are still not rich enough to satisfy the future 3D video market. There is a rising demand on new techniques for automatically converting 2D video content to stereoscopic 3D video displays. However, in recent years, there has been rapid progress in the field's image capture, coding and display which brings the realm of 3D closer to reality than ever before. The survey investigates the existing 2D to 3D conversion algorithms developed in the past years by various computer vision research communities across the world. Each algorithm has its own strengths and weaknesses. Most conversion algorithms make use of certain depth cues to generate depth maps. Among 2D-to-3D image conversion methods, those involving human operators have been most successful but also time-consuming and costly. Fully-automatic methods typically make strong assumptions about the 3D scene. Although such methods may work well in some cases, in general it is very difficult to construct a deterministic scene model that covers all possible background and foreground combinations. In practice, such methods have not achieved the same level of quality as the semi-automatic methods. In this survey we Survey Block-based depth from motion estimation, color based region segmentation, fusion, Multi cue fusion, Bilateral Filter, DIBR techniques.**

Keywords: Motion estimation, Depth map, fusion, DIBR, Bilateral Filter, Depth Cues.

I. INTRODUCTION

Rapid development of 3D displays technologies and digital video processing has brought 3DTV into our life. As more facilities and devices are 3D capable, the demand for 3D video contents is increasing sharply. However, the tremendous amount of current and past media data is in 2D format and 3D stereo contents are still not rich enough now. Compared to the direct capture of 3D video contents, video conversion from 2D to 3D is a low-cost and backward compatible solution. The term "3D" in this context denotes "stereoscopic," meaning a two view system is used for visualization. Stereoscopic images that are displayed on 3D displays can increase the visual impact and heighten the sense of presence for viewers The successful adoption of 3D-TV by the general public will depend not only on technological advances in 3D display and 3D-TV broadcasting systems, but also on the availability of a wide variety of program content in stereoscopic 3D (S3D) format for 3D-TV services [1].The visual cortex in our brains use this disparity to gain a sense of depth in a scene. Essentially, the bigger the shift between the two views, the closer the object is to the viewer (i.e. a Small depth), and vice-versa. For any image, or frame in a video, we want to create depth maps which will allow us to convert things into 3D. Most of the time, the original image itself is used as the *left* view, while the use of a depth map would generate the right view. Once the left and right views are created, these can be presented on any 3D compatible technology, as long as you format both the views properly for the technology you want to view them on. Depth maps are black and white images that are of the same size of the images or videos that you want to convert, where each pixel in these images or videos give you a sense of depth in the scene. Darker pixels denote a pixel being very far away, while lighter pixels denote a pixel being very close. Stereo Vision-The slightly different perspectives from which 2 or more cameras perceive the world lead to different images with relative displacements of objects – disparities - in the different monocular views of the scene[5]

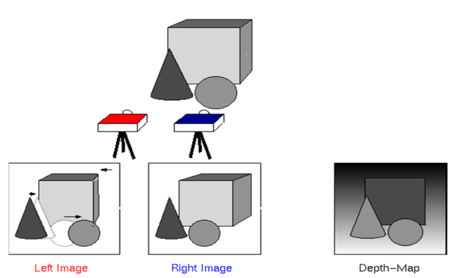

Figure: 1 camera for a single object

Most of the stereoscopic techniques are based on 2 offset images each simulating the different eye i.e. the right eye sees the left portion and the left one sees the right portion [4].The conventional 3D imaging depicts the concept that the Left eye

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sees the right portion of the scene and Right eye sees the Left portion of the image. Using this principle various conventional cameras have been developed. These cameras use 2 lenses. Thus, it takes 2 images, a right side image and left side image.

II. APPLICATIONS

A. The three-dimensional (3D) displays provide a dramatic improvement of visual quality over the 2D displays. The conversion of existing 2D videos to 3D videos is necessary for multimedia application.
B. 3d Display have many Applications which are broadcasting, movies, gaming, photography, camcorders, and education.
C. That system achieves the goals by first sensing the real-time drawing, calculating the time delay and hence the distances from it and then displaying its 3D image simultaneously from all angles
D. 2D videos to 3D videos is necessary for multimedia application.
E. Some commercial software, such as DDD‟s TriDef 3D player and Samsung's 3DTV, can generate stereoscopic views from monocular videos in real-time.
F. The three-dimensional (3D) displays provide a dramatic improvement of visual quality over the 2D displays. The conversion of existing 2D videos to 3D videos is necessary for multimedia applications.

III. MOTIVATIONS

In this Motivation, the concept of stereoscopy has existed for a long time. But the breakthrough from conventional 2D broadcasting to real-time 3D broadcasting is still pending.[13] In recent years, with the giant leap in image and video processing technologies the introduction of three-dimensional televisions (3D TVs) into the commercial market is becoming a reality [11]. Nowadays, there are many commercial companies, such as Samsung, Sony, Panasonic and LG, producing 3D TVs. The 3D TV can be more attractive to viewers because they produce stereo scenes, which create a sense of physical real space. 3D vision for humans is caused by the fact that the projected points of the same point in space on the two human eyes are located at different distances from the center of focus (center of fovea). The difference between the distances of the two projected points, one on each eye, is called disparity. Disparity information is processed by high levels of the human brain to produce a feeling of the distance of objects in 3D space. A 3D television employs some techniques of 3D presentation, such as stereoscopic capture, 3D display and 2D plus depth map technologies. Due to the success of introducing 3D visual technologies, including 3D games and 3D TVs, to the commercial market, the demand for a wide variety of 3D content such as 3D images, 3D videos and 3D games is increasing significantly. To satisfy this demand, there is an increasing need to create new 3D video content as well as converting existing 2D videos to 3D format. Converting 2D content into 3D depends on different 2D to 3D conversion tools. Three-dimensional television (3D-TV) is anticipated to be the next step in the advancement of television Stereoscopic images that are displayed on 3D displays can increase the visual impact and heighten the sense of presence for viewers [1]. The successful adoption of 3D-TV by the general public will depend not only on technological advances in 3D displays [2] and 3D-TV broadcasting systems [3], [4] but also on the availability of a wide variety of program content in stereoscopic 3D (S3D) format for 3D-TV services [5]. The supply of adequate S3D content will be especially critical in the early stages of 3D-TV rollout to ensure that the public would be willing to spend money for 3D displays and 3D-TV services. However, a certain length of time will be required for content providers to capture and to create enough S3D material with stereoscopic cameras.2D-to-3D conversion techniques can be profitable for content providers who are always looking for new sources of revenue for their vast library of program materials. This potential market is attracting many companies to invest their manpower and money for developing 2D-to-3D conversion techniques.

IV. STATE OF THE ART

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. [13] 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 special cameras have been designed to generate 3D model directly. For example, a stereoscopic dual-camera makes use of a co-planar configuration of two separate, monoscopic cameras, each capturing one eye's view, and depth information is computed using binocular disparity. A depth-range camera is another example. It is a conventional video camera enhanced with an add-on laser element, which captures a normal two-dimensional RGB image and a corresponding depth map. A depth map is a 2D function that gives the depth (with respect to the viewpoint) of an object point as a function of the image coordinates. Usually, it is represented as a gray level image with the intensity of each pixel registering its depth. The laser element emits a light wall towards the real world scene, which hits the objects in the scene and reflected back. This is subsequently registered 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. Figure 1 shows the typical product of 2D to 3D conversion algorithm – the corresponding depth map of a conventional 2D image. A diversity of 2D to 3D conversion algorithms has been developed by the computer vision community. Each algorithm has its own strengths and weaknesses. Most conversion algorithms make use of certain depth cues to generate depth maps. An example of depth cues is the defocus or the motion that could be present in the images.

A Detailed study of few 2D to 3D video Conversion methods is given below:

A. Robust Semi-Automatic Depth Map Generation in Unconstrained Images and Video Sequences for 2D to Stereoscopic 3D Conversion [5]

In the system for robustly estimating synthetic depth maps in unconstrained images and videos, for semi-automatic conversion into stereoscopic 3D. Currently, this process is automatic or done manually by rotoscopers. Automatic is the least labor intensive, but makes user intervention or error correction difficult. Manual is the most accurate, but time consuming and costly. Noting the merits of both, a semi-automatic method blends them together, allowing for faster and accurate conversion. This requires user-defined strokes on the image, or over several key frames for video, corresponding to a rough estimate of the depths. After, the rest of the depths are determined, creating depth maps to generate stereoscopic 3D content, with Depth Image Based Rendering to generate the artificial views. Depth map estimation can be considered as a multi-label segmentation problem: each class is a depth. For video, we allow the user to label only the first frame, and we propagate the strokes using computer vision techniques. We combine the merits of two well-respected segmentation algorithms: Graph Cuts and Random Walks. The diffusion from Random Walks, with the edge preserving of Graph Cuts should give good results. This graph representation has been successfully used in image segmentation, most notably with Graph Cuts and Random Walks We use a combination of Graph Cuts and Random Walks to find an optimal labeling of the depths for the source images or videos, given an initial set of depth labels/strokes. Graph Cuts is used to determine an initial depth map, known as a *depth prior*. This serves as an additional channel of information into the Random Walks algorithm, and is weighted accordingly to control the contribution this information has to the final output. The practical reasons of combining these two methods will become evident later. To merge the two depth maps together, a depth prior is created, serving as an initial depth estimate, and provides a rough sketch of the depth. This information is fed directly into the Random Walks algorithm. The depth prior is essentially the Graph Cuts depth map, and should help in maintaining the strong boundaries in the Random Walks depth map.

1) *Advantages:* The results show that this method produces good quality stereoscopic image pairs. A much more simplified method is used in comparison to the related work.
2) *Disadvantages:* The core of our system incorporates two existing semi-automatic image segmentation algorithms in

Fig. 2 (a) label (b) Depth map and (c) Anaglyphs. [5]

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a novel way to produce stereoscopic image pairs. The incorporation of Graph Cuts into the Random Walks framework produces a result that is better than either on its own.

B. Automatic 2d to 3d video conversion technique based on depth Formation and color segmentation [1]

In this paper, using an automatic monoscopic video to stereoscopic 3D video conversion scheme is presented using block-based depth from motion estimation and color segmentation for depth map enhancement. The color based region segmentation provides good region boundary information, which is used to fuse with block-based depth map for eliminating the staircase effect and assigning good depth value in each segmented region. The experimental results show that this scheme can achieve relatively high quality 3D stereoscopic video output.

1) *Advantages:* It creates better visual quality.
2) *Disadvantage:* semiautomatic methods could produces high quality depth maps but they are very time consuming and expensive.

C. 3D-TV Content Creation: Automatic 2D-to-3D Video Conversion [2]

In this Paper Summarizes that 3D-TV is the next major resolution in television. This paper provides an overview of automatic 2D-to-3D video conversion with a specific look at a number of approaches for both the extraction of depth information from monoscopic images and the generation of stereoscopic images. Some challenging issues for the success of automatic 2D-to-3D video conversion are pointed out as possible research topics for the future.

1) *Advantages:* No hole filling involved due to planner image transformation.Transperencies can be represented.
2) *Disadvantage:* Limitations on camera motion required. Camera parameters and static background are required. Planner transformations is an approximations and not always valid.

D. Visual Pertinent 2D to 3D Video Conversion by Multi-cue Fusion [3]

Our approach to conversion of 2D to 3D video Conversion that stereoscopic video in a 2.5D depth map is first estimated in a multi-cue fusion manner by motion cues and photometric cues in video frames with depth prior of spatial and temporal smoothness. Two cues are used to estimate the depth map, dark-channel prior and motion magnitude. The first one indicates the distance from objects to the camera due to variance of atmospheric light. The second one is always used to predict the pseudo-disparity value which is inversely proportional to the depth value. We combine the two cues together to estimate depth map of the scene in a video frame. The depth map is converted to a disparity map and then fix the original 2d frames as the left view and warp them to virtually view. The main contribution of this method is to combine motion and photometric cues together to estimate depth map. Using of this methods it gets good result.

1) *Advantages:* In this multi-cue fusion method combines motion and dark-channel prior to estimate the depth map. That will be show that this method gets better results than directly using any one of them. Several generated 3D videos show the feasibility of our method. The morphological operation improves the depth map by removing tiny noisy regions, but the thin objects are also blurred or removed.
2) *Disadvantage:* Some commercial software, such as DDD‟s TriDef 3D player and Samsung's 3DTV, can generate stereoscopic views from monocular videos in real-time. However, these products are not able to robustly estimate pixel disparities. User interaction required during stereo-scopic conversion.

E. Learning-Based, Automatic 2D-to-3D Image and Video Conversion [7]

Among 2D-to-3D image conversion methods, those involving human operators have been most successful but also time-consuming and costly. Fully-automatic methods typically make strong assumptions about the 3D scene. Although such methods may work well in some cases, in general it is very difficult to construct a deterministic scene model that covers all possible background and foreground combinations. In practice, such methods have not achieved the same level of quality as the semi-automatic methods. Two types of methods are used in the project. The first one is based on learning a point mapping from local image/video attributes, such as color, spatial position, and motion at each pixel, to scene depth at that pixel using a regression type idea. The second one is based on globally estimating the entire depth map of a query image directly from a repository of 3D images which is a set of image + depth pairs using a nearest neighbor regression type idea. This approach is built upon a key observation and an assumption. The key observation is that among millions of 3D images available on-line, there likely exist many whose 3D content matches that of the 2D input query. The key assumption is that two 3D images whose left images are photo metrically similar are likely to have similar depth fields.

Fig. 3 (a) Anaglyph images generated using the ground-truth depth and (b) depths estimated by the proposed global method [7]

1) *Advantages:* The 2d-to-3d conversion based on learning a local point transformation has the undisputed advantage of computational efficiency. The point transformation can be learned off-line and applied basically in real time. The same transformation can be applied to images with potentially different global 3d scene structure. For global method millions of 3D images are available on-line. It requires less computation time only. Also, it has reduced complexity compared to the previous methods.
2) *Disadvantage:* Low resolution images give better output.

F. A Global nearest-Neighbour Depth Learning Based Automatic 2D to 3D image and Video Conversion [12]

Despite a significant growth in the last few years, the availability of 3D content is still dwarfed by that of its 2D counterpart. Methods involving human operators have been most successful but also time-consuming and costly. Automatic methods, that typically make use of a *deterministic* 3D scene model, have not yet achieved the same level of quality for they rely on assumptions that are often violated in practice. The proposed work is to present a new method based on the radically different approach of *learning* the 2D-to-3D conversion from examples. It is based on *locally* estimating the entire depth map of a query image directly from a repository of 3D images (image depth pairs or stereo pairs) using a nearest-neighbor regression type idea. To this effect, methods have been developed that estimate shape from shading, structure from motion or depth from defocus. There are two basic approaches to 2D-to-3D conversion: one that requires a human operator's intervention and one that does not. In the former case, the so-called semiautomatic methods have been proposed where 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. The involvement of a human operator may vary from just a few scribbles to assign depth to various locations in an image to a precise delineation of objects and subsequent depth assignment to the delineated regions. In the case of automatic methods, no operator intervention is needed. Although restricted to architectural scenes, these methods opened a new direction for 2D-to-3D conversion. There are two types of 2D-to-3D image conversion methods: 1).semi-automatic methods- Semi atomic method May work well in specific scenarios, in general it is very difficult, if not impossible, to construct heuristic assumptions that cover all possible background and foreground combinations. Such real-time methods have been implemented in Blu-Ray 3D players by LG, Samsung, Sony and others. DDD offers its TriDef 3D software for PCs, TVs and mobile devices. However, these are proprietary systems and no information is available about the assumptions used. 2).Automatic methods- The problem of depth estimation from a single 2D image, which is the main step in 2D-to-3D conversion, can be formulated in various ways, for example as a shape-from shading problem However, this problem is severely under-constrained; quality depth estimates can be found only for special cases. This method based on learning a point mapping from local image attributes to scene-depth. The other method is based on globally estimating the entire depth field of a query directly from a repository of image+ depth pairs using nearest-neighbor-based regression. While the local method was outperformed by other algorithms, it is extremely fast as it is, basically, based on table look-up. Global Method performed better than the state-of-the-art algorithms in terms of cumulative performance across two datasets and two testing methods, and has done so at a fraction of CPU time.

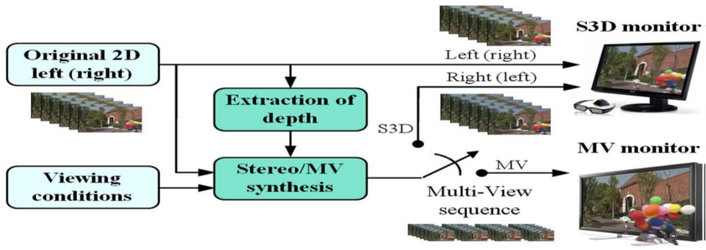

Fig.4 2D to 3D video Conversion Diagram [12] [2]

1) *Advantages:* In this methods using different algorithms' which are well understood and produces good quality images.
2) *Disadvantage: In this method* result is in a comfortable 3D experience but are not completely void of distortions.

G. Real-Time 3D Rendering Processor for 2D-to-3D Conversion of Stereoscopic Displays [8]

Since 3D display technology advances rapidly; 3D-relative products become popular recently. Stereo vision techniques use stereo matching and view synthesis method generally. Currently, stereoscopic display technology has been an extension of H.264/AVC in 3DAV for backward compatible with 2D video contents, depth image based rendering (DIBR) is the key technology in 2D-to-3D conversion. The proposed fractional precision image warping and hole filling architecture can effectively decrease the output buffer size.

1) *Advantages*: Through Human interaction of 3D TV achieve better visual quality. It is use for Real time Application.
2) *Disadvantage*: Base on Hardware decrease a complexity.

H: A Block-based 2D-to-3D Conversion System with Bilateral Filter [6]

This paper presents an automatic and robust system to convert 2D videos to 3D videos. The proposed 2D-to-3D conversion combines two major depth generation modules, the depth from motion and depth from geometrical perspective. A block-based algorithm is applied and cooperates with the bilateral filter to diminish block effect and generate comfortable depth map. After generating the depth map, the multi-view video is rendered to 3D display.

1) *Advantages:* 3D provide Good visual quality over 2D.
2) *Disadvantage:* No human interaction required.

V. CHALLENGING ISSUES

Even though much research has been done to enable automatic 2D-to-3D conversion, the techniques are still far from mature. Most available products and methods are only successful in certain circumstances. In addition to the limitations imposed on each approach, the following are some key challenging issues to be solved and some of not solved.

1) One issue that directly affects the image quality is the occlusion/ disocclusion problem during the generation of the stereoscopic images. In that camera is horizontally located so any new scene information is generated in view current viewpoint the texture information is missing in the current frame to another frame [2]

2) The depth ambiguity from monocular depth cues is one issue that impacts the depth quality. [2]

The solution to solve the depth ambiguity of moving objects is to use additional depth cues, such as depth from geometrical information, to generate the depth information for each video frame.

3) The integration of various depth cues is another issue affecting the success of automatic 2D-to-3D video conversion. To retrieve the depth from such video sequences, different strategies of depth generation are required. The challenge is how to integrate all the extracted depths from different cues to form, not only spatially, but also temporally stable and reasonable depths. From the literature, only some research on the integration of various depth cues in the spatial domain has been proposed. However, more investigations are still required to provide spatially and temporally consistent depths.

4) The real-time implementation of 2D-to-3D conversion is also a critical issue for the adoption of the proposed techniques by

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the general public. The availability of real-time 2D-to-3D conversion will allow broadcasters and consumer electronics (CE) manufacturers to remove the natural fear from users of not having enough content for their new 3D-enabled TV set. Real-time, however, adds a new hard constraint that is difficult to meet while maintaining a high quality standard for the converted material. There are several real-time implementations incorporated into TV sets (e.g., Samsung's 3D-TVs), sold as stand-alone equipment (e.g., JVC's IF-2D3D1 Stereoscopic Image Processor), or incorporated into software packages (e.g., DDD's TriDef-Player). However, the quality of the resulting stereoscopic images, with respect to the depth sensation, is still an outstanding issue that requires more research. [2]

5) The major challenge of 2D-to-3D video conversion lies in the disparity estimation of monocular videos, which is closely related to the scene depth estimation.

VI. CONCLUSION

The survey investigates the existing 2D to 3D conversion algorithms developed in the past years by various computer vision research communities across the world. The results of some 2D to 3D conversion algorithms are 3D coordinates of a small set of points in the images. This group of algorithms is less suitable for the 3D television application. The depth cues based on multiple images yield in general more accurate results, while the depth cues based on single still image are more versatile. A single solution to convert the entire class of 2D images to 3D models does not exist. Combing depth cues enhances the accuracy of the results. It has been observed that machine learning is a new and promising research direction in 2D to 3D conversion. It is also helpful to explore the alternatives than to confine ourselves only in the conventional methods based on depth maps. 2D to 3D conversion is presented. Main Motion estimation and color segmentation fused with respecting depth map and finally using DIBR technique which is using 3D wrapping and Hole Filling and Multi cues fusion, Bilateral Filter. It has been shown that approach can greatly reduce the complexity with real time applications.

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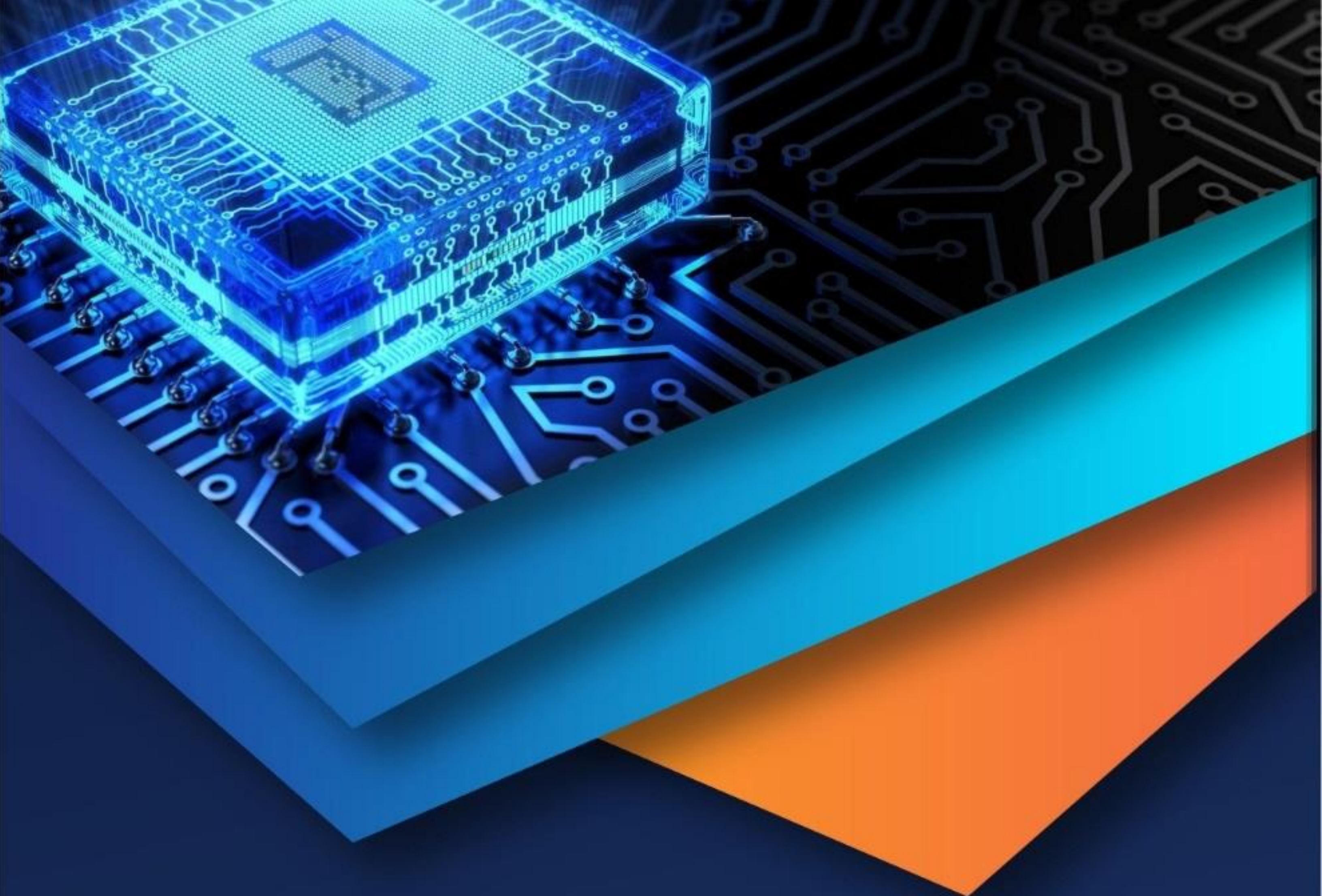

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