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A Brief Review of Methods of Moving Object Detection, Challenges and Shortcomings

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Abstract: Moving object detection from dynamic scenes has been used in many computer vision applications like face detection, video processing, video surveillance, traffic monitoring etc. Finding the position is much more challenging task than detecting the moving object in a video. Here we are presenting a brief review of various algorithms for moving object detection which are already available. Moving object detection from dynamic scenes using Multiple Color Space Histogram Model is briefly discussed in this paper. In this model, at first, convert each frame from RGB space to other color spaces and calculate the histograms of selected color components, then we can obtain the background histogram model; then, detect the objects using statistical histogram superposition principle; at last, update MCSHM by the result of detection. The experimental results demonstrate that our method can quickly and accurately detect moving objects in dynamic scenes.
Keywords: Dynamic scene, Moving object detection, Multiple Color Space Histogram Models, Histogram superposition principle.

I. INTRODUCTION

Moving object detection is an important research field in various computer vision applications, including video processing, video surveillance and traffic monitoring [1]. It is a fundamental and challenging step. Moving object detection is defined as the recognition of the physical movements of an object in a given region. In a video sequence an object is said to be in motion, if it is changing its location w.r.t. its background. The primary goal of motion detection is to detect motion of objects with respect to two consecutive frames. Motion detection from any video stream does not require any prior stored database but only multiple consecutive frames. Video is a sequence of no. of images, each sequence is called as frame. There are both moving and static object(s) in the sequence of images. Moving object(s) which can be anything for example; person(s), bird(s), vehicle(s) etc. which are nothing but foreground object(s) and background object can be the static i.e. fixed camera with static background as well as dynamic things. i.e. case1 is of moving camera with static background and case2 is of fixed camera with changing background i.e. dynamic. The moving object detection is actually the process of detecting moving object in video sequence [2]. Video primarily contains two sources of information which is useful for detection of objects: visual features (i.e. color, texture and shape) and motion information. Many researchers have worked on and proposed a large no. of methods focusing on the object detection from a video sequence. Most of them utilizes different techniques and there are combinations and convergences among different methodologies. This makes it very difficult to have a uniform classification of existing approaches [3]. In this paper we present different methods of moving object detection for example; background subtraction, frame differencing, optical flow etc. We have also evaluated the accuracy rate of these methods and studied the benefits and challenges of these methods.

II. REVIEW OF LITERATURE

Motion object detection is the first step to track non-stationary object. Moving Object detection is the method of finding the mobile objects in a video sequence. Some of the important methods of detecting the moving objects are Frame differencing Optical flow, Background subtraction and Multiple color space histogram model etc. are discussed in this paper. Different detection methods are as shown in figure1.

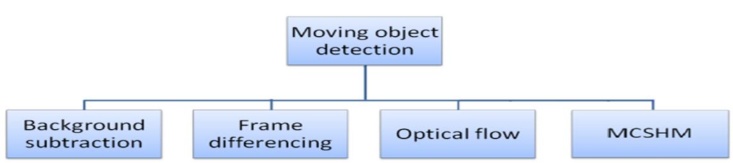

Fig.1. Moving Object Detection techniques

A. Background Subtraction

Background subtraction is the most common method for detecting moving object. In this method, subtraction of the current image pixel-by-pixel from a reference background image takes place. The pixels where the difference is above a certain limit are classified as foreground. And background can be known as an empty scene without any object of interest. The BS consists of two main steps one is the modelling of the background representation and second is the detection of the foreground pixels.

The frames are first extracted from a video sequence. The background frame is then generated using the desired algorithm. Thus creating the background image is known as background modelling. And the foreground is detected by making suitable comparisons from the generated background model. Once the desired object is detected in the foreground, then some morphological operations for example; erosion, dilation and closing can be performed to reduce the effects of noise and to enhance the detected regions. The reference background is refreshed with new images after some time to adjust to dynamic scene changes [3].

The equation (1) and (2) shows the background subtraction method for first frame as the background image[5].

$$B(a, b) = A(a, b) \quad (1)$$

Where,

B(a, b)= background image pixel by pixel

A(a, b)=current frame

$$C(a,b)\begin{cases} 1 \quad if\ B(a,b) - A(a,b) > threshold \\ 0\ otherwise \end{cases} \quad (2)$$

Where,

C(a, b) = foreground pixel

Threshold value can be set manually

1) *Literature Survey:* Wang et al [1] proposed an adaptive Local-Patch Gaussian Mixture Model (LPGMM) as the dynamic background model for detecting moving objects from video with dynamic background. They proposed a two-stage system to detect moving object and remove shadow from surveillance videos with dynamic background. The first stage is to detect moving objects by using the proposed LPGMM model and second stage is to remove shadow from the extracted foreground region for this purpose they utilized the linear SVM classifier to classify each pixel which is detected as moving object at the first stage to foreground or shadow. The performance of the proposed model is superior over the previous competing methods for videos with dynamic background scenes. Dewan et al [6] proposed a method which is based on color features of an image namely FCDH (Fuzzy color difference histogram). Unlike pixel level, This method uses patch level approach. In this approach attention is paid on the color difference and not on the color magnitude. The color difference histogram is computed for a local neighbourhood of pixels using the color difference corresponding to two color components. Then, fuzzy c-means clustering (FCM) is employed to obtain fuzzy color difference histogram. This helps to overcome the impact generated due to change in illumination (sudden or gradual). Background modelling is done and foreground is detected using similarity matching. The proposed algorithm will work robustly in environments such as non-stationary backgrounds, varying illumination, frames with mask etc. This algorithm is very useful in various applications like video surveillance, traffic monitoring and controlling systems, human interaction systems and automation of industrial methods. Zhang et al[7] proposed a new method for detecting moving object based on background subtraction which is different from traditional methods. At first, they established a reliable background updating model based on statistical and used a dynamic optimization threshold method to obtain a moving object. Secondly, morphological filtering is introduced to remove the noise and to solve the background disturbance problem. At last, contour projection analysis is combined with the shape analysis to eliminate the effect of shadow, the moving human body is accurately and reliably detected. Results show that the proposed method is fast and simple, having high accuracy and compatible with the real-time detection. Chan et al [8] introduced a generalization of Stauffer-Grimson background subtraction model. This approach is suitable for not only static scenes but also for dynamic scene, unlike original Stauffer-Grimson model. They derived k-means algorithm to update the parameters. At last, they reported an experimental result, which shows that the proposed model surpasses over the methods those restrict to static scenes.
2) *Challenges:* Illumination i.e. change in lighting robustly affects the appearance of background which shortens the accuracy of ROI detections. Moving object detection in dynamic background is a challenging due to irregular movements. Due to presence of shadows of foreground objects, object detection using background subtraction becomes more challenging. Video can be captured by moving camera. Due to motion of camera object detection becomes more complicated. Moving object detection is more complex in challenging weather conditions ex; snow storm, air turbulence, fog etc [3].

B. Frame Differencing

Frame differencing is object detection method in which the moving object is detected by finding the difference between two consecutive frames. In this method, each current frame pixel is subtracted from its previous frame pixel. The Equation (3) shows the formula for frame difference.

$$F(a,b) = \begin{cases} 1 & I_n(a,b) - I_{n+1}(a,b) > T \\ 0 & Otherwise \end{cases} \qquad (3)$$

Where,
I_n = previous frame pixel
I_{n+1} is the pixel rate of the current frame.
T = threshold value which can be set manually by the user.

Its implementation is easy and it's calculation is comparatively simple. For moving object, it is usually difficult to detect complete outline due to strong adaptability, for dynamic environments, so that result can't be accurate for the moving object detection [2-4].

1) *Literature survey:* Hatwar et al [2] represented the steps involved in tracking of an object in a video sequence. They described different methods of object detection and tracking and they compared various techniques for different phases of tracking. They concluded that, in object tracking methods, identifying the movement of the object is critical. According to their study, they concluded that the frame differencing and background subtraction methods are suitable for object detection because their implementation is easy. Performance of Frame differencing is better than others, also computation is less complex and consumes less time. It provides higher accuracy. Sunitha M.R. et al [5] presented a brief review of various object detection, object classification and object tracking algorithms which are already available. In this paper different stages of object tracking approaches for example: object detection, object representation and object tracking are abridged. According to their survey, they concluded that background subtraction is the simplest method among various detection methods, which provides complete information. Zhu et al [9] proposed an enhanced frame difference method, which can reduce the computational time and improve the correctness of the object detection. The results of the experiment show that, the detection speed is amplified by 21.06 times and the image detection accuracy is enhanced about 8%. This approach can be modified to different scenes i.e. indoor as well as outdoor. It proved to be better in the applications, such as Intelligent Driving, UAV aerial detection technology etc. Han et al [10] proposed a moving detection algorithm. They proposed a combination of the optical flow method and three frame difference method use OTSU to process. Due to use of this method calculation of optical flow becomes simpler, and it can meet real-time requirements. It brings adaptive threshold of OTSU in and can make three frame difference algorithms get more precise results for some pixels in foreground image.
2) *Challenges:* Camouflage is a problem because some objects may poorly differ from the background, which increases classification complexity. The speed of the moving object should be within appropriate zone is also a challenging task. If the object is moving at very slow speed, the frame differencing method will not able to identify the portions of the ROI. Conversely, a very fast moving object leaves a trail of ghost region in the wake of it in the identified foreground camouflage [3].

C. Optical Flow

Optical flow method is an example of apparent movement of objects, surfaces, and edges in a visual scene due to the relative motion between an observer and a scene. Optical flow method uses the flow vectors of moving objects over time to detect moving regions in an image. In this method, computation of the apparent velocity and direction of every pixel in the frame must be done [3]. The optical flow method is of the velocity field which represents the 3D motion of object points across a 2D image [4]. Background motion model can be accurately calculated with the help of optical flow method as compared to that of background approach. This method is able to detect motion in video sequences even from a moving camera as well as dynamic background; nevertheless, most of the optical flow methods are computationally complex and hence can't be utilized progressively without specific hardware. Though it is an effective method, it's time-consuming too [3, 5].

1) *Literature Survey:* Aggarwal et al [11] presented Optical flow technique for moving object detection. The algorithm they presented, can detect and track motion objects in video frames taken from static camera; which is immaterial of background and area. They tested this particular algorithm on datasets which exists online, real time videos and also on manually recorded videos. At first, the average flow vectors are calculated and then produce optical flow vectors. Morphological operations like erosion and dilation are performed. Lucas-Kanade algorithm is chosen to calculate optical flow due to the fact that it has high accuracy. At last the filtering is done for smoothening the boundaries of the moving object using median filters. Finally, the

algorithm detects only those moving objects which will satisfy the conditions those are applied on the blob areas and remaining will stay as undetected. Liu et al [12] applied principle component analysis (PCA) to examine optical flows to perform better to detect moving object. Combination of optical flow and PCA methods can detect moving objects efficiently. In case of static as well as dynamic background, the approach works well, particularly for motion detection from outdoor videos having low quality and tiny moving objects. They concluded that this joint method surpasses other available methods by detecting motion object more accurately. Fan at al[13] presented applications of optical flow field, and also announced an enhanced Horn-Schunck optical flow estimation method used for detecting moving targets in infrared images. In this paper, the movement of re-enacted image and infrared image is utilized and the confirmation of these two images is made. The experimental results demonstrate that this technique can make an exact judgment for moving targets in infrared images. Zhang et al [14] proposed multiple object detection and tracking algorithm based on optical flow in polar-log images. Optical flow calculation is only used in moving area. At first, the moving edge is removed in polar-log coordinate. Then, the generalized dynamic image model (GDIM) based method is utilized and the gradient operator in polar-log coordinate is utilized to estimate the optical flow directly in moving area and the object tracking is completed. Due to use of GDIM approach accuracy of optical flow method is increased. It can be used for real time object tracking.

2) *Challenges:* Brightness must be constant over time. Also, velocity smoothness assumptions should not be infringed [4].

Shortcomings Of All The Above Discussed Methods

From the above discussion, it is clear that there are some shortcomings in the traditional moving object detection methods:

a) Background subtraction: Though this method is widely used it has limitation that, it can't deal with sudden, drastic lighting changes.
b) Frame differencing: This method exhibits poor performance in extracting the complete shapes of certain types of moving objects. i.e. it is not able to detect the extra contour of moving object[14].
c) Optical flow: Although this method can detect the moving object in case the camera moves, it requires more time for its computation which is also very complex, and it is very sensitive to the noise. And optical flow estimation involves only local computation [15].

III. METHODOLOGY

A. *Multiple Color Space Histogram Model*

There are many algorithms to detect objects in motion. Here, a fast and simple algorithm, which combines histograms in multiple color spaces with the superposition principle of statistical histogram, called Multiple Color Space Histogram Model (MCSHM) is used. MCSHM first calculates statistical histograms of many color components in multiple color space and then use the variations of statistical histograms to find out whether there is an object. Thus, the computational complexity becomes very low[16].

1) *Relevance/Motivation:* Our main aim is to implement multiple color space histogram model for detection of moving object from dynamic scenes. In computer vision, moving object detection is the recent research topic which is used for many video surveillance applications. This project proposes a fast and simple algorithm to detect moving object in dynamic scenes. Here we are not concerned with the location of the object but only aim is to determine whether a moving object appears in the scene or not; hence we do not require spatial information of pixels. For most dynamic scenes, the inherent attributes (intensity, texture, topology structure, etc.) of dynamic scenes are stable although the background is constantly changing. Histogram describes an inherent attribute of an image i.e. intensity. Statistical histogram will show a very good stability when there is no object in the scene; if an object appears, the histogram will change obviously. In order to describe the background histogram model more accurately, we are using multiple color space because of its good complement and redundancy. Multiple color components histograms can retain more information in the image. So, it can describe the background model better than a single color component. Additionally, we use histogram superposition principle to capture the changes in histograms. In multiple color space, we utilize the range of each color component's histogram to determine if an object has appeared [16].
2) *Block Diagram:* Multiple color space histogram model consists of combination of histograms in multiple color spaces and the superposition principle of statistical histogram. This model first calculates statistical histograms of many color components in multiple color space. Then, the variations in statistical histograms are used to detect whether there is an object and not the changes in pixels or pixel level regions.

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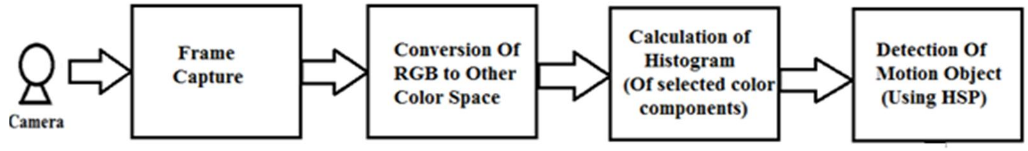


Fig.2 Block Diagram of Methodology

The above figure demonstrates the methodology of moving object detection using multiple color space histogram model. Here we deal with Static camera. At first, with this fixed camera we capture N frames of video sequence to obtain stable background model. Then convert each frame from RGB color space to an appropriate color space, after this calculates the histogram of selected color components. Finally, detect the desired moving object using Histogram superposition principle. Equation(4) describes the impact on the histogram when suddenly an object appears on the empty background.

$$H_{new} = H - P + R \qquad (4)$$

Where,

H_{new} = The histogram after superposition,

H = The original histogram

P = The histogram of the pixel set before the pixel intensities change

R = The histogram of the pixel set after the pixel intensities change.

This expression can be interpreted as H_{new} equaling H minus P plus R[16].

IV. EXPERIMENT AND RESULT

We have performed an experiment. Here we have taken 2 frames of a video sequence. Original frame is as shown in figure 3 below. Then we converted the original frame which is in RGB format to the HSV color space. And then we calculated the histogram of selected color components and histogram superposition principle(HSP) is applied over the frame as shown in figure 3 below.

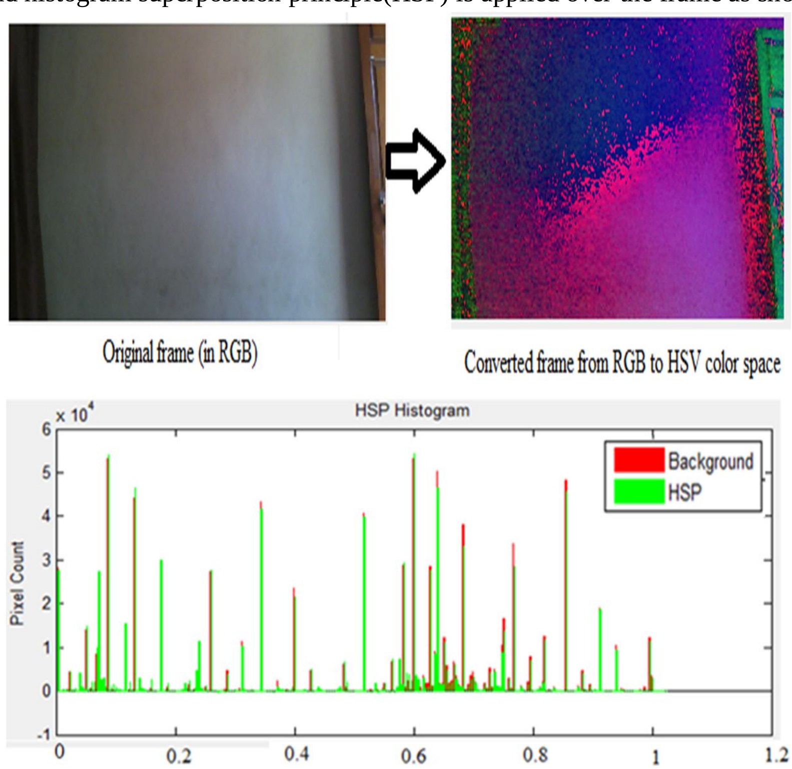
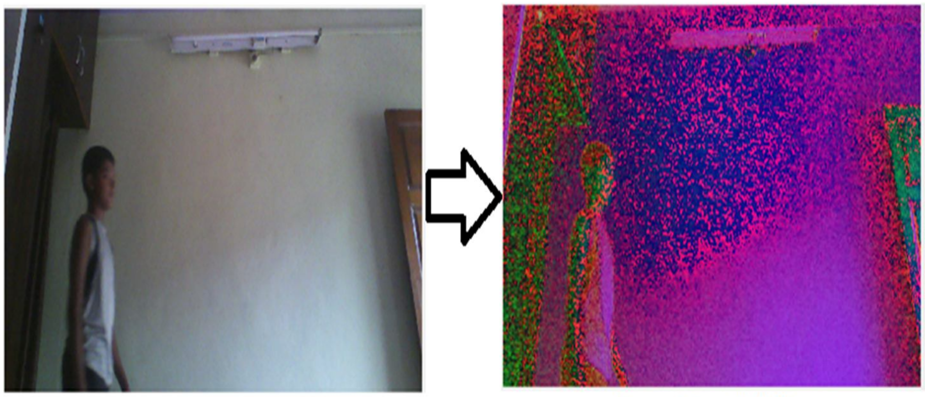


Fig.3 Histogram with no object

When an object appears suddenly, we can see the abrupt change and variations in histogram. Also, Histogram superposition principle (HSP) is applied over the frame as shown in figure 4 below.



Next frame (in RGB) Converted frame (in HSV)

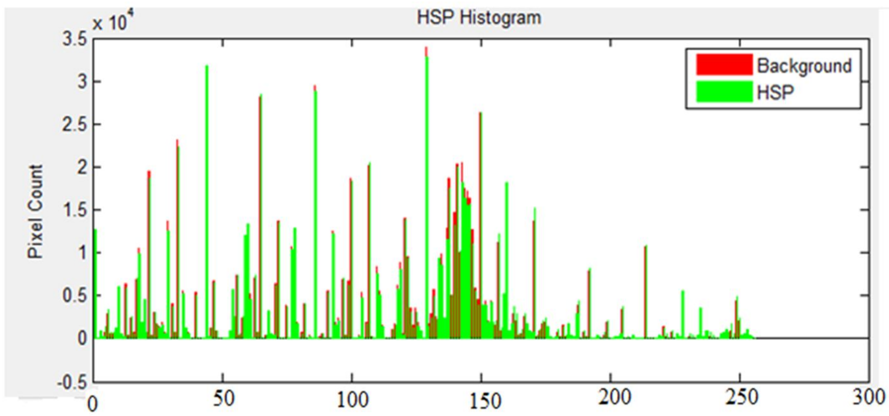


Fig.4 Histogram when object appears

V. PERFORMANCE ANALYSIS

Here we are using a fixed camera to capture video frame sequence. After that we converted each frame from RGB color space to HSV color space. Then we calculated histograms of selected color components and compared them, after comparing we can find the change in histogram if there is an object appears. In such a way we detect a moving object. This moving object detection technique can be used in different applications for example; Video surveillance, Video processing, traffic monitoring system, people counting, banks, stadiums, railway/metro stations for suspicious person detection, Parking management, face detection and content based video retrieval.

VI. FUTURE WORK

Until now, we completed the work up to calculation of histogram of two different frames of a video sequence. Also, we applied histogram superposition principle to original as well as the next frame. The remaining work is to detect the objects using statistical histogram superposition principle; and updating of MCSHM by the result of detection. In future the detected objects can be tracked to give extra information about them. This will be helpful in various applications mentioned above.

VII. CONCLUSION

Moving object detection in dynamic scenes is one of the crucial tasks in many computer vision applications, including video processing, video surveillance and traffic monitoring. The primary goal of motion detection is to detect motion of objects with respect to two consecutive frames. In this paper we have surveyed three methods of object detection briefly. And also working with another method which is based on multiple color space histogram model. At first, by converting each video frame from RGB to HSV color space and calculating Histograms of selected color components, we obtained the background histogram model as shown in result. And then we applied Histogram Superposition Principle to detect the particular object. This proposed method models the background based on histogram which is different from pixel level modelling method. Hence, the computational complexity of this algorithm is very low. Multiple color space is very flexible; hence this method also has great flexibility

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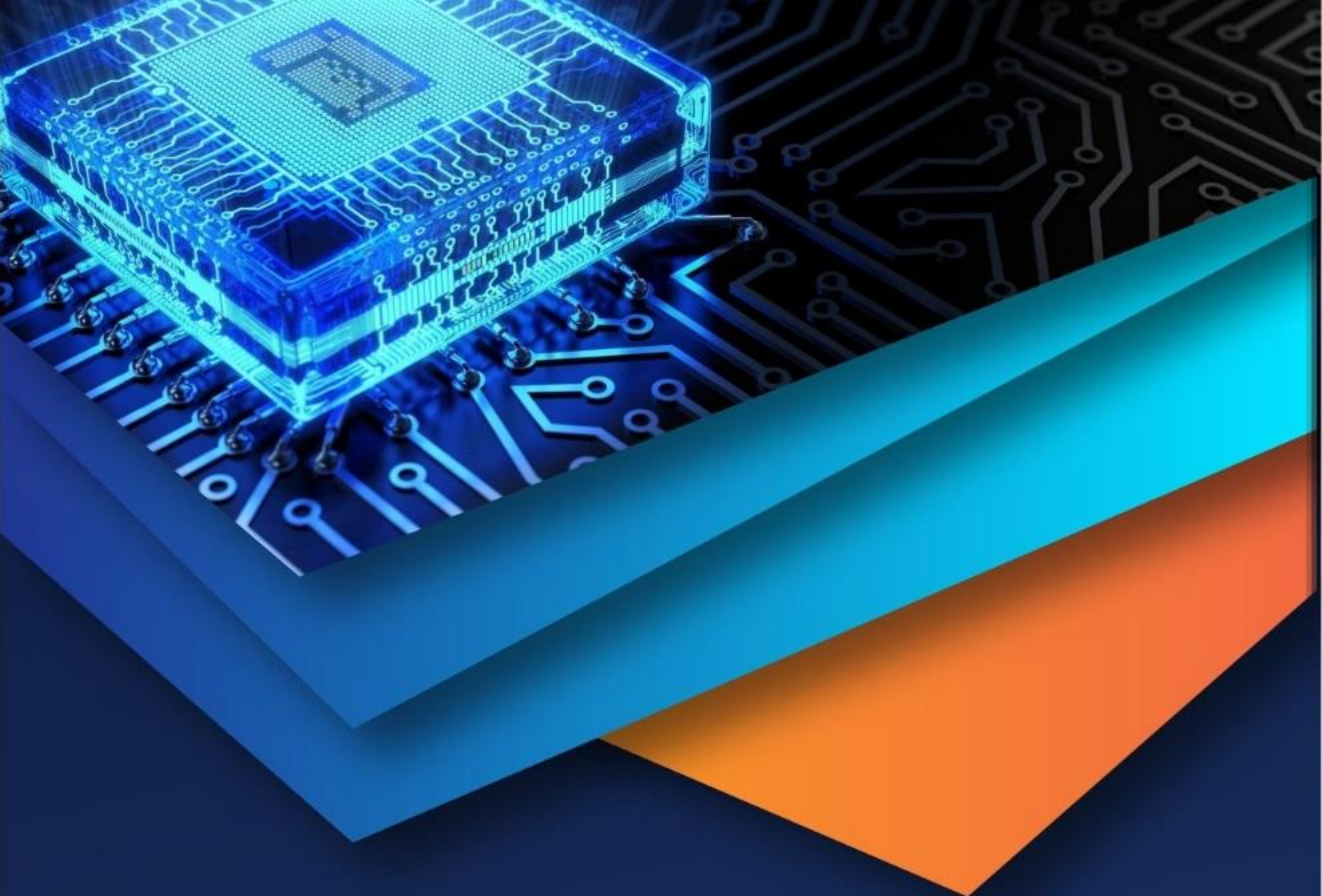

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