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REAL-TIME MOTION DETECTION FOR STORAGE VIDEOS IN SURVEILLANCE CAMERAS

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ABSTRACT

Recently, motion detection is essential in computer vision applications because of the significant demands for developing digital video reordering systems (DVR). In this paper, we present a new technique for motion detection, which can handle the challenges of motion detection. The proposed technique can be used in real-time surveillance camera systems. It can capture the motion from any camera that is extracted from each enrolled images or video for each moved objects. We implemented the processing and dissemination stages for the processed images that are used for digital surveillance systems. On the other hand, the need for high recording quality with the increase of camera numbers required huge storage space. Therefore, we used a registration point in the case of traffic motions. In order to take advantage of storage space that made high benefits with four different processes of first obstacles of motion detection, the speed of the moving object, the presence of mobile cameras, moving background algorithm that responsible for detecting movement. A comparative study is presented in this paper to investigate the reliability and robustness of the proposed system.

Keywords: *Motion Detection, Background Subtraction, Temporal Difference, Optical Flow, Grid Processing, Area Highlight, Object Tracking, Border Highlight.*

1. INTRODUCTION

Video change detection or motion detection is an artificial intelligence application that means making a smart algorithm to capture motion from closed-circuit television (CCTV). The cameras are considered an essential device in humans' lives. They are the perfect solution for keeping safety and personal security. They also save time and effort. So, the user can monitor and follow up company, factory, office, etc. In the past, surveillance camera depended on a video cassette recorder (VCR). This type of recording was slow and difficult to back up. Cassette needs large archive room to storage tapes besides the importance of visual surveillance increased for security purposes. In the present time, other styles provide efficiency as motion detection, face detection, storage large capacity, track, and classify objects from frame sequences.

Hence, designing CCTV primary aim is to continue observation because it records all time with no stop or having a rest. There are various technological developments in information technology fields and issues among them security systems devices and methods of recording using a modern DVR. It was difficult to record what was happening or enable the recording of that period. There are many methods to calculate motion. It will be discussed later, clarify benefits as reducing cost related to real-time motion detection implementation, also change illumination conditions which have a false impact on motion detection To support the idea, unit for recording using DVR and follow-up via the Internet was established. This should be designed according to accurate specifications [1].

The rest of the paper is presented in six sections. Section 2 discusses the challenges of motion detection. In Section 3, presents the current related work. Section 4 describes the motion detection algorithm. Section 5 introduces our proposed framework, which is based on real-time motion detected video storage algorithm for surveillance cameras. Section 6 explains the implementation and experimental results. Finally, Section 7 presents the conclusion and our future work.

2. CHALLENGES OF MOTION DETECTION

In this section, we attempt to overview describes the limitations in motion detection such as the

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change in light, moving background, extreme weather, and noise [2]. All these problems are very critical in motion detection systems that are briefly illustrated in the next subsections.

2-1 Illumination Changes: Lighting change happing in open places is more than closed. We move quickly from cloudy to bright, such as sunlight. This is a false movement. The system or algorithm must be sensitive to changes that occur suddenly in lighting.

2-2 Dynamic Background: Animated background is one of the most difficult problems of motion detection as some parts of the scene contain false movement such as tree wobbles wave movement etc. Dealing with these background dynamics is mission challenge.

2-3 Camouflage: The speed of the moving object may result in obtaining a camouflaged image with or without the intention of making the classification difficult, especially in the control systems.

2-4 Shadows: Shadow may negatively affect motion detection when subtracting the background and there is a shadow that gives incorrect results to know the type, size, and shape of the moving object.

2-5 Motion of the Camera: Sometimes called camera jitter that means that the camera is not stable well or strong winds are moving the camera. It yields poor results and impediments to motion detection [3].

2-6 Challenging Weather: It is difficult to detect the moving object from the existence of difficult weather conditions such as the presence of storms or snowfall, heavy rain, and other air disturbances, which reduce the quality of the discovery of the object moving within the frame.

2-7 Fast motion Objects and Intermittent: Moving object is also one of the obstacles facing the discovery of motion in the CCTV System. If the movement is slow or stopped, the time difference algorithm fails to know or the presence of the object inside the image.

2-8 Night Videos: Realization of foreground objects in the night scene is hard as their pixels have the same color, especially in case of using only color information for segmentation.

3- RELATED WORK

Real-time motion detection is an active research topic. There are many studies that discuss the improvements in this field. For example, Sehairi et al. [4] proposed a simplified self-organized background subtraction method. They tested twelve detection methods changes using the CDNET 2014 video dataset by comparing the evaluation of every method and at finally compared with the previous comparative evaluation. Their experimental results opened the way for the user to choose the suitable method as there was not a perfect method than another. Every method they were done gave a good performance in a particular case and failed in another. Therefore, they did not provide a definite method. They worked together to find the best method by comparing the good results of different methods and avoid the challenges of motion detection.

Martins et al. [5] used methods to explain the difficulty and trouble of background subtraction that based on the background model called (GMM) known as a mixture of Gaussians (MOG). Sets of experiments used Boosted MOG (BMOG) method showed that Boosted Gaussian Mixture Model BMOG was constant outperform MOG and a Region-based mixture of Gaussians modeling (RMOG) slightly outperform BMOG. BMOG approaches SUBSENSE considered complex algorithms are combining different approaches.

The previous method faced many challenges, such as reduced visibility of cars, buses, and taxis on the street. They suggest a good solution to solve the challenge of BS. It relies on a flexible background model proposed by Zivkovic commonly known as MOG2 that increase accuracy in several backgrounds without influencing its performance and is considered an essential issue in real-time applications. This option makes it a worldwide choice in real-world applications, despite the appearance of other methods of high performance.

Their way called BMOG analyzes the qualities of the color spaces and further adapts the algorithm and used modest but efficient rules to enhance the achievement of MOG2 complete group of experiments was achieved on public datasets. Results show that BMOG typically overtakes MOG2 and that it reaches top classification, but much more complicated algorithms its controlled complexity makes it an acceptable option for real-time motion detection application.

Babaee et al. [6] used a new technique depend on learning for background subtraction from video

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sequence used a deep Convolution Neural Network (CNN) to improve the segmentation, also proposed algorithm anew to produce background model. They utilized a median filter to improve the segmentation results. The used system proved their performance in experimental results. Their method evaluated with different data sets, and it (so-called Deep-bs) outperforms the existing algorithm that was very accurate over different evaluation metrics.

Jiang [7] supposed a new technique method to improve the quality of change foreground detection to better that helps them to use a few samples with different weights to improve the change detection. In the experiment, their algorithm incorporated into an adaptive feedback technique to allow more videos that are challenging. They faced strategy of weights as a minimum-weight update policy is firstly proposed to replace the most inefficient sample instead of the oldest sample or a random sample, so the weights of simply influential samples were raised, and fake modernization of essential samples with smaller weights was decreased. In addition, other techniques such as spatial-diffusion policy and random time sub-sampling agreed to confirm the adaptability of the suggested method.

Giordano [8] used Weightless Neural Networks (WNNS) to learn and detect background region in video processing. In this paper, they presented a change detection method in video processing that used a WNN, called WiSARDrp, as an underlying learning mechanism, equipped with a reinforcing/weakening scheme, which builds and continuously updated a model of background at pixel-level. The experimental results carried out on the Cdnet2014 by using WiSARDrp with the same setting, their results were supportive in WiSARDrp although it was not the perfect one but considered the 10th best method. The method was very straightforward, so it was not a good competitor in the CDNET 2014 challenge.

Sajid et al. [9] supposed multimode background subtraction that system handle a multitude of challenges related to video change detection. It makes multiple background models of the scene then measured foreground/background for each pixel then every image pixel combines to become mega-pixels which were used in measurement binary with two types of RGB and YCbCr color spaces the final evaluation showed that higher performance than another state of algorithms.

As discussed before, there was a limitation in the related work. They used many methods that everyone gave a good performance in a particular case and filled in the other. Therefore, there was not a definite method to detect the motion. They decreased-weight update policy was proposed first to take the place of the most disabled sample instead of the oldest model or a haphazard sample, so the weights of simply crucial models were raised, and fake modernization of effective samples with smaller weights was reduced.

Allebosch et al. [10] proposed a foreground-background segmentation by using the video sequence detection change detection in video sequences is often used mainly in high-level applications and analytics. There is no method able to address the complex nature of dynamic scenes in real surveillance tasks. They suppose a universal pixel-level segmentation method based on color information and spatiotemporal binary features to detect changes. This help to detect hidden foreground objects so easy but ignore most illumination variations. Besides, they utilize loops in pixel level in order to adapt or modify their method's internal parameters automatically alternative than using set frame-wide constants which are set manually to determine model sensor and the speed of adaptation. These adjustments are stood on the continuous monitoring of model fidelity and the level of local segmentation noise levels. This new technique aids them to exceed all related work that uses the same change detection data set on the 2012 and 2014 versions of

Sehairi et al. [11] aimed in their study to find the best ways to overcome the complex weather changes and moving background which is not fixed by using dataset CDNET 2014. They tried to get rid of the hindrances of the dataset. They tested more than 12 methods. These methods range from what easy to what more complex they also used the performance equations (metrics) to calculate the results as most of these methods have not been evaluated yet. These studies have shown that there is no ideal way to overcome these troubles. They have proved that these methods succeeded in some cases but failed in other ones.

Braham et al. [12] proposed an approach of semantic background subtraction, to sum up. They talked about the merits of background subtraction firstly they decided to find an ideal way to overcome the challenges and scenario problems secondly. They combined the output of background

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subtraction with the information of segmentation algorithm thirdly. They reduced the false positive rate of illumination changes, ghosts, strong shadow, dynamic background, and camouflage. This leads to a fully semantic background. The result of the research has shown they achieved the best high rate in background subtraction CDNET 2014. They reduce the average error rate.

Table 1: *A comparison of all related work results.*

Yea r	Researchers	ABB	Average RE	Averag e SP	Averag e FPR	Averag e FNP	Averag e PWC	Average f-Measure	Averag e precisi on
2012	**L. Maddalena [27]**	SC_SOBS	0.7621	0.9547	0.0453	0.2379	5.1498	0.5961	0.6091
2014	**Xiqun Lu [14]**	STEI	0.6621	0.9542	0.0458	0.3379	5.5456	0.5141	0.5536
2014	**De Gregorio [8]**	WNNS	0.6608	0.9948	0.0052	0.3392	1.5273	0.6812	0.7725
2015	**Sajid, Hassan,[9]**	MBS	0.7389	0.9927	0.0073	0.2611	1.2614	0.7288	0.7382
2017	**Kamal Sehairi [4]**	SSOBGS	0.4895	0.9710	0.0290	0.5105	4.8631	0.3977	0.5116
2017	**Martins [5]**	BMOG	0.7265	0.9813	0.0187	0.2735	2.9757	0.6543	0.6981
2017	**Babaee [6]**	DEEPBS	0.7545	0.9905	0.0095	0.2455	1.9920	0.7458	0.8332
2017	**M. Braham, [13]**	ICBGS	0.7890	0.9961	0.0039	0.2110	1.0722	0.7892	0.8305
2017	**Jiang S, Lu X.[7]**	WESAMBE	0.7955	0.9924	0.0076	0.2045	1.5105	0.7446	0.7679
2018	**KunfengWang [12]**	M4CD	0.7885	0.9841	0.0159	0.2115	2.3011	0.7038	0.7423

As discussed before, there was a limitation in the related work. They used many methods that everyone gave a good performance in a particular case and filled in the other. So there was no definite method to detect the motion. Dealing with low-visibility of vehicles was another limitation and their very strong headlights that cause halos and reflections on the street. The strategy of weights also included as a minimum-weight update policy was first proposed to replace the most inefficient sample instead of the oldest sample.

There is not a perfect method until now to detect the motion. Researchers do best to face the limitations. Researchers introduced four methods to detect the motion and supposed that object tracking is the best one. In the proposed, Researchers border the moving object, so there are no reflections and define what is moving. Our used program is sensitive to different conditions so give good accuracy in every one of the Moving objects.

4- MOTION DETECTION ALGORITHM

Some basic concepts will be discussed in detail in the next subsections.

4-1 Background Subtraction

In general, there are many techniques for removing backgrounds of the input images as shown in Fig. 1 an example of background subtraction.

Fig. 1: Background subtraction.

Background subtraction save the first image in memory used for detecting moving objects from the difference also called foreground detection.

4-2 Temporal Difference

Using consecutive frames (two or three) subtracted to recognize the moving area. Instead of using a fixed reference image, this method can adapt to dynamic scene changes. It fails to detect not moving objects in the scene.

4-3 Optical Flow

Optical flow is the best motion detection technique until now. It Gives a good description of motion and can be translation used to study moving static objects, and moving objects or both moving the important part In optical flow, every pixel used to calculate the motion the vector of each pixel represents the motion of every pixel the region of the image where brightness change observed. Here object moving is done for good performance. However, the complexity of that algorithm related to storing images thus resulting in memory requirements and in-turn leads to it occupies the memory and requires storage, and it is very

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expensive. Compute motion within a region or the frame as a whole.

4-4 Template Matching
This Technique classifies objects by compares portions of images against one another. Discover the motion by following the template in the overall image. First, find the region of the current image.The next step uses one of an algorithm like feature based detection and appearance based detection. After finding the ROI (Region of Interest) finally catch the template matching. Benefits of using this algorithm are it decreases the computation time as the Region and more effective and cheaper used for small moving objects. Finally, we make a comparison of the four motion detection techniques in Table 2. The previous table, optical flow is the best method for detecting motion. However, it needs high memory, and more one image need to store in one second.

Table 2: The motion detection algorism comparison.

	Background subtraction	Temporal Difference	Optical flow	Temporal Matching
Definition	Detected by comparing the difference between a present image and the next camera image	It discovered by analyzing the difference in successive images	Divide each image up into smaller blocks, and then makes comparisons	Discover the motion by finding the template in the overall image first find the region of current image
Advantages	Easy to implement and use all pretty fast also corresponding background models are not constant	Effectiveness, also, simple requires less computation	Good performance	Decreases the computation time as the region
Disadvantages	The threshold is not a function of it. therefore, these approaches will not give good result to the following conditions	Difficulty in identifying stopped objects in the scene	Very complex- needs than more image to be stored. the requirements it needs expansive higher memory	Difficulty in identifying in large moving objects

5- THE PROPOSED FRAMEWORK
The importance of the framework is making a backup to record moves through the internet. In case of corrupt or destroy the DVR system, it works to detect the motion and record it from all types of cameras and video file as(web, CCTV, DVR) via the internet by using four different processing methods, and every one suit special place, as shown in Fig. 2.

First, we take the image from the camera and convert it to gray the second denoising the new image then convert it to pixels. Comparing the background frame with the current frame image if their first frame saves the background frame image and get a new image and repeat the step. Else compare the current image with background frame image. If there is not any change update background frame. Moreover, get a new image. If there is any change, the algorithm will catch the motion with four types of processing (border highlight, object tracking – grid processing- area highlight). This framework is a combination of the optical flow and background subtraction. There are four different processing in our algorithm, as shown in Fig. 3.

5-1 Grid processing
Makes a matrix continue the object movement and flow it anywhere. The drawbacks of this processing are difficult to know what is moving. First frame convert to the grid–grid convert to the cell. Then calculated the level of motion for each cell individually it high light shadow frame.

5-2 Border Highlight
It makes a frame to the moving object the benefit of this method can define the shape of the moving object; also it flows the object. Only borders of motion areas. It also exactly defines the moving object and its types.

5-3 Objects Tracking
Its flow the moving objects and surrounded by a rectangle this process allows count number object the motion frame Researchers can ignore the object with the small frame

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5-4 Area highlight

Make a shadow to the moving object and flow; also it gives the same benefit as border highlight processing. This process used a specified highlight color the motion area. Storage it in HDD go to next step and choose one of the four processing if there an object in the frame and continue moving so object detection then object segmentation, feature extraction and matching finally save the motion as video file else save motion as an image file. The overall steps are shown in Fig. 2 that investigates the block diagram of the proposed algorithm.

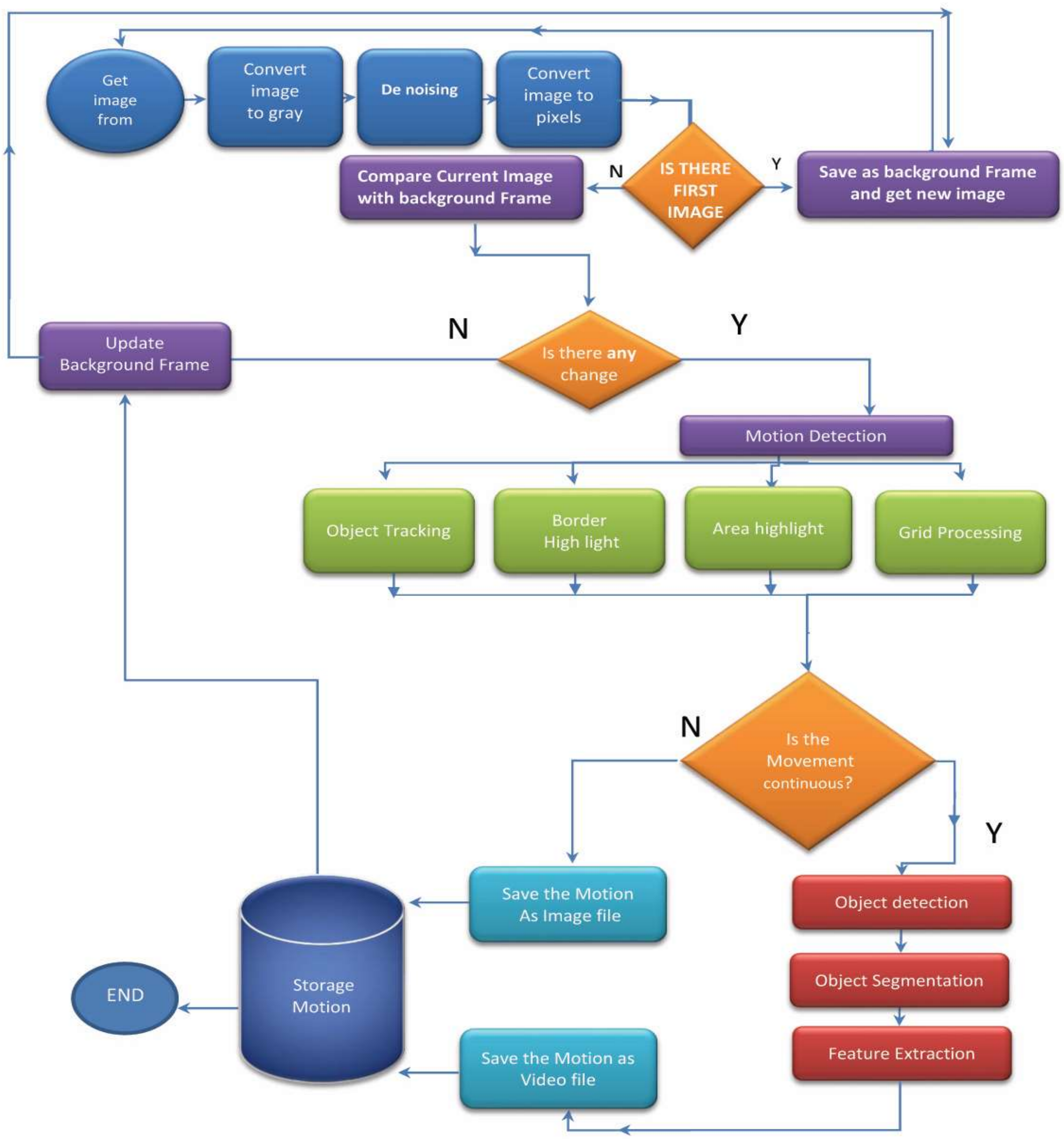

Fig. 2: The block diagram of the proposed algorithm.

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A - Grid processing

B - Border highlight

C- Object Tracking

D- Area highlight

Fig. 3: The four processing methods.

6- THE EXPERIMENTAL RESULTS

By using the proposed method to detect the motion, we record from IP CAM [15] in 15 fps by using a core I7 laptop processor. We detect the motion by four processing techniques at the same time. The output of the step can be categorized image or video file. In Table 3, we compare the four methods with these evaluation matrices, as shown in Fig. 4.

Evaluation matrices [16] are:

- TP (True Positive): The positives images that are detect well the motion.
- FP (False Positive): A test result which wrongly indicates that motion is present in the image.
- FN (False Negative): A test result which wrongly indicates that motion is absent in image.
- TN: (True Negative): Test result is one that does not detect the motion when the motion is absent.

$$\text{Re (Recall)} = \frac{\text{TP}}{(\text{TP} + \text{FN})} \quad (1)$$

$$\text{Sp (Specificity)} = \frac{\text{TN}}{(\text{TN} + \text{FP})} \quad (2)$$

$$\text{FPR (False Positive Rate)} = \frac{\text{FP}}{(\text{FP} + \text{TN})} \quad (3)$$

$$\text{FNR (False Negative Rate)} = \frac{\text{FN}}{(\text{TP} + \text{FN})} \quad (4)$$

$$\text{PWC} = 100 * \frac{(\text{FN} + \text{FP})}{(\text{TP} + \text{FN} + \text{FP} + \text{TN})} \quad (5)$$

$$\text{F-Measure} = \frac{(2 * \frac{\text{TP}}{(\text{TP} + \text{Fp})} * \frac{\text{TP}}{(\text{TP} + \text{FN})})}{(\frac{\text{TP}}{(\text{TP} + \text{Fp})} + \frac{\text{TP}}{(\text{TP} + \text{FN})})} \quad (6)$$

$$\text{Precision} = \frac{TP}{(TP + Fp)} \quad (7)$$

Table 3: The evaluation matrices results.

	FP	FN	FP	TN
Area highlight	16	24	23	10
Object Tracing	13	14	47	7
Grid processing	22	12	41	6
Border high light	30	19	22	10

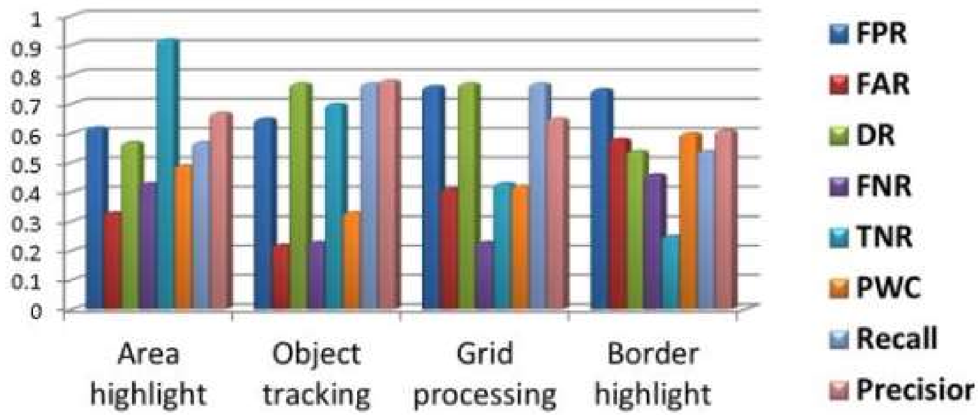

Fig. 4: The comparison with the four methods.

Also, we compare the four processing with the CDW-2014 dataset in change detection First we record the four motion detection video from all category and then we used evaluation **Python code** in the http://changedetection.net/ site. We compare the best-proposed methods with the other related work in changedetection.net [17] site. This site contains the most significant data set CD.net 2014 for video and photo for testing change detection algorithms.

6-1 CDW-2014 Dataset

This dataset contains 11 categories with 4 to 6 folder of videos sequences. In each category each video file (.zip or .7z) Baseline - moving Background – unfixed Camera -Intermittent Object Motion - Shadows - Thermal - Challenging Weather - Low Frame-Rate - Night video - Air Turbulence. Our result uploads to change detection site with the RTMD name method [18] RTMD (real-time motion detection) achieved almost the same ratio on average (Recall, SP, FPR, FNR, and PWC) in comparison with others. We face strategy in average f-measure and precision that gives us a lesser ratio than the others. Researchers' new technique gives a chance to reduce the used time in motion recording. Its fast processing and do not need high hardware.

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Table 4: Our RTMD method result comparing with other methods.

Method name	Average across categories	Average ranking	Average Re	Average SP	Average FPR	Average FNR	Average PWC	Average F-Measure	Average Precision
FgSegNet_v2 [25]	1.36	1.29	0.9891	0.9998	0.0002	0.0109	0.0402	0.9847	0.9823
FgSegNet_S (FPM) [24]	1.91	2.14	0.9896	0.9997	0.0003	0.0104	0.0461	0.9804	0.9751
FgSegNet (FSN) [23]	2.73	2.57	0.9836	0.9998	0.0002	0.0164	0.0559	0.9770	0.9758
BSPVGAN [22]	4.00	4.00	0.9544	0.9990	0.0010	0.0456	0.2272	0.9501	0.9472
BSGAN [21]	5.45	6.00	0.9476	0.9983	0.0017	0.0524	0.3281	0.9339	0.9232
Cascade CNN [20]	7.00	6.43	0.9506	0.9968	0.0032	0.0494	0.4052	0.9209	0.8997
IUTIS-5 [19]	10.45	11.71	0.7849	0.9948	0.0052	0.2151	1.1986	0.7717	0.8087
SemanticBGS [12]	11.82	9.86	0.7890	0.9961	0.0039	0.2110	1.0722	0.7892	0.8305
IUTIS-3 [19]	14.09	14.43	0.7779	0.9940	0.0060	0.2221	1.2985	0.7551	0.7875
DeepBS [6]	14.27	19.71	0.7545	0.9905	0.0095	0.2455	1.9920	0.7458	0.8332
OUR methods RTMD	**5.00**	**5.57**	**0.9492**	**0.9983**	**0.0017**	**0.0508**	**0.3260**	**0.9353**	**0.9245**

We calculate FPR –FAR- DR – FNR – TNR – PWC – Recall-border high light is the best method because it gives a good performance like the heights value of precision, recall, and TP. On the other hand, it provides lower value in FP, TN, FAR, FN rate and PWC in TP.

7- CONCLUSIONS

As a result of this paper, Researchers aimed to present new motion detection architecture and its various approaches; this algorithm is easy in real time motion detection. Compared with other similar motion detection algorithms, the main improvement of the proposed method is that it records from any type of camera thus suitable for use in real-time applications. This technique is an image file or video file if the motion does not contain an object and not continues. The second if the motion sequence contains an object background is needed for the implementation of this method, and it is quite robust to background changes, not accumulating previous mistakes. Tests on the standard datasets also demonstrate that it. In the future work, there are many enhancements possible with this research to add quality and features. Here are some future enhancements possible as below. In addition to previous, researchers will do their best to minimize challenges of motion detection. Put into consideration challenges that effect of motion detection like Shadow of things, Fast objects, Trees moving, Cloud moving, sunlight, Noise of the frame, Snowstorm and Sea waves. This research achieves good performance in some challenges, and Researchers hope to improve the other challenges.

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