Real-Time Motion Detection Framework For Surveillance Cameras

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Abstract— The most important field of computer vision and surveillance system in today's World is Motion detection. It achieves mechanical or electronic methods and plays an essential role in security system .Motion achieved by comparing one frame with another to make a difference from it. The challenges that effect motion detection like fast objects, weather changes etc **.**This paper aims to present a new smart technique which detects moving frames in real-time, it requires only a little memory and computation based on motion detection in video frames Experimental results show that this method can detect the moving objects efficiently and accurately form video recorded from many digital video recording (DVR). The proposed system is Real-time motion detection (RTMD) algorithm used four processing types, and that was the best one objects tracking. Our system saves motion result in images form and video file. Object tracking was the best method as it achieved the least one in the (PWC) percentage of wrong classification Also; we compare it with other related work and give a good performance.

Keywords — Motion detection, background subtraction, Temporal Difference, Optical flow**,** Grid Processing, Area highlight, Object Tracking, Border Highlight**.**

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1 Introduction

Video change detection or Motion detection is an artificial intelligence that means making a smart algorithm to capture a motion from Closed-circuit television (CCTV). Cameras are considered important devices in our lives. They are the perfect solution for keeping safety and personal security. They also save time and effort. So that you can monitor and follow up your company, your factory, office, etc. Through a mobile phone or via the Internet to reduce potential attacks, robberies and be sure of having security all time. In ancient times, surveillance camera depended on 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. Nowadays, other styles provide efficiency as motion detection, face detection, storage large capacity, track, and classify objects from frame sequences [1][2][3].

Hence, the primary aim of designing a CCTV is to continue observation because it records all time with no stop or having rest. There are various technological developments in information technology fields and issues among them security systems devices and methods of recording using modern Digital Video Device, then following up via Internet through mobile devices and smartphones, it was difficult to record what was happening or enable the recording, 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, a unit for recording using DVR and follow-up via the Internet was established. This should be designed according to accurate specifications.

This paper is presented in the following. Section II Related work, Section III the Basic Concepts. In Section IV, the proposed of the framework, which is based on real-time motion detected video storage algorithm for surveillance cameras; part V explains the implementation and the experimental results. , finally Section VI contains the conclusion and our future work.

2 Related Work

These papers overcome recording problems by actual movement of digital video recording devices directlyp at the real time. Using optical flow and background subtraction algorithms technique which is considered the most important discovery in movement compared to their systems. When motion discovered by the natural organism, this is called motion perception or sensing physical organism. Motion measured by change in pixel or vector speed and identifies an object is moving this application used for security intelligent digital video recorder based on motion detection.

Sehairi et al. [4] tested twelve detection methods changes using the CDNET 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 wasn't perfect method than another. Every method they were done gave a good performance in particular case and failed in another. So, they did not provide a definite method. They worked together to find the best method by comparing good results of different methods and avoid the challenges of motion detection

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Martins et al. [5] used a robust and computational method to explain the problem of background subtraction (BS) that based on Gaussian Mixture Model (GMM) background model known as 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 SUB-SENSE considered complex algorithms are combining different approaches. Deal with low-visibility of vehicles was their challenge and their very strong headlights that cause halos and reflections on the street.

Babaee et al. [6] used a new technique depend on learning for background subtraction from video sequence used a deep Convolutional 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 was 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 weight- sample-based method for foreground detection 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 challenging videos. 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 relatively effective samples were increased, and false updating of effective samples with smaller weights was reduced. Also, other strategies such as spatial-diffusion policy and random time subsampling incorporated to confirm the flexibility of the proposed method.

De Gregorio and 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 CwisarDRP with the same setting, their results were supportive in CwisarDRP although it wasn't the perfect one but considered the 10th best method. The method was very simple, so it wasn't good competitor in the CDNET 2014 challenge

Sajid and Cheung [9] supposed multimode background subtraction that system handle multitude of challenges related to video change detection, it make a multiple background models of the scene then measured foreground / background for each pixel, then every image pixel combine with each other 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 in test sequences from the CDnet and the ESI data sets.

As discussed before, there was a limitation in the related work. They used a lot of methods that everyone gave a good performance in particular case and filled in the other. So there was not 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 firstly proposed to replace the most inefficient sample instead of the oldest sample or a random sample, so the weights of relatively effective samples were increased, and false updating of effective samples with smaller weightswas reduced. Also, other strategies such as spatial-diffusion policy and random time subsampling incorporated to confirm the flexibility of the proposed method.

There is not a perfect method till 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 not reflections and define what is moving. Our used program is sensitive to different conditions so give good accuracy in every one of the Moving object.

3 Motion Detection Techniques

3.1 Background subtraction

(BS) save the first image in memory used for detecting moving objects from the difference between the current and a reference frame, Sometimes called foreground detection [10].3.2 Final Stage.

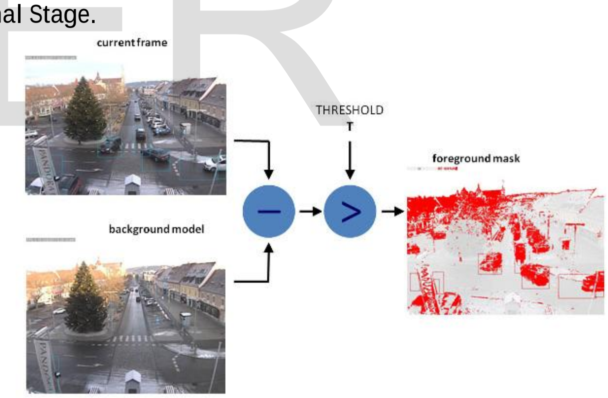

Fig.1: The background subtraction methods.

3.2 Temporal difference

Using consecutive frames (two or three) subtracted to identify moving region Instead of using a fixed reference image, this method can adapt to dynamic scene changes. It fails to detect stopped objects in the scene

(A) The original Frame

(B) The original Frame

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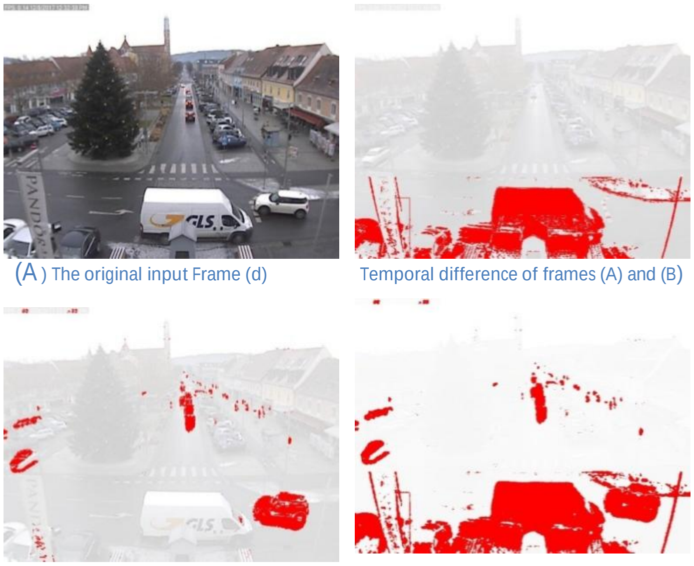


(A) The original input Frame (d) — Temporal difference of frames (A) and (B)

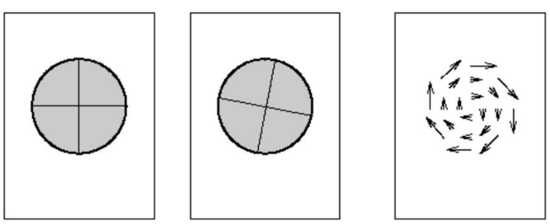
(E) The difference frame (B) and (c) — (F) Detected moving region of the input frame

Fig 2 Temporal difference algorithm

3.3 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 a motions moving static objects, and moving objects or both moving the important part of optical flow that the analysis does not result in motion route instead, more general motion properties are detected that can increase more the reliability of complex dynamic frame analysis. 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 resulting in high cost.

Compute motion within a region or the frame as a whole **[11].**



Optical Flow (a) Time T_1, (b) time T_2 (c) Optical Flow

Fig 3 Optical flow computation

3.4 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 [12]. Finally we make a comparison the four motion detection techniques in table 1

	Background subtraction	Temporal difference	Optical Flow	Temporal Matching
Definition	Detected by comparing the difference between a preset image and the next camera images.	It discovered by analyzing the differences in successive images.	Divide each image up into smaller blocks, and then makes comparisons	Discover the motion by finding the template in 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.	Effectivness. In addition, simple, Requires less computation	Good perfmance	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 object's shape resulting in difficult posterior recognition. It fails to identify stopped objects in the scene.	Very complex- needs more than one image need to be stored. Need higher memory requirements.	Difficulty in identifying in large moving objects

From the previous table, optical flow is the best method for detecting motion. But it needs high memory, and more one image need to store in one second.

4 The Proposed Framework

The importance of framework is making a backup to record motion 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 especial place. This framework is a combination of the optical flow and background subtraction. There are four different processing in our algorithm

- 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.

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- 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 flow the object.
- Area highlight:- its make a shadow to the moving object and flow also it gives the same benefit as border highlight processing.
- Object tracking: - its flow the moving objects and Surrounded by a rectangle.

First, Researchers take the image from the camera and convert it to gray second noising the new image then converts it to pixels. Comparing the background frame with current frame image if there is no change in frames gets a new image and repeat the step. Else go to next step and choose one of the four processing(border highlight, object tracking – grid processing- area highlight) 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 proposed algorithm block diagram show in fig 4

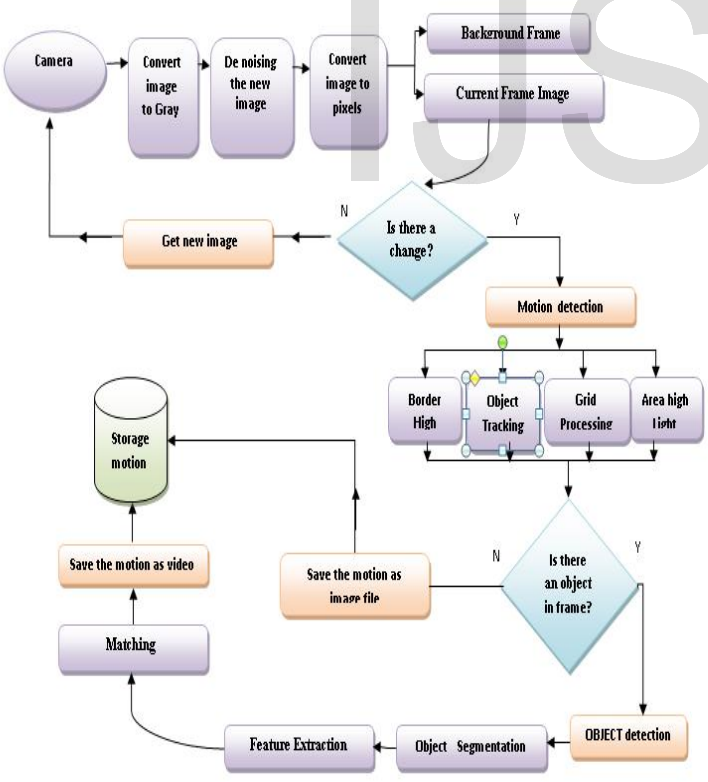

Fig 4 block digram of the propoused algorithm

5 The Experimental Results

By using the proposed method to detect the motion, we record from IP CAM [13] in 35 fps by using a core I3 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 2 we compare the four methods with these evaluation matrices [14]

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 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.

Precision: is the fraction of detected items that are correct

$$\text{Precision} = \frac{TP}{(TP + FP)} \quad (1)$$

Recall is the fraction of items that were correctly detected among all the items that should have been detected.

$$\text{Recall} = \frac{TP}{(TP + FN)} \quad (2)$$

FPR: False Positive Rate: It is a measure of how well the system correctly rejects false positives

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

FNR: False Negative Rate It is a measure of the likelihood that a target will be missed given the total number of actual targets.

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

TNR: a measure of the likelihood of a negative response given the total number of actual negative detections.

$$\text{TNR} = \frac{TN}{(TN + FP)} \quad (5)$$

PWC: (Percentage of Wrong Classifications).

$$\text{pwc} = \frac{(FN + FP)}{(TP + FN + FP + TN)} \times 100 \quad (6)$$

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The F-measure gives an estimate of the accuracy of the system under test

$$F-\text{Measure} = \frac{2\times\text{Precision}\times\text{Recall}}{(\text{Precision} + \text{Recall})} \quad (7)$$

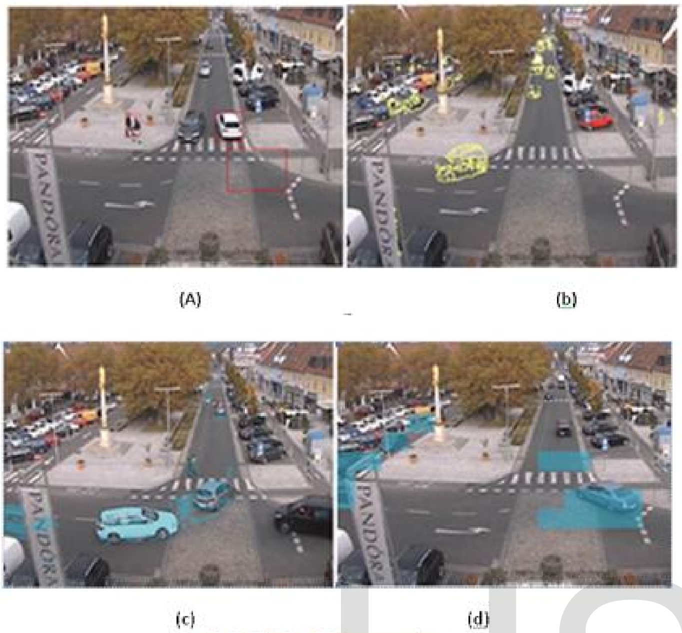

Fig 5 The Four Motion processing.

a) Object tracking: this process algorithm allows count number object the motion frame Researchers can ignore the object with the small frame
b) Border highlight: highlighting only borders of motion areas. It also exactly defines the moving object and its types.
c) Area high light: - this process algorithm used a specified highlight color the motion area.
d) Grid processing: first frame convert to grid –grid convert to cell. Then calculated the level of motion for each cell individually it high light shadow frame.

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

Table 2 results of our simple

	FPR	FAR	DR	FNR	TNR	PWC	Recall	Precision
Area highlight	0.62	0.33	0.57	0.43	0.92	49%	0.57	0.67
Object tracking	0.65	0.22	0.77	0.23	0.7	33%	0.77	0.78
Grid processing	0.76	0.41	0.77	0.23	0.43	42%	0.77	0.65
Border highlight	0.75	0.58	0.54	0.46	0.25	60%	0.54	0.61

Table3 comparison with four methods

In Table 3, we calculate FPR –FAR- DR – FNR – TNR – PWC – Recall-object tracking 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. It also makes a Roc curve & PR curve and DET curve.

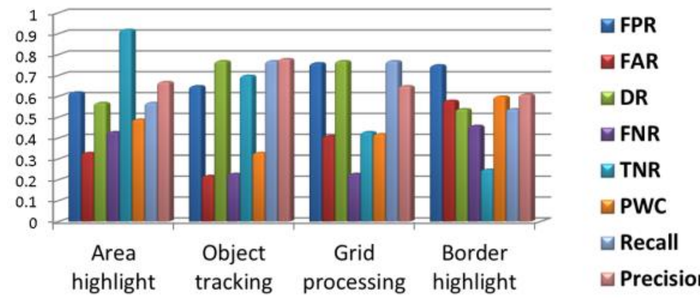

Fig 6 The Four Motion processing comparison Chart.

ROC CURVE is the result of true positive rate (TPR) against the false positive rate (FPR) to the four methods as in fig (7)

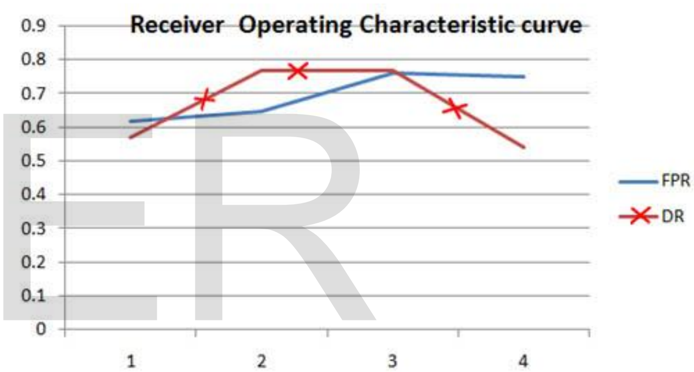

Fig 7 Receiver Operating Characteristic curve

PRECISION –RECALL CURVE Shows the tradeoff between precision and recall for different threshold to the four methods as in fig (8)

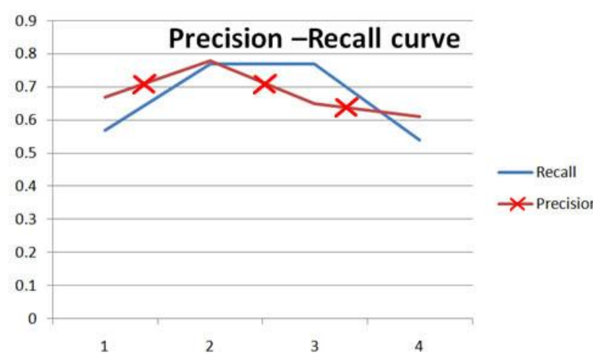

Fig 8 Precision –recall curve

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DETECTION ERROR TRADE-OFF CURVE Planning the false rejection rate vs. false acceptance rate to the four methods as in fig(9)

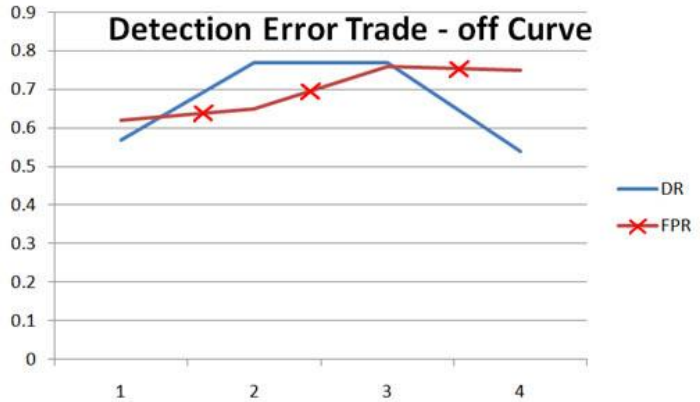

Fig 9 Detection Error Trade-off Curve

In this section, Researchers compare the proposed methods with the other related work in changedetection.net [15] site.This site contains the most significant data set CD.net 2014 for video and photo for testing change detection algorithms. The result is blown chart with the table4.

	Average Recall	Average Sp	Average FPR	Average FNR	Average PWC	Average F-Measure	Average Precision
Cascade CNN	0.9312	0.9993	0.0007	0.0688	0.1911	0.9431	0.9555
DeepBS	0.7517	0.9996	0.0004	0.2483	0.3784	0.8301	0.9677
RTMD	0.6929	0.9862	0.0046	0.3071	0.6323	0.8063	0.9021
DCB	0.2588	0.9984	0.0016	0.7412	1.5795	0.3835	0.8261
Multiscale Spatiol	0.5964	0.9892	0.0108	0.4036	1.6752	0.6371	0.7680

Results, for the bad weather category

Form last table and the last chart, RTMD (real-time motion detection) achieved almost the same ratio in average (recall, Sp, for, fnr, and PWC) in the comparison with other. We face strategy in average f-measure and precision that give us lesser ratio than the others. Researchers' new technique gives chance to reduce the used time in motion recording. Its fast processing and don't need a high hardware configuration.

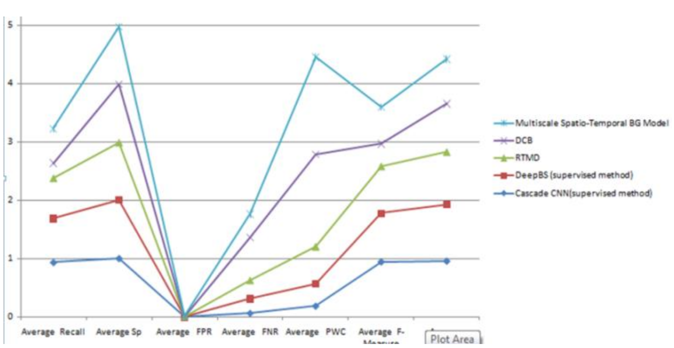

Fig 7 comparing our (RTMD) methods with other work

6 CONCLUSIONS AND FUTURE WORK

In this paper, Researchers aim 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 requires only a little time and memories. Also, it records form any type of camera thus suitable for use in real-time applications. This technique is an image file or video file if the motion doesn't 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 the quality and features. Here are some future enhancements possible as below.

Also, Researchers will do their best to minimize challenges of motion detection. Put into consideration challenge 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 challenge, and Researchers hope to improve the other challenges.

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