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Robust and Sensitive Video Motion Detection for security purpose analysis

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Abstract

Today theft and crimes rates are very high, so there is a significant need to monitor and monitor our property.

Cameras usage was limited to surveillance; nowadays we don't, merely, need to monitor our offices, banks and houses; but we also need to lessen and /or prevent damages; including as theft, and other types of crimes.

Cameras can track pedestrians, monitor traffic and city management, etc. These cameras send the video frames in real time to our system; the latter detects the moving objects within the frame, to decide whether the moving object is a human or not. The research aims to identify the requirements to develop an Anti-theft Camera real-time recorder for personal property surveillance, in addition to try and evaluate the proposed Anti-theft Camera real-time recorder system. Our goal is to discover and analyze the pedestrian (movement), whatever the lighting or camera angle , by analyzing the video then restart an alarm to prevent the thieves all in real time, even though if there are some factors of disruption .In this research we have developed a system to detect a moving objects within the video frame depend on developing subtracting the current image coming from the video frame from the stored reference image (or the previous image coming from the video frame); it is called "motion blocks detection". To lessen to complexity to become more effective in real time We have got relative highly precise results; (after conducting a trial over 50 moving objects within the image). The results approximate the 50 actually detected moving objects in the video. This has been achieved through improving and analyzing images taken from the video frame. We got a high accuracy results relatively, through applying multiple algorithms to detect motion within video frame.

Keywords: Object Detection; Real time Human detection; Real time anti-theft system; surveillance system.

1. Introduction

For many years, cameras have been a quite a useful tool in identifying and bringing to justice those involved in various criminal activities; most notable of which are serious crimes and terrorist attacks. The spread of digital cameras has taken the world by storm. There are many types including fixed cameras, infrared, and those with animation capabilities that capture UV images. They vary in properties and complexity based on their specified usage .Cameras are used to monitor public as well as private places and record images of what takes place in specific locations in real time. Collected images are, then, sent to a monitor and recorded on video tapes or as digital data on a hard drive. The recorded information can be stored and reviewed by those who have access to the recordings. In this technology driven era , cameras play a significant role in protecting the public and assisting the police in the investigation of crimes , protection and recovery of stolen property. Camera systems have evolved over a period of time, as a result of several changes. Cameras and their various applications have greatly become a feature of our daily lives. Generally, people change their attitudes and behaviors if they feel that they are under surveillance. Cameras can be used as a part of visual surveillance technology, that aims at monitoring a variety of places and activities .Now we can see the cameras in public roads and streets for traffic surveillance, in order to avoid accidents and enforce law and order. The objectives of the existence of such cameras are to provide a degree of comfort and safety for common people. The role of the cameras has not been visualized not only to control roads, but also to monitor shops, restaurants and even homes. Primarily they are used to guard against theft through early warning systems, enabling the authorities to catch thieves. The presence of a large number of shops makes it almost impossible to provide enough people to monitor and guard them around the clock, so we need to have an electronic system to cover all these tasks; and also to give warning signal of potential thieves within the monitored area.

The beginnings there were used systems recorded the incoming videos, to be shown again later, But this required a lot of efforts. But we need a deterring policy, so to speak. This has led to devising motion detecting systems that give warning in case of any movement within the room. Still sometimes it gave a lot of false warnings; especially if there is a non-human movement within the monitored area. Human detecting systems have recently been launched to differentiate between human and non-human movement in real time. And that is exactly what our research aims at.

In other words, the goal of the project is to build an intelligent system that collects videos from surveillance cameras in a place. It analyzes the content of videos to pick up any movements in the monitored area, and gives early warning signal about the presence of humans in the vicinity of the place. All of the above must be in a real time; as there is a need for speed of implementation; as the speed of treatment is very important in this case.

Mounted camera monitors the room, the camera is connected to a computer; and the user adjusts the work mode of the camera. I fit worked in a warning Alarm Mode, and when there is a movement in the room, this movement is detected using multiple algorithms for this purpose, called Motion Detection. Then the camera stores the moving for the body on the hard drive.

It may also detect motion at the starting the movement; then the computer may give a special sound alarm, based on the choice of the user.

2. Main ideas (included within article)

We'll examine some of the research conducted to detect the movement, some of which rely on optical flow for the movement of objects; while others have developed some techniques to detect motion depending on a change on the edges of the body.

And finally others have been adopted to subtract the current image from the reference image; i.e. the original.

We have developed the last one to make it fit the real-time, with regard to the speed of implementation. We have got a high success rate as far as detecting moving objects for the video clip in a real time is concerned.

3. Previous Literature Review

As mentioned above, the research is divided into two parts; the first is the discovery the movement, and the second is distinguish human bodies from other objects to pursuit the latter subsequently.

Many researches have been conducted in both areas; we find first the research on the discovery of movement, including what was presented by the researchers in [1], the researchers have developed a model to pursue the objects ,depending on (*optical flow*)

The Optical flow [5] of a body is defined as the pattern of movement of the body or the change of the position of the edges of the body, giving the impression of relative movement to the outside observer (the human eye or the camera).

The optical flow can be found by solving a set of partial differential equations resulting from the movement of each pixel between two consecutive moments; the results achieved by the results in [1] have been good. The only problem with this method is the relative high performance time, as a result of the calculations of the optical flow. Researchers have depicted their model in [2] in order to detect the location of the moving bodies, depending on background subtraction [6].

The method depends on subtracting each pixel of the first image taken at the moment t, together with the pixel of the subsequent image taken at the moment t+1. The method has many advantages; the most important of which is speedy performance compared with what we have previously mentioned. Still, it is not sensitive to noise and lighting, that might lead at times, to create *foreground pixel false*, resulting from difference in lighting or the noise resulting from the video itself, between one frame and another.

As for detecting human bodies, many researches have been conducted about detecting human bodies, including what is submitted by researchers in [3]. They offered a model using different training samples. Then such samples have been classified using *Support Vector Machine (SVM)* [7]. It classifies offered samples to return a number of these types, as the looked-for object might be one of them. Then the types that have got the highest number of votes are further classified using a new application, that is used to choose the best one among the selected objects.

Tests' results have shown a high percentage of success of identifying objects. Still, problems encountered in the last research were the relative high implementation time, as a result of classifying many models; in addition to the need for a large number of training samples, to be trained regularly.

As for [4] researchers submitted their models in real-time, relying on *Average of Synthetic Filters (ASDR)* [9]. This is among the fast algorithms in implementation time; it depends on conducting some mathematical processes over the object to be compared with previously stored models. Based on such calculations it can know whether the object is identical to one of such models.

The problem is that it is greatly sensitive to lighting and disruption , and also used filter *ASEF*, is not efficient enough on changing the angle of the camera view, and its inability to handle several moving objects simultaneously and in different sizes in the same image and at the same time.

We can conclude from the above that detecting movement based on optical flow is good, but it suffers from a relatively high implementation time. The background subtraction method has partially solved the problem; still it suffered from the false objects detected as moving objects. We will try, through our research, to solve the problem of the high implementation to fit the real-time and to limit the number of false objects detected as moving objects.

4. Methodology

Our anticipated system handles received video frame, then it processes them in real time. The smart system is built over following several stages:

- Processing and converting incoming videos into images, to be processed consequentially; i.e. showing every image over a period of time.
- Applying certain techniques to remove disruption and noise of processed imaged.
- The system can store new received images even if it has not finished processing older images.
- Using some filters to improve and make images more suitable for the next step.
- Removing the background and focusing on moving objects of the images only.
- Chasing and storing moving objects (we rely on detection algorithms; such as the blob).
- Eliciting a set of features from moving objects; then such features are separately studied, to decide which one is to extracted as the more important ones.
- Depending on extracted features of each object, the system determines the type and identity of captured objects. (At this stage a SIFT logarithm may be developed to extract key points and of required objects to be studied and identified).
- If the captured objects are human, then the system runs an optical or acoustic warning against a potential theft, As shown in(see Figure1).
- Each stage several methods are adopted, and they will be analyzed at each stage, and compare algorithms used with such methods to decide on the best method to use. In other words we aim at discovering and analyzing the movements of human beings, irrespective of the lighting or the camera angle, even in the presence of some disruption factors.

▪ Firstly, we need a camera attached to a computer with an average performance. Cameras will transmit images for specific area to the device (wired or wireless).

▪ Building an intelligent system which is capable to receive videos from surveillance cameras and that store ,process in a real time

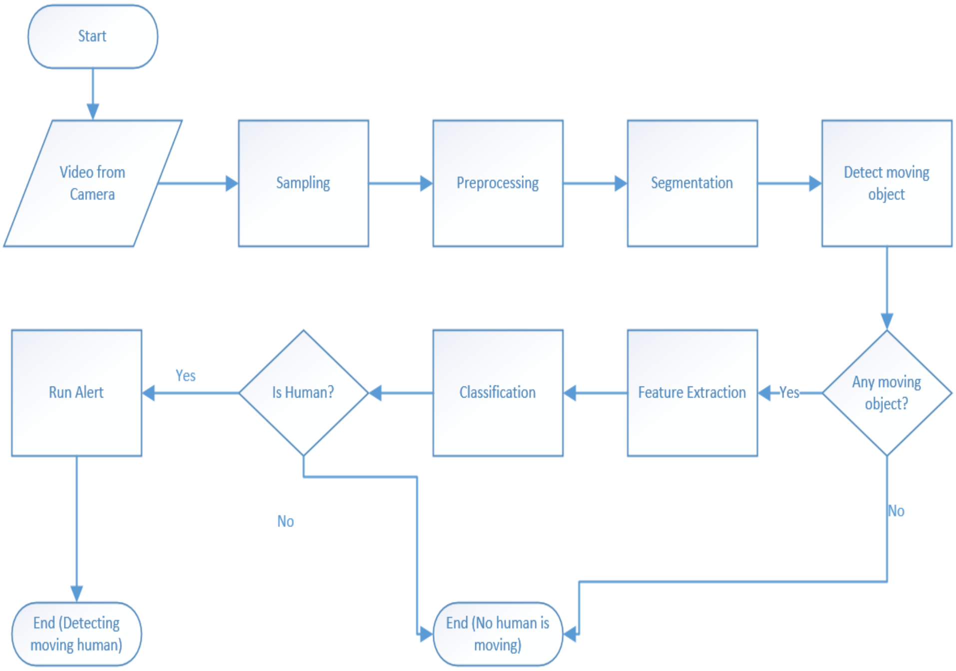

Fig:1 Shows the methodology of work

5. Implementing Plan & Initial Results

There are a number of existing algorithms for detecting movement, we will try to develop a new algorithm to improve the method of motion detection.

Project Stages**:**

- Sampling: Samples are taken from the analog signal, during equal periods, and fixed frequency is called frequency sampling Fs.
- Image Processing: Image processing system consists of successive stages as flowing

1- Image Acquisition: the process of capturing the image; and it is performed by the optical sensor; that is a camera in this case.

2- Preprocessing: A set of operations that prepare the data to be analyzed later on, and to correct errors in geometric manner or another, The techniques are used in this phase varies according to the nature of the extracted data from processed Image. Operations used in the optimization related with the type of data which we want to deal, and the purpose of analyzing the image. The operations that have been applied are (Fourier transformations, filtration, improve the contrast in the image).

3- Segmentation: Dividing the image into elements; the input of which is an image, while the output is the important elements of the image**.**

4- Features Extraction: that is the phase in which we are getting important data from the image; then classifying each pixel in the appropriate object. Where was extracted hallmarks of images, and which are the underpin the project.

5.1. Motion Detection Algorithms

All motion detection algorithms that were used depend primarily on converting the image from RGB pattern or any other colorful pattern to gray, then these algorithms compare the gray frames with each other, through these comparisons the motion and movable objects are detected. The used algorithms are different from each other in the mechanism of comparison, and with the nature of comparing frames with each other; in the following we will clarify the mechanism of these algorithms.

5.2. Continuous Frames Comparison Algorithm:

Algorithm is based on comparing the successive frames only; that is , merely, comparing executed current with previous frame

The stages of this algorithm are as follows:

1-Converting the current frame and the next frame to the gray type.

2-Comparing pixel peer to peer for the first frame with the corresponding pixel in the second frame.

3- If the result of a comparison between two pixels - in absolute value - was smaller than the difference threshold , we consider there is no movement in this pixel (fixed pixel) and make the pixel value in the Current Frame equal to zero.

4-If the result of comparison was greater than the threshold value, we will store 255 in the pixel of current frame , then store the value of this pixel in the corresponding pixel for the previous frame.

5-We count all pixels in the current frame which got a value of 255, and store their numbers in parameter which is called Pixels Changed.

6-We will paint red the all pixels which have a value of 255,to distinguish animated areas form others.

7-Calculating the rate of motion level; motion Level=pixels changed / frame size.

8-Through this value we can do some control operations on the program.

9-Motion level expresses the amount of motion in the current image within video clip.

5.3. Motion Blocks Detection

In order to develop past algorithms, we have adopted a principle of reducing the complexity, resulting from comparing processes of all pixels on the image, and later on assigning processes. In order to reduce above complexities, we divided the image (the current frame) and the reference frame (the previous frame) to a definite number of blocks. For example, we divide both frames into two states only: still blocks and motion blocks. We can define the state of the block through studying a few numbers of pixels, instead of studying all pixels within the same block. Positions of such pixels are carefully selected to correctly reflect the state of the block. If all of these pixels are fixed without changes, then we consider this block as a still (fixed block), we do not bother with studying other pixels within the block.

On the other hand, if all selected pixels within the block are motion pixels, then we consider the block as a motion block, and then we study all the pixels within the block to define the number of moving pixels within this block.

All that we do then is to adjust the reference frame only, at the pixels within the motion blocks.

The main advantage of this development is to largely lessen the complexity; especially with the cases that do not show a great change in motion; such as the night monitoring operations.; as the complexity is greatly lessened to a percentage that might reach 60% if we applied this algorithm .

6. Analyzing the Results

A trial over 50 moving bodies has been conducted on the video frame, to see the effect of a parameter called Diff Threshold. It is used to decide the degree of difference between each image of a frame compared the previous one in the same frame, or merely to compare it to the average previous images (we have changed the value of the parameter from 0 to 200, to define the optimal values for such a parameter, then we can notice the effect of such a parameter on the detected- objects in the video frame). (see Table 1 , figure 2).

Table 1. Values of Parameter Diff Threshold &impact

DiffThreshold	Number of detected objects
0	Most of the image
3	212 object detected
5	153 object detected
7	103 object detected
9	76 object detected
10	68 object detected
12	57 object detected
13	51 object detected
15	50 object detected
17	49 object detected
25	36 object detected
50	24 object detected
100	11 object detected
150	1object detected
<150	0object detected

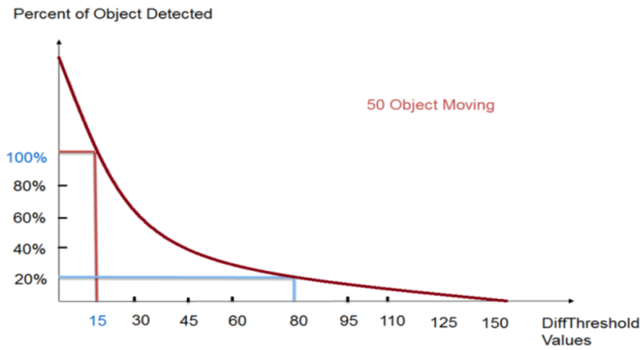

Fig 2: The Relation Between the Percentage of the detected Objects Against the Value of the Parameter

The horizontal axis represents the value of the studied parameters, while the vertical axis represents the percentage of the detected objects, compared to the total number of objects. We notice from the graph that when the value of the parameter exceeds 150, the number of detected moving objects is nearly 0.thenhigher values than 150 approximately no moving object can be detected. It is also worthy of note, that when the value of the parameter is closer to 0, the number of moving objects to be detected is greater than the actual moving objects, i.e. it starts to detect still objects mistaking them for moving objects, that is called *Positive Error.* When the parameter value is 0, the number of detected objects the greatest, then the curve starts to get down, until the number of detected objects approximates the number of actual moving objects, then the percentage detected objects becomes almost 100% of the actual moving objects.

At which case the parameter falls between 12-18. Then the graphic curve goes down again to make the actual moving objects to be detected less than the actual moving objects. We have started to come up with what is called *the False Negative Error.* After that, the value of the parameter increases above 80 where the number of the detected moving objects becomes about 20% of the actual moving objects; then the value of parameter increases until it approximates 150 the number of detected objects becomes almost nil. We have studied the effects of another parameter**;** so we have conducted a trial on the same previous samples (50 moving objects within a video clip) to test the degree of the effect of another parameter, called *Threshold Neg.* Sometimes it becomes difficult to distinguish or detect the moving objects in normal color images; due to the differences in their color thresholds, resulting from the disruption in the image. Hence we do not study the movement in images resulting from only segmenting the video. We can only reflect the colors in a video clip, through taking the complimenting color to make it a white image. Then the black color becomes white and vice versa. Such parameter is used to determine the degree of differences between every image of a video clip, with the previous image, but after inverting the colors of both images (or comparing them with the average of previously inverted images).We have changed this parameter as of -200 to 200 to define the optimal values of it. We notice the effect of this parameter on the number of detected objects in the video clip.(see table 2,figure 3)

Table 2. Values of Parameter Neg Threshold & impact

Neg Threshold	Number of detected objects
0	Most of the image
-5	145 object detected
-7	98 object detected
-9	77 object detected
-10	64 object detected
-12	53 object detected
-13	50 object detected
-15	50 object detected
-17	48 object detected
-25	37 object detected
-50	27 object detected
-100	17 object detected
-150	2object detected
>-150	0object detected

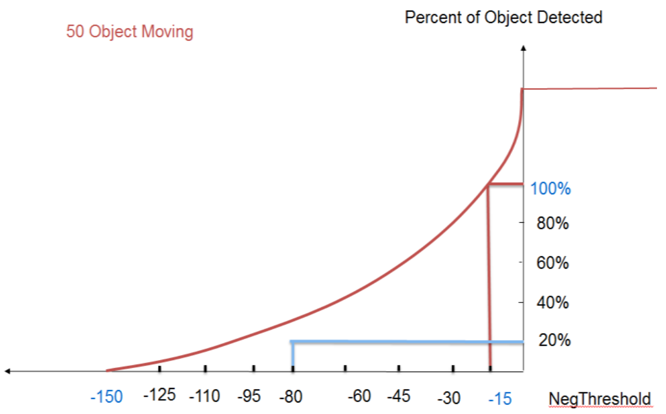

Figure 3: Shows the Relation Between the Percentage of the detected objects and the Value of the Neg- Threshold Parameter

The horizontal axis represents the value of the studied parameter, while the vertical axis represents the percentage of the detected objects, compared to the total number of objects. We notice from the graph that when the value of the parameter decreases to -150, the number of detected moving objects is nearly 0.Below this value (-150) approximately no moving object can be detected. It is also worthy of note, that when the value of the parameter is more than 0, the number of moving objects to be detected is greater than the actual detected objects; that is some fixed objects are detected as moving objects: which is called *A False Positive Error.*

When the value of the parameter is equal 0, the number of detected objects will be the greatest. When the value decreases to less than to 0 , the curve goes down to until number of detected objects becomes the same actual moving objects; in which case the percentage of detecting moving objects will be almost 100% of the number of actual moving objects, in this case the value of the parameter is going to be between -12 to -18.Then the curve goes down again to show that the number of detected moving objects is lesser than the actual moving objects. In other words we have started to get what is called *A False Negative Error.* Thus, when the parameter decreases below -80 approximately, what we get is equal to

20% of the actual moving objects; so when the value of the parameter becomes almost -150, then the number of moving objects the parameter detected becomes almost nil. When tow parameters work together (See table 3)

Table 3.Valuesof parameter Neg Threshold & Diff Threshold & both impact

NegThreshold	DiffThreshold	Number of detected objects
0	0	Most of the image
-5	3	145 object detected
-7	5	98 object detected
-9	7	77 object detected
-10	9	64 object detected
-12	10	53 object detected
-13	12	57 object detected
-15	13	51 object detected
-17	15	50 object detected
-25	17	49 object detected
-50	25	36 object detected
-100	50	20 object detected
-140	100	5 object detected
-145	150	1object detected
>-150	<150	0object detected

7. Future Horizons

After tracking and storing moving objects in an image, we can extract some of the features of the moving objects; then the features turn into a classifier to compare such features with previously classified features, that express the movement of human beings. In such a case if the detected object is a human being an audio or a visual system is to be activated to warn against some theft.

8. Conclusion

Based upon the importance of the protection against theft, we have seen the preliminary results of the study.

we have devised a new system to detect moving bodies within the video frame " into motion blocks detection ". We adopted the method of improving subtracting every pixel of the incoming current image from a comparable previous image. Thus we could alleviate the complexity resulting from the comparing operations. It has become more effective in real time. We could achieve relative precise results, (a trial was done on 50 moving objects within an image); the results were nearly realistic. The study handles detection of movement in real-time, and the degree of the effect of our parameters.

Then we have chosen and compared the our optimal algorithms. We hope that we can detect the movements of human beings over other living creatures (animals or birds) as precisely as possible, to successfully a warning of the presence of a human being in the vicinity of property.

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