

The Use of Motion Detection in Real-Time Video Surveillance

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Abstract-

As things stand now, security is a major issue. With the global rise in armed battles, unlawful immigration, and terrorism over the past decade, it is more important than ever to ensure the safety of limited areas like boundaries and buffer zones. Currently, such regions are monitored using a combination of technology and human labor, but automated tracking has been making strides to eliminate the possibility of human mistake

I. INTRODUCTION

When the video cassette became widely available, the prevalence of video surveillance skyrocketed. This is because video-cassette recording allows the surveillance to be saved on film, which can then be used as proof if necessary. Because of this, sleuthing is simplified, accelerated, and improved greatly. A camera, TV, and video recorder made up a full analog video monitoring setup. In contrast to the traditional tube camera, which could only record during the day, and the VCR, which could only record for up to eight hours at a time, this device has its own limitations. This shortcoming meant that not long after the video-surveillance system was introduced to the market, its proprietors and workers would become lax and stop changing the cassettes daily or the tapes would wear out after being used for a month. In 1990, the Charge Coupled Device (CCD) was developed, which utilized microprocessor computer technology to solve this issue. When the technology used

in this new system, digital multiplexing units, became accessible to the public, it sparked a change in the security camera market by making simultaneous recording possible with a large number of cameras.

The widespread adoption of the DVR can be attributed to three main causes. As such,

1. The development of better encoding methods has made it possible to hold more data on a hard disk.
2. The price of hard drives has dropped significantly in recent years.
3. Increases in hard drives' storing capacities have been phenomenal in recent years.

With the advent of cheap digital recording thanks to the development of computers, digital video monitoring made perfect sense. The user can save time by recording a month's worth of video on a hard

disk instead of swapping cassettes every day. The idea behind the Normalized Cross Correlation (NCC) method is to identify the degree to which two successive frames in a picture series share a common pattern of variation. The primary function of correlation is to determine the degree of resemblance between two images. The Normalized cross correlation number is highest when the two sequential pictures are identical. In that situation, we don't pick up any motion. Assume now that there is a moving object in the series of images, which means that the locations of the pixel values in the two successive frames are not identical. In that situation, the Normalized cross correlation number is lower than the highest possible value. The identification of moving objects in a picture series relies on the principle of normalized cross correlation. This document uses the following structure. In the preceding lines, we provided a cursory overview of the monitoring setup. In Section 2, the features of this system are outlined, and in Sections 3 and 4, task specifications and motion recognition in real-time video streams are discussed. In Section 5, we see an illustration of motion detection using normalized cross correlation (NCC). In Section 6, we see an illustration of motion detection using the Sum of Absolute Difference (SAD) algorithm. In Section 7, we see an illustration of how to implement the motion detection algorithm in MATLAB. The conclusion follows the presentation of the results and comments in Section 8.

II. SYSTEM FUNCTIONALITY

A. Previous Work

When it comes to contemporary information gathering tools for moving situations, motion recognition is one of the most crucial topics. This article builds on the work of Asif Ansari and Dr. T.C.Manjunath

[2], who created a motion recognition method using frame difference; this technique is described in detail by Jain R. and Nagel. H in [3]. Zhao Yanling, li Na, and Wu Hummin [5] describe a thresholding technique for motion detection, which is used to determine whether or not motion has been observed. There are a number of motion recognition methods available, such as the normalized cross correlation algorithm developed by Mrs. Madhuri et al. [7] and the backdrop removal technique developed by Deepa Rajang and Chang Eng. Song[6].

B. System Overview

The system has three primary features: data capture, data comparison, and data storage and monitoring. A simplified diagram of this system's design is provided below.

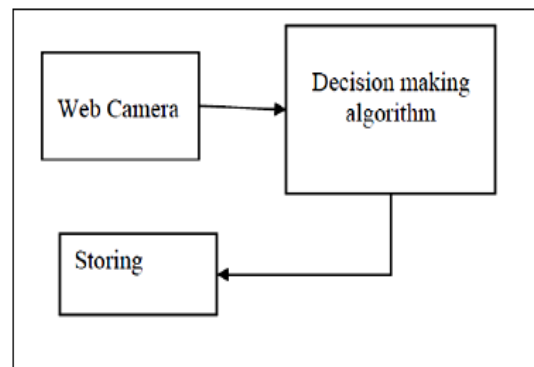


Figure 1: The System's Primitive Structure

C. System Architecture Functioning

This is how the design of the system is currently operating:

Using a webcam to record the live feed: The first stage in motion detection is gathering live video frames of the area under observation. This is typically accomplished with a web cam, which constantly gives a series of video frames at a constant frame rate (FPS). (Frames per second). Using a frame-by-frame comparison of recent and archived images to identify motion: The

webcam provides pictures in real time that can be compared with one another to look for differences that indicate the presence of motion and thus allow for the prediction of its occurrence. The pictures are saved to memory if motion is recognized. We need to save motion that is recognized so that the viewer can watch it at a later time. The person can also use this as evidence in court against anyone who tries to accuse them of wrongdoing.

III. WORK SPECIFICATION

Language of Code: We have used the powerful programming software MATLAB 7.7 to create a monitoring system. Selection Criteria: Since MATLAB has built-in Image Acquisition and Image Processing Toolboxes, we were able to use it to create our project's GUI and code. The method involves acquiring and analyzing real-time data from a video input object in order to determine if there is any motion between two consecutive picture frames. Videos have the moving object marked and any changes in the picture stream are displayed in a MATLAB figure frame.

IV. MOTION DETECTION IN LIVE VIDEO STREAM

There are many various fields that could benefit from the ability to detect differences in picture frames of the same subject taken at different periods. One such essential application that calls for dependable scene change recognition is video monitoring. People's expectations for the security of their possessions will increase as they learn more about the threats they face. The new digital camera systems must implement additional layers of safety. They should make the consumers happy and make it much more likely that those who attempt to cheat the system will be found. Therefore, the modern digital video surveillance systems ought to ensure a high level of

safety. Only if the owner knows he will be notified immediately of any attempted crimes on his land will he be able to rest easy. He would feel safer if he knew that the video system, he installed would do more than just record footage for use in court; it should also actively deter crimes.

V. MOTION DETECTION USING NORMALIZED CROSS CORRELATION (NCC)

Detection of Movement Similarity between two pictures can be evaluated with the help of the Two-Dimensional Cross Correlation Method. Features can be recognized and registered with its help. It can be shown that the expression for the normalized cross correlation [7] (1).

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right) \left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \dots\dots(1)$$

Normalized with regard to both pictures, r is always in the range $[-1, 1]$. Here, A and B represent the average pixel value in photos A and B , respectively. A method is suggested here for identifying a series of images that contains a moving object. Each of four sub-frames from a picture series is subjected to Normalized Cross Correlation (NCC) [7]. Based on the dissimilarity between the two linked variables, this procedure generates four values between -1 and 1 .

VI. MOTION DETECTION USING SUM OF ABSOLUTE DIFFERENCE (SAD)

This program takes advantage of image-difference methods. Subtracting the current frame from its predecessor generates a difference picture, the absolute value of which is summed and then compared to a predetermined cutoff. If the disparity is

larger than a certain level, it means that something is moving between the frames of the video [10]. The following expression can be used to describe it numerically.

$$D(t) = \frac{1}{N} \sum |I(t_i) - I(t_j)|$$

N represents the picture at a given instant in time, t represents the image at $t+1$, and r represents the standardized total of absolute difference at r . When there is no motion, the formula reads as follows:

$$I(t_i) = I(t_j)$$

A superior model of the pictures without motion will be 0 (tad), but noise is always present in images.

$$I(t_i) = I(t_j) + n(p)$$

VI. IMPLEMENTATION OF MOTION DETECTION ALGORITHM

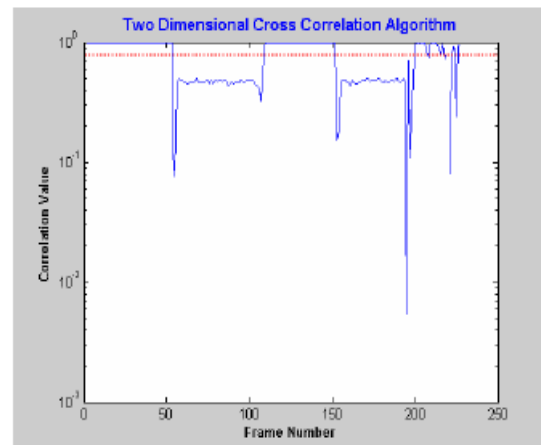
On top of the previously viewed pictures, a motion recognition method was implemented. There were two main ways that the motion recognition method was implemented. Two-dimensional cross-correlation was used in the first method, and the sum-absolute-difference technique was used in the second. The following two parts provide elaborate explanations of these.

A.Two-Dimensional Cross Correlation for Motion Detection

- To begin, each of the two pictures was split into quarters. This was done so that smaller differences in the picture could be more easily detected by the computation.
- To do this, we computed a two-dimensional cross correlation between each sub-picture and its matching region in the other image. Based on the dissimilarity between

the two linked pictures, one of four numbers from -1 to 1 is generated.

- The accuracy of this technique was improved by setting the cutoff at the lowest possible association value.
- In most situations, the lowest cross correlation number can be used as a criterion to identify motion with relative ease. On the other hand, recognition fails when there are worldwide changes in the picture, such as when the lighting changes or the camera shifts.



Threshold values for direct correlation are shown in Figure 2.

The preceding graphic depicts a test scenario with a series of on-off light manipulations. There is a high connection between frames 1-50 and 100-145 when the lights are on, and a low correlation between frames 51-99 and 146-190 when the lights are off. When the lights are turned off, motion can still be detected constantly if the cutoff is set to a number of 0.95. The issue could not be fixed without constant re-estimation of the cutoff number. Using an adjustable filter to achieve this is possible, though its implementation can be challenging. One alternative is to examine the data collection that results from the cross

correlation procedure and search for movement based on its variation. Using this technique, we were able to avoid having to constantly adjust the lighting and camera angles.

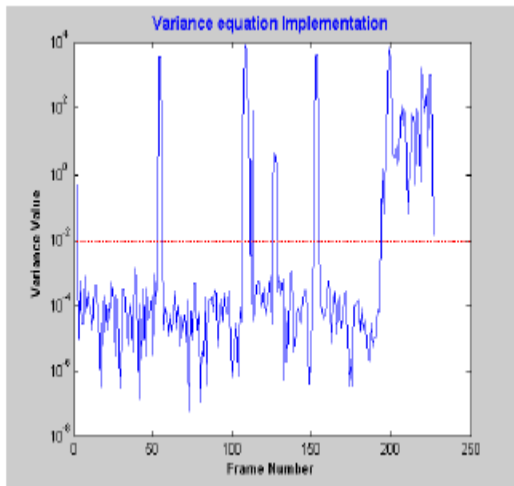


Figure 3 Variance Values as Reference for Threshold

Above figure shows the variance signal calculated from the same set of images. It can be seen that the need for continuously re-estimate the threshold value is eliminated. Choosing a threshold of 1×10^{-2} will detect the times when only the lights are switched on and off. This results into a robust motion detection algorithm with high sensitivity of detection

B. Motion Detection Using Sum of Absolute Difference (SAD)

Matlab's user interface makes it possible to specify which instructions will be executed at runtime. After the user has set up the video feed, the program can begin processing the data. The method was developed to capitalize on Matlab's greatest strength—the ability to hold information in the shape of matrices. Therefore, the pixel values are stored in the workspace as a grid where each element of the matrix

corresponds to a single pixel value. The frames acquired are stored as a matrix in the Matlab directory, and each element of the matrix contains information about the pixel value of the image at a particular location. Matlab is able to analyze and handle picture data much more quickly than other programs because it treats matrices as a single, unified collection of values rather than a collection of smaller ones. As a result, the program compares the overall values of the currently-being-captured frame to those of the previously-captured frame, looking for any discrepancies. The user establishes a cutoff point, or benchmark, against which the disparity in numbers is measured. The video feed is said to contain motion if the disparity is larger than the set benchmark.

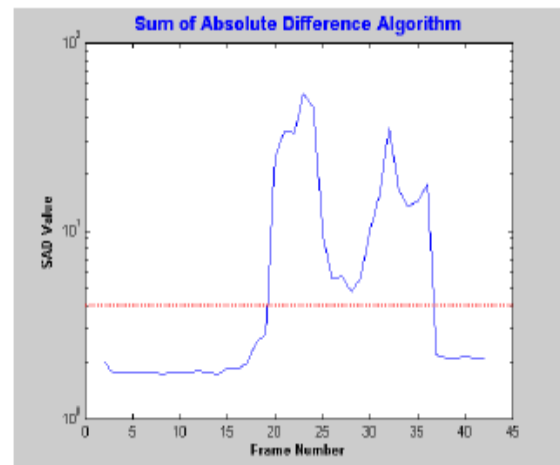


Figure 4: SAD Values with Direct Thresholds

The camera was moved to create the scenario depicted in the previous figure, which features a significant shift in the scene being recorded. The SAD value averaged about 1.87 seconds before the camera was relocated, and about 2.2 seconds afterward. Once the camera stops moving, if the criterion is set to a number of less than 2.2, it will continue to identify

motion. The same approach used to fix the association method will be used to fix this issue. Figure 5 below displays the outcome of computing the variation value after gathering two SAD values for the same test instance.

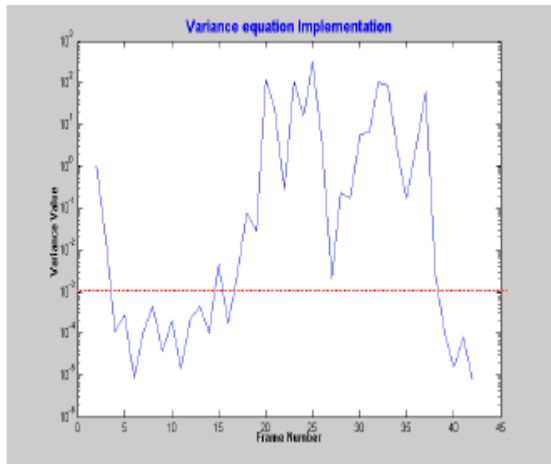


Figure 5: Threshold Values Based on Variance

The need to regularly recalculate the barrier is eliminated with this method. By setting the cutoff to 1×10^{-3} , you can see when it's just the camera that's shifted. The end product is a motion recognition system that is immune to fluctuations in lighting and camera position.

C. Graphical User Interface Design

MATLAB's GUI development environment (GUIDE) is a useful resource for developers [11]. The user interface was made to be user-friendly in terms of interactivity. The graphical user interface can be used to configure the software, run it, halt it, and show the output. The user is encouraged to pick a motion recognition method and sensitivity level during the setting phase. Toggle between launching the system and calling the chosen application to conduct the

computations by pressing the start/stop icon. Once the calculations are complete, access will be returned to the GUI. The outputs are log file, video, and frame number vs. variation value plots. The stages involved in using the GUI are depicted graphically in Figure.

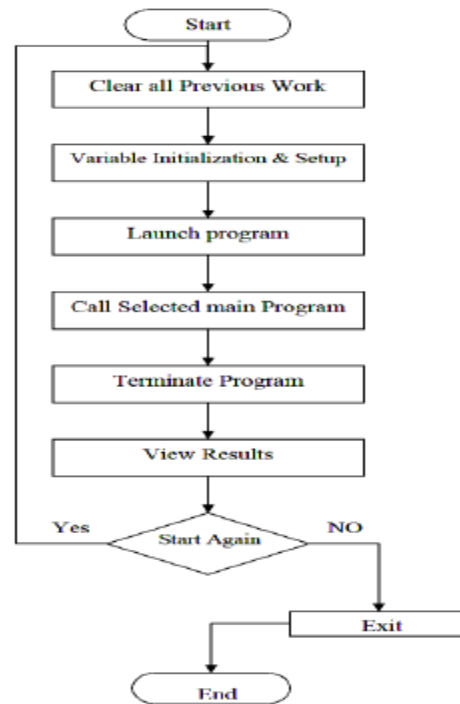
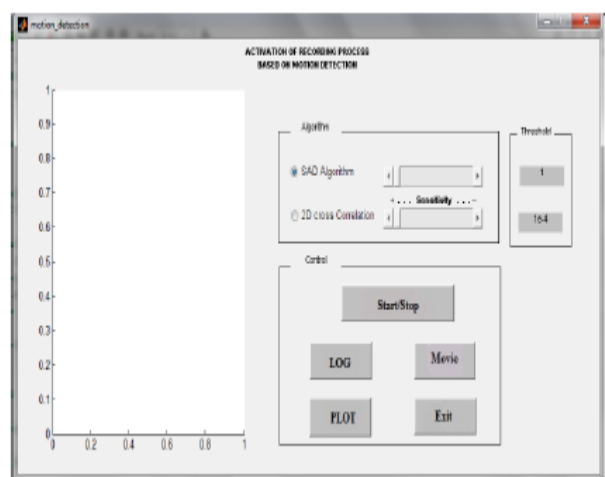


Figure 6 GUI flow Chart



7: Sample User Interface Layout

MATLAB GUI Builder was used to create the graphical user interface depicted in the figure. Two selection buttons, two scales, two fixed text fields, four push buttons, and a control switch make up the form. Input validation was implemented with sliders and choice buttons.

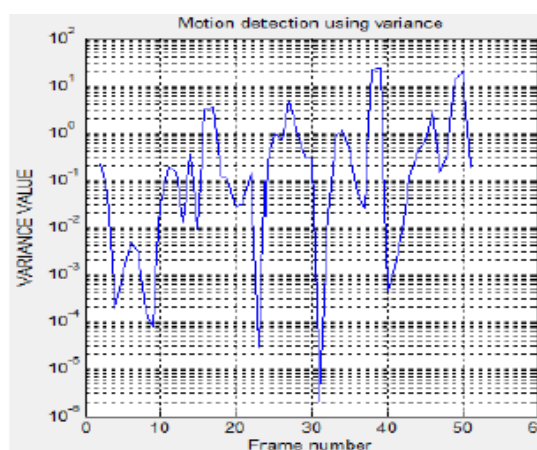
You can select the SAD algorithm or the 2D cross correlation method using the radio keys. Neither method can be chosen alongside the other. The recognition intensity can be adjusted with sliders; for the most sensitive detection, move the adjuster all the way to the left. The immediate value of the barrier is displayed in the stationary writing. When the Start/Stop button is pressed for the first time, it sets a marker with a value of 1, and then it checks the state of the radio buttons to see if it should start the default application or not. When you click the log file button, a file will appear that details the time and date of movements along with the frame number. When you click the "Exit" option, MATLAB is completely stopped. Whenever the show movie button is pressed, MATLAB reads the previously-created film structure from the hard drive, converts it into a movie, and plays it back at a frame rate of 5 frames per second. The completed video will be stored to storage with the extension [film.avi]. Clicking the final option, the display plot symbol, imports the variance values for plotting against the frame number.

VIII. RESULTS AND DISCUSSION

MATLAB software running on Windows has been used to evaluate and execute all of these methods. MATLAB 7.7 was used for the writing. This program was set up to receive live stream footage from a webcam. Video at a resolution of 320x240 pixels can be stored at a rate of 5 to 7 frames per second on this device. Sum of Absolute

Difference (SAD) method with a value of 0.01 was chosen for software verification.

Figure 8 displays the video series we evaluated as a scatter histogram of variance values versus frame number. The cutoff, represented by the dashed line in the image, (0.01 in this case) Only frames with a variation value greater than the cutoff line are kept in memory, as these are the frames in which motion has been observed.



Motion activity graph with threshold=0.01 shown in Figure 8.

```

1  MOTION WAS DETECTED AT 12-Jul-2011 12:27:34
2  in frame number 00002
3  MOTION WAS DETECTED AT 12-Jul-2011 12:27:34
4  in frame number 00003
5  MOTION WAS DETECTED AT 12-Jul-2011 12:27:35
6  in frame number 00010
7  MOTION WAS DETECTED AT 12-Jul-2011 12:27:35
8  in frame number 00011
9  MOTION WAS DETECTED AT 12-Jul-2011 12:27:35
10 in frame number 00012
11 MOTION WAS DETECTED AT 12-Jul-2011 12:27:35
12 in frame number 00013
13 MOTION WAS DETECTED AT 12-Jul-2011 12:27:35
14 in frame number 00014
15 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
16 in frame number 00016
17 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
18 in frame number 00017
19 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
20 in frame number 00018
21 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
22 in frame number 00019
23 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
24 in frame number 00020
25 MOTION WAS DETECTED AT 12-Jul-2011 12:27:36
26 in frame number 00021

```

Figure 9: Activity graph with a cutoff of 0.01

Above, you can see the log file of the evaluated video frames, which includes information about the time and date of

movements along with the frame number acquired by clicking the log file symbol.

IX. CONCLUSION

Partitioning Normalized Cross correlation and Sum of Absolute Difference (SAD) are two algorithms suggested for identifying moving objects in a video frame. These algorithms' primary benefit is that only minimal pre-processing of picture sequence frames is necessary. The programs work well in a wide variety of lighting situations. The program improves performance even when illumination is low. This study therefore effectively created a camera surveillance and recognition system. With its primary focus on facilitating effective monitoring, this system stands to greatly benefit any individual or group that employs it. This concludes the effective implementation of a motion-based change detector for the avi video codec.

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