Feature Detection Extracted for Video Tracking Based on the Histogram of the Oriented Gradient HOG Technique[1]

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ABSTRACT

Video tracking systems face many natural and industrial challenges when tracking objects in intelligent surveillance systems, which are complicated by the speed of movement of objects and their change in terms of location and angle and are affected by many factors such as weather conditions, lighting, and the path of the moving object to be tracked. In our research, to detect, we apply many pre-processing stages such as implementation or choosing the background by static background image, optimization, and object segmentation (splitting and cropping) on an object and optimizing its appearance, after that the object is converted to a fixed size (128×64). It uses the application Histogram of Oriented Gradient (HOG) algorithm to determine properties, and their use in discrimination, comparison, and other operations**.**

INTRODUCTION

There are many challenges in the process of tracking objects in monitoring systems, which are complicated by the speed of movement of objects and their change in terms of location and angle as well as affected by many factors such as weather conditions, illumination, object tracking, and others. Critical issues in establishing any tracking system depend on detecting or recognizing features of object extraction [1].

First, it chooses the appropriate pre-processing operations to extract the object trace and chooses the appropriate technology to generate the scene background template of the scene to distinguish the moving objects in each frame of the fixed parts; secondly, extracting crops from the binary image by cropping the area with segmentation technique; third, use the zoom method to convert the cropped image to a fixed size (64×128) pixels; fourth a mathematical model of swine was applied to extract the features; fifth, save the vector extraction features in the database or compare to select the object [2].

RELATED WORK

Lately several researches have been done for utilize the static or cumulative histogram mechanism for constructing a template of background for this scene [Israa and Adil, 3], in [M. Kachouane and et al, 4] Introducing a real-time algorithm for detecting and recognizing human, from images captured by a CCD camera fixed on a car-such moving robot depend on HOG algorithm and SVM classifier. In [Mahale, Pravin and Ashokm, 5] suggest how to detect Image asymmetry by HOG method that helps us identify the block that manipulates the images, in [Seyed Hesamoddin Hosseini, 6] for the purpose of evaluation, using two categories of square geometries, which are divided into grids of square or rectangular spatial cells, and circular blocks divided into pole-shaped cells: (square "R-HOG" and circular block "C-HOG").

PROPOSED METHOD

For the purpose of finding its properties, we determine the background of the movie by static background image of the place before the presence of the moving object and then extract the moving object using the subtraction method,

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and then convert the image to a fixed size (128 * 64) and apply the HOG algorithm to determine properties and their use in discrimination, comparison, and other operations. The proposed method consists of six main units:

1. Pre-processing: (conversion, enhancement, implementation background model by static background and convert to binary image).
2. Segmentation: (Crop image of the object) according to region growing method.
3. Zooming: Crop image zoom to fixed size (64×128) Pixels.
4. Applied HOG algorithm.
5. Taking average HOGs features for all frames.
6. Saving features in a database or compare with the resolution.

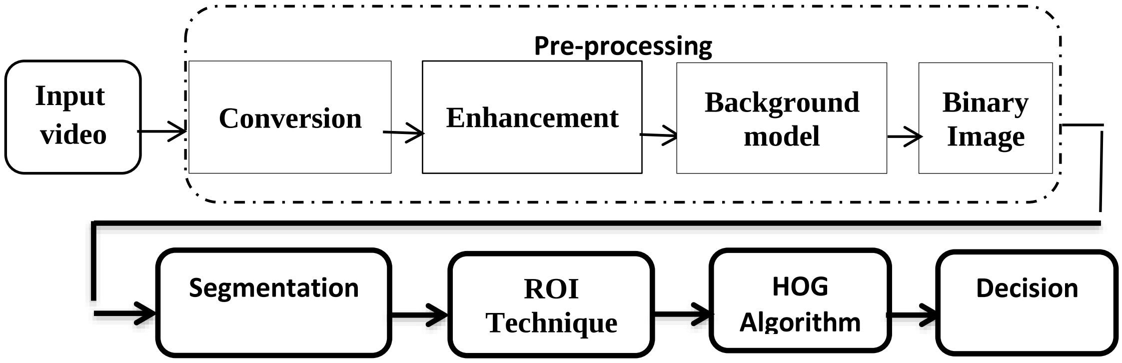

Figure (1): The main diagram of the proposed method.

Pre-processing

It is consisting of fourth stages below:-

a. **Conversion technique:** Converts the true color of a digital image to gray scale image by the RGB mode of the luminance component ($Y_{Comp.}$) in the form below:

$Y = 0.299\ Red_{comp.} + 0.587\ Green_{comp.} + 0.114\ Blue_{comp.}$ …….(1)

b. **Enhancement technique:-** Uses median filter model to remove noise from digital image.

c. **Background Model (Static background):** It is taking the sense without any object movie and uses subtraction model to around and constraint the object [1].

d. **Binary Technology:** Through the threshold technique for the gray transformation of the digital image into an image (B/W).

Segmentation technique

It contains the division of the frame into a meaningful set and a set of homogeneous regions, uses a practical area cropping technique, and starts with a set of seed points, which aggregate pixels or sub-regions, into larger regions. The best case for a growing region consists of (selection, growing, similarity, and minimum area threshold connected with the minimum region size in pixels).

Region-of-Interest Image Geometry (ROI)

Through the cropping process, select the ROI area in the image from the previous step, and then apply the zoom method to an area of 64 × 128.

HOG Algorithm

It is described as a feature that is often used to extract features from the image data and is similar to the Canny filter in edge detection or Scale invariant and feature transform (SIFT). It is widely used in computer vision tasks to detect objects and count pig features for the number of gradient direction event descriptors in the local part of the image. Focuses on the shape or structure of an object and relies on the direction and magnitude of the gradient to calculate the features, i.e., the image is divided into smaller blocks and the 'localized' parts are calculated. Creates a histogram of all regions separately. To implement the algorithm, you need five steps which are given below:

1. **Data Pre-processing (64×128)**: The image pre-processing step is very important to prepare the image for the best features for selecting an object, Choosing an aspect ratio of 2:1 and image size (64 × 128) suitable for image extraction feature, along with the extracting features that divide the image (64×128) to blocks (8×8) or (16×16).
2. **Calculating Gradients (direction x and y):** the next step determines the gradient of each pixel in the cropped digital image.
3. **Calculate the Magnitude and Orientation:**

G_X = PixelValue(X+1, Y) – PixelValue(X-1,Y)……………..(4)

G_Y = PixelValue(X, Y+1) – PixelValue(X,Y-1)……………..(5)

Calculates the magnitude and orientation of each pixel value:

$Total\ Gradient\ (magnitude) = \sqrt{G_X^2 + G_Y^2}$………..(6)

$Angle\ (Orientation)\ \theta = \ tan^{-1}\left(\frac{\Delta Y}{\Delta X}\right)$……………..(7)

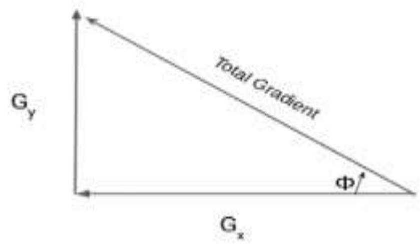

Figure (2): Graph the magnitude and orientation of each pixel.

Calculate Histogram of Gradients in 8×8 cells (9×1).

A histogram is a chart showing the frequency distribution of data that used four methods to calculate it as shown below:

- **Method 1:** It depends on the value of orientation of each pixel and adds to the frequency table.
- **Method 2:** After calculating the orientation such as in method 1, the resulting values for the bins and their frequency distribution are stored in nine bins.
- **Method 3:** This method is based on the amount of gradient instead of frequency bins.
- **Method 4:** It is closer to method 3, the value gradient is distributed on both sides, and the higher value is distributed to the value of the buckets of the direction closest to the container.

HOG feature vectors

Combine the histogram into a 1-D matrix. So, the feature vectors size per block is 4×9=36

V = [a_1, a_2,a_3,…….a_{34}, a_{35}, a_{36}]………………..(8)

Therefore, the final HOG feature vectors will be: 7 × 15 × 36 = 3780

Normalize gradients in 16×16 cell (36×1).

Image gradations are sensitive to lighting, and hence need to be normalized to reduce luminance contrast. From equation (9) below, calculate the gradient normalization (K).

$K = \sqrt{(a1)^2 + (a2)^2 + \cdots \ldots \ldots + (a35)^2 + (a36)^2} \ldots \ldots \ldots \ldots \ldots (9)$

$Normalized\ Vector = \left[\frac{a1}{K} + \frac{a2}{K} + \cdots \ldots .. + \frac{a35}{K} + \frac{a36}{K}\right]$…………(10)

RESULT AND DISCUSSION

There are many challenges in the process of tracking objects in surveillance systems, which are held by the speed and change of objects in terms of location and angle, as well as affected by many factors such as weather, lighting, moving object, and others. The aim of this research is to select the best features to increase detection rate and reduce processing time. How the HOG algorithm works can be illustrated in the example below (Albert *Einstein* image):

Data Pre-processing (64 × 128):

Original HOG (64×128) Crop 8×8

Figure (3): Segment stage data preprocessing.

91	**91**	**91**	**91**	**82**	**82**	**73**	**82**
91	**82**	**82**	**82**	**82**	**73**	**73**	**0**
91	**82**	**82**	**0**	**0**	**82**	**73**	**73**
91	**91**	**91**	**85**	**0**	**82**	**73**	**73**
91	**91**	**81**	**82**	**73**	**82**	**82**	**82**
155	**155**	**155**	**91**	**91**	**91**	**91**	**91**
155	**155**	**155**	**91**	**91**	**155**	**155**	**155**
91	**155**	**91**	**91**	**155**	**155**	**155**	**155**

Calculating Gradients (direction x and y): by applying equations 4 and 5 then gradients are the simple adjustment in the direction of the (x, y) axis that highlights the pixel value 82, which results in the direction of the (x, y) axis for that pixel, the gradual ranges in the direction control X axis 81 - 73 = 8, for example, applying the mask [-1, 0, 1], the gradient control in the direction of the Y axis 91- 85 = 6 is applied to mask $\begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$, take the absolute value if the result is negative.

Calculate the Magnitude and Orientation: by applying equations (6 and 7) then

$$Total\ Gradient\ (magnitude) = \sqrt{G_X^2 + G_Y^2} = \sqrt{8^2 + 6^2} = 10$$

$$Angle\ (Orientation)\ \theta = tan^{-1}\left(\frac{\Delta Y}{\Delta X}\right) = tan^{-1}\left(\frac{6}{8}\right) = 36.87^{\circ}$$

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Segment Data of image			△X	△Y	Mag	Angle
91	**91**	**91**				
91	**82**	**82**	9	9	12.72	45
91	**82**	**82**	9	-9	12.72	45
91	**91**	**91**	0	-9	9	90
91	**91**	**81**	10	-64	64.77	81
155	**155**	**155**	0	-64	64	90
155	**155**	**155**	0	0	0	90
91	**155**	**91**				

(a) (b) (c) (d)

Figure (4): (a)True color image, (b) Gray image, (c) Enhancement image, (d) Gradient Image .

Calculate Histogram of Gradients in 8×8 cells (9×1):

- **Method 1:** The orientation of pixel value (82) is 36.87° then round to 37° and added to the angle table.

45	**0**	**0**	**84**	**0**	**0**
45	**6**	**2**	**45**	**7**	**0**
0	**9**	**42**	**88**	**0**	**45**
81	**82**	**37**	**0**	**45**	**0**
0	**49**	**8**	**0**	**9**	**0**
0	**45**	**0**	**45**	**45**	**10**

The table below shows the number of occurrences of angles in this segment of the digital image.

Frequency	1	1	1	1	1	1	1	8	1	[illegible]	1	1	1			
Angles	2	6	7	8	9	37	42	45	49	81	82	84	88	…	179	180

- **Method 2:** The distribution of frequency data from nine bins is as shown in the table below:

Magnitude	5	1	10	0	4	0	0	0	0
Bins	0	20	40	60	80	100	120	140	160

In Whole image

Frequency	12220	11241	14787	9585	3581	4233	4465	3729	3743
Bins	0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-180

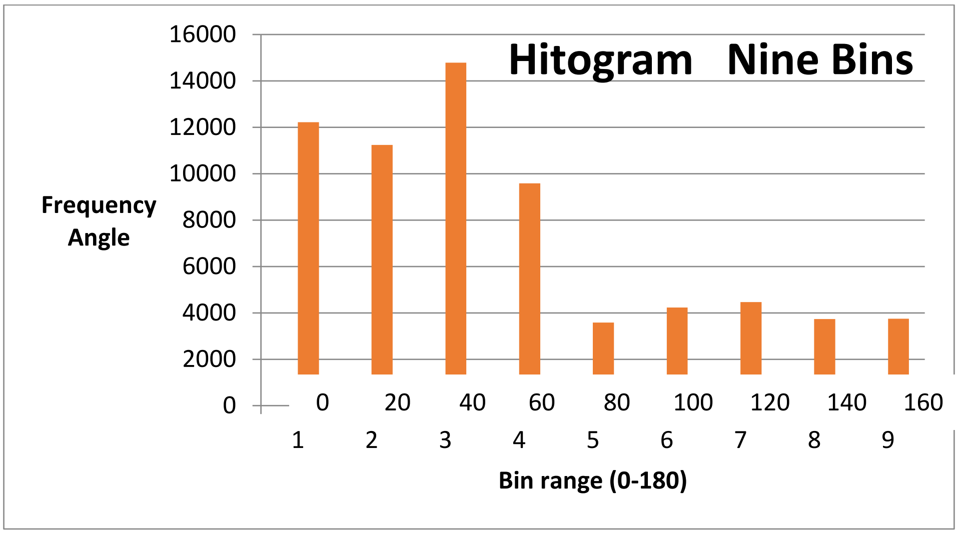

Figure (5): Histogram account of nine bins of **(**Albert *Einstein*) image**.**

- **Method 3:** The distribution of frequency data from nine bins but depend on magnitude is as shown in the table below:

Magnitude = 10, Orientation= 36.87									
Magnitude		10							
Bin	0	20	40	60	80	100	120	140	160

- **Method 4:** The value gradation is distributed on both sides shown in the table below:

Magnitude = 10, Orientation= 36.87									
Magnitude		[(40-36.87)/20]*10	[(36.87-20)/20]*10						
Bin	0	20	40	60	80	100	120	140	160

HOG feature vectors

Applying equation (8) to each block (8 * 8) with an image size of (128 * 64), which is shown in the image below, and obtaining 3780 HOG feature vectors.

Figure(6): The image is divided into blocks (8×8).

Normalize gradients

After applying equations (9 and 10), calculate the normalization value (K) for the image test K= 23500 and then determine the normalization vector is

Frequency	12220	11241	14787	9585	3581	4233	4465	3729	3743
K	23500								
Normalize	0.52	0.48	0.63	0.41	0.15	0.18	0.19	0.16	0.16
Bins	0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-180

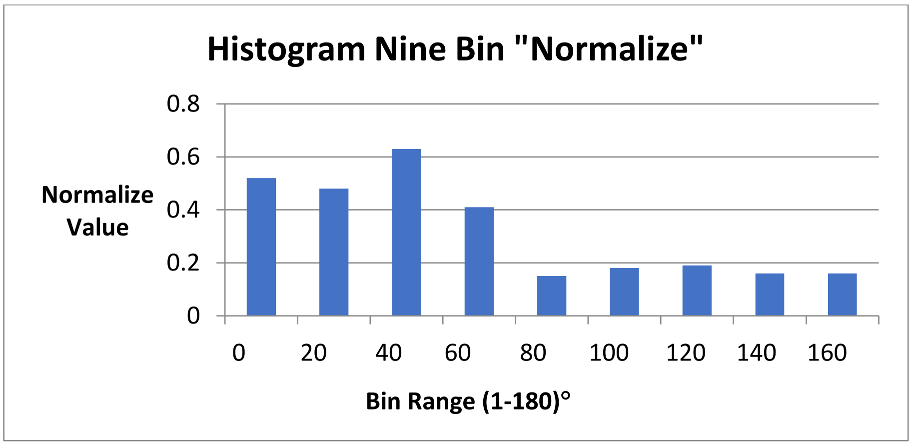

Figure (7): Histogram normalized from nine bins (Albert *Einstein* image).

CONCLUSION

The systems of detecting the movement of the objects adopted in its construction are characterized by the HOG algorithm quickly due to the dependence of the algorithm on the change in the object (x, y) as well as the angular change in it. One of the advantages of the pig algorithm is the ability to combine it with other algorithms, especially in the field of building this technology and integrating it into complex tasks or robots. The algorithm is to summarize the image modification into a fixed dimension, then divide the image into a number of fixed dimension blocks, and then calculate and combine the features for each block to find the histogram of each image and use it to train and test the motion of the object.

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