Crowd Counting From Digital Image Based on Statistical Method

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Abstract: In this paper, face detection based on statistical method has been implemented to get accurately estimation to the crowd counting from an individual image. Random sample is used as statistical method to the estimation purpose. Once the image is given, Viola – Jones algorithm is implemented on the image and it give the number of faces on that image, then simple random sample is choose according to predefined condition which is the value of the last bounding rectangle box that surrounding the face on that image. The results show that proposed statistical method gives good result about (98%) by estimating the nearest true number of the crowd people than the standard face detection(Viola-Jones) technique when it used alone which give about 90% detection rate.

Keywords: Face Detection, Statistical Method, Viola–Jones, Simple Random Sample.

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1. Introduction

Crowd counting from image or video has become an important application of computer vision task .Since it is interested in wide number of application such as public rallies and sport safety, traffic monitoring, adverting human resource schedule for purpose of reliable observation, crowd control and public safety.

The Viola-Jones detection is used as detection method to obtain the number of faces from the input image, in crowd image ,Voila – Jones expose to miss detection of a number of faces, the reasons of miss detection because of high density of the crowd image and sensitivity to the light and condition of frontal face pose, hence this detection algorithm is not useful when it used alone so statistical sample method has been proposed in this paper[1].

The benefit of proposing statistical sample method is that, any crowd image can be used rather than particular image in specific data set, one condition is that, all face images must be frontal, and the dimension of the given image (Width,Hieght) is required.

2. Historical Background

Many methods have been illustrated for crowd counting, object detection have been used for Low-Density crowd while for High-Density crowds more consideration have been taken to the feature-based method. Earlier Antoni B.Chan and Nuno Vasconcelos in 2009 produced an modification to the standard possion regression model in a Bayesian setting via adding a Gaussian prior for the weights of the linear log-mean function. Closed form approximation has been proposed for the Bayesian inference, many contributions with respect to (Bayesian Poisson Regression) BPR are considered, closed form approximation has been derived for the predictive distribution to the BPR, then kernelized the predictive distribution by executed the representation of non-linear log-mean functions by kernel functions, lastly approximate marginal likelihood function has been derived to the optimizing the hyper parameters for the kernel function[2]. More recently J.Xing et.al in 2011 illustrate a new stand point for crowd counting is produce to break the restrictions that recommended detector to count people in crowd the detection flow it is proposed as the counting representative method. The detection flow,

which is concerned as a collection of temporal detection return in video sequence, is created by a head-shoulder detector by an effective flow guided scanning and a pair –wise association approach. A straightforward counting model which help produce both the miss flow false flow problem is used to efficiency count the people on the generated flows method [1]. More recently Bo Liu and Nuno Vasconcelos in 2015 illustrate a model adaptation method for the Gaussian process, the adaptation of the Gaussian process for the reason of its ability to account for non-linarites crowd counting and at the same time its support for transfer learning via model adaptation. This method leverages the Bayesian formula of Gaussian process. This leverages contribute the supports of the interpretation for the source model as a prior which make the adaptation dataset as a collection of observations, then the two components has been combined to make predictive distribution which captures the input information in both adaption data and the source data[3]. Ankan Bansal and K. S.Venkatesh in 2015 develop an effective texture-based method to solve the problem of counting the number of people in extremely dense crowds. Their goal is to arrive to a method that works well for dense crowds but at the same time is robust to variations in density. Dense crowds can be thought of as a texture and this texture corresponds to a harmonic pattern at fine scales. The results gained from using this model are very promising and the model is extremely simple, it can be used for real time counting in critical regions such as pilgrimage sites and other regions that considered a danger of stampedes [4].

3. Viola-Jones Face Detector

A widely used algorithm for object detection Viola-Jones detection method has been used to count the number of faces in image, It has been developed in 2001 by Paul Viola and Michael Jones, ,inspite it can be used to detect different object type, it was motivated specially to the problem of face detection [5,6].

There are many characteristics make Viola-Jones a good detection algorithm such as , robust according to very high detection rate, real time for almost applications at least (2 frame per second processed), face detection recognize face from non-face ,in the other side it requires full view frontal face and the face must point towards the camera [6]. It has four stages [6]:-

1. Haar Feature Selection-all human faces has the same properties, a few considered common to the most human faces as shown in Figure (1) below:

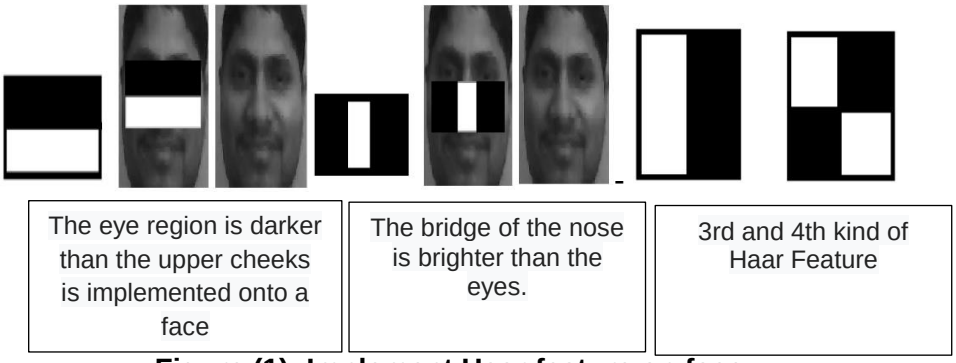

Figure (1): Implement Haar feature on face

2. Making an integral image-image representation named as integral image evaluates rectangular features in *constant* time constraint, that gives them the speed advantage compared with the more sophisticated alternative features.

3. Adaboost training- an algorithm that employs for the reason of constructs a powerful classifier by made a linear combination of weighted simple less powerful classifiers.

4. Cascading classifiers- in cascading steps, every stage contain a strong classifier, so all the features are joined into several stages where every stage has certain number of features, the duty of each stage is to decide whether a given sub-window is considered not a face or may be considered a face. A definitely sub-window is as soon as discarded if it fails in any of the stages to recognize the face.

4. Statistical Method

In this work the drawback of Viola - Jones algorithm has been oven covered by use statistical sampling method depend on two major features, the dimension of image and the sample to be choose. Sampling has been proposed to get more accurate result to the crowd counting; there are two types of sampling:

4.1 Probability Sampling

It is a sample in which each unit in the population has a chance (greater than zero) of being chosen, probability sampling considered the most accurate type of sampling[7] .

There are many types of probability sampling which are [8]:

Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling, Multi Stage Sampling.

From all type list above it has been found that the simple random is more suitable to the proposed algorithm, because every member of population have an equal chance of selection. It is the simplest type that produce defensible estimate of population and sampling method.

4.1.1 Simple Random Sampling

Is a fundamental type of sampling, also it can be a component of other more complicated sampling methods. The base of simple random sampling is that each object has the same probability of being chosen. Every individual has been chosen randomly and completely by chance, such as each individual has the same probability of being chosen at any stage during the sampling operation[7].For the proposed system the simple random sample has been choosing by select the value of the last bounding rectangle box that surrounding the face on that image which gives accurate estimation for counting the all faces on that image.

4.2 Non Probability sampling

It is any sampling method in which some elements of the population has no chance of being chosen, or also can be considered as the probability of selection can't be accurately determined. It include the selection of elements based on supposition concerning to the population of interest. There are many types of no probability sampling which are [8]:

Convenience sampling, Quota sampling, Purposive sampling.

5. Proposed Algorithm

A statistical method (Simple Random Sample) has been combined with the detection method (Viola-Jones) to construct the proposed system, below an explanation of the main steps of the proposed algorithm:

5.1 Detection Step

The proposed algorithm employ Viola – Jones face detection method in order to detect the face .The main steps of this method is:

1-Implement the Viola-Jones algorithm to detect faces in the image.

2- When the determination of face guaranteed, draw a bounding box on it and start the count process.

3- Obtain the image dimension (Width, Height) that later has been used for the statistical method.

4- Obtain the number of faces on image, because of this number always not precise in case of crowd image ,the needed of proposed method is require, statistical method is used as proposed method.

5.2 Improvement Using Statistical Method Steps

Since the number of faces estimated by Viola-Jones method not always gives a precise estimation in case of crowd image, a statistical method for number of face estimation has been proposed.

Simple Random Sampling used as statistical method that it considered powerful tools that added precise result to the count in crowd cases. The use of it in the proposed system explained by the following proposed steps:

1. The sample chosen randomly in the image, there is no consideration to the location may be the chosen sample in the center or in the right or left of image also it may be between that, the condition proposed to this case is by using the value of the size of the last bounding box that obtained from (5.1 The Detection Steps step 2).
2. Divide the width of image by the value of the random sample.

Div1= W/Sample Value (2)

3. Divided the height of image by the value of the random sample.

Div2= H/Sample Value (3)

4. Multiply the result from step 2 by the result from step 3.

Result= Div1× Div2 (4)

5. Output the estimation count number of the crowd people on image represented by the number that gained by step 4.

5.3 Proposed crowd counting algorithm using proposed statistical method

In this algorithm Simple Random Sample is use through select the size of last bounding box which surrounding the face randomly depend on Viola-Jones algorithm and then obtain the dimension of the image and predict the number of faces in the image using estimation principle.

Input: Image (jpg,Bitmap,Tif,…..) Output: Image with message box show the estimation number of crowd people.

Start
Step1: Read the Image.
Step2: Convert Image from RGB to Gray color.
Step3: Implement Voila-Jones Detection algorithm.
Step4: For i=1 To number of faces in the Image.
Step5: Draw Rectangle Box for each face.
Step6: Obtain Image Dimension (Width, Height).
Step7: Get The size of the last face Rectangle Box.
Step8: End for.
Step9: Return Image with message Box show crowd count.
Step10: Implement Equation (2) //Divided the result obtained from step 7 by the Width of the Image obtain from step 6.
Step11: Implement Equation (3) //Divided the result obtained from step 7 by the Height of the Image obtain from step 6.
Step12: Implement Equation (4) //Multiply the result from step 10 by the result from step 11.

Step 13: Return Image with message box show the crowd counting using the statistical method.
End

6. Experimental Results

In this section, experimental results for crowd counting by aids of proposed statistical method has been explained. Different images from the Google engine has been used, the benefit from that eliminate the need to choice an image with condition restricted by Viola-Jones method such as the image must be frontal face, toward camera, not titled only there is one condition to gain best result, the images that has been chosen has the same zooming (all nearest or all far).The more accurate results was to the images with only head show, figure(2) show the implementation of the proposed system by using four images as shown figure(2):

Test image **Detection by Viola-Jones algorithm** **Estimation by the proposed algorithm**

Figure (2): The Detection by Viola-Jones algorithm and estimation by the proposed statistical algorithm of four test Images.

The ground truth of the number of faces in the images, the miss detection and the number which gained by using the proposed algorithm has been shown in table (1) as below:-

Table (1): Number of detected faces by Viola-Jones and by the proposed system.

Image	Ground Truth	Voila-Jones Method		Accuracy Ratio	Proposed Method		Accuracy Ratio
		Number of Detected faces	Number of Miss Detected		Number of Detected faces	Number of Miss Detected	
1	29	27	2	0.93	28	1	0.96
2	24	23	1	0.95	24	0	1
3	14	10	7	0.71	14	0	1
4	17	11	6	0.64	16	1	0.94

7. Conclusions

Based on the experiment results, the statistical method by using simple random samples give a good results suited for crowd counting with the support of Viola – Jones detection method. Accurate estimation result gained due to the selection of the last size value of rectangle box that bounding the face in the image and by using the dimension of the image, the proposed equations which has been used in the proposed algorithm gives a powerful impact to estimate the number of faces in the given image.

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حساب العدد لحشد من الاشخاص في الصورة الرقمية بالاعتماد على الطرق الاحصائية

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المستخلص : في هذا البحث، يتم الكشف عن الوجه باستخدام طريقة إحصائية تم تنفيذها للحصول على تقدير دقيق لحساب عدد الوجوه لحشد من الاشخاص في الصورة الرقمية. تستخدم العينة العشوائية كطريقة إحصائية لغرض التقدير، وبمجرد أن يتم إعطاء الصورة، يتم تنفيذ خوارزمية فيولا - جونز على الصورة التي تعطي عدد الوجوه على تلك الصورة، ثم العينة العشوائية البسيطة هي الاختيار وفقا لحالة محددة مسبقا وهي حجم المستطيل الأخير الذي يحيط بالوجه على تلك الصورة. وتظهر النتيجة أن الطريقة الإحصائية المقترحة تعطي نتيجة جيدة بحدود (98%) من خلال تقدير أقرب عدد صحيح لحشد من الاشخاص من تقنية الكشف عن الوجه باستخدام الطرق التقليدية كـ (فيولا جونز)عندما تستخدم وحدها والتي تعطي بحدود (90%) كمعدل للكشف عن الوجه.

الكلمات المفتاحية: إيجاد الوجه، الطريقة الإحصائية، فيولا- جونز، العينة العشوائية البسيطة.

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