Development of a Counting System Method for Managing Crowd Using Image Sensing Device

IOP Conf. Series: Materials Science and Engineering **413** (2018) 012059 doi:10.1088/1757-899X/413/1/012059

Development of a Counting System Method for Managing Crowd Using Image Sensing Device

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Abstract. Counting of people and collecting good data is a major problem in every organization. Counting of people may be manual or automatic. In order to create an efficient counting system, this study focused on automatic counting system to sense, count and collect data using image sensing device technology. The image sensing device was able to sense, and count people. Also, adaptive algorithm was developed to ensure accurate counting for both indoor and outdoor counting. Background Subtraction is also considered for varying shadows and lighting conditions. This was done using MATLAB. Finally the method of image processing, gives good result of quick sensing, and rapid counting.
Keywords: Counting, Detecting, Image sensing device, and Manual

1. Introduction

Counting of people and collecting data is a major problem in every organization. However, conventional method of people counting system is manual. Manual counting of people is time consuming, labour intensive and highly costly. Humans have limited attention span and reliability when large amount of data has to be collected and analyzed over a long period of time, especially in a condition where resources are limited [1]. The defects of labour waste and subjectivity could not meet the need for public safety [2] [3]. This problem can be solved by the utilization of fast growing computer vision technology and high speed computer as a processor for counting. Due to rapid development image sensing device is possible to count people with high degree of accuracy and efficiency. This image processing comprises of segmentation, background extraction and blobs detection and is done in MATLAB. Accurate counting of people and data collection will enable the administrators to have data of people in attendance for proper planning. Image sensing device captures images [4].In this paper, background Subtraction is considered for varying shadows and lighting conditions. Background Subtraction is based on colour and texture. Its application is to count people only and is placed at overhead position. The result of analysis of data will enable the knowledge of statistical information on the people flow at different periods of time.

Also, the counting system is important especially in areas like people flow analysis, video surveillance, behavior analysis access control or event management. The methodology is more flexible to count. Likewise, adaptive algorithms are developed to ensure accurate counting for both indoor and outdoor counting using image sensing device counting. In order to create an efficient system, this study focused on counting system that provides a quick method of sensing, counting and collecting data with an image sensing device

2. Previous Works

Crowd counting based on count estimates in a multi-view camera environment was done using k-NN classification from the feet maps. The proof of the foreground likelihood was obtained in each view through a robust bio-inspired mechanism which has self-organizing background subtraction against foreground detection challenges. It was able to detect both stationary and moving foreground objects [5]. Proposed multi-view Computational complexity of a people counting system is linear and depended on views only in the computational feet map. However, the denser and larger the crowd, the harder individual detection and tracking becomes. This makes crowd counting inaccurate.

An approach was proposed based on perspective weight model to segment the crowd from the background for dense crowd counting in public, the setting of region of interest and background subtraction are proposed first. Likewise, a perspective weight model was produced through feature extraction, [6]. The results indicate that the proposed approach is effective for crowd counting but suffer from poor effects of a dynamic background in outdoor crowd counting and real-time performance. In scene invariant multi camera, the algorithm of people counting designed operates across multiple view cameras [7]. Camera calibration approach was used to normalize features to compensate for regions of overlap between viewpoints. The evaluation of the combination of multi camera crowd counting and scene invariance was evaluated using system on footage obtained from the QUT camera network which was trained and tested on three major cameras from the 2009 database of PETS. Crowd counting observed indicates less than 10% mean relative error. A proposed automated counting of people in crowd with low-resolution visual and infrared cameras was carried out. The experiment conducted by mounting the low cost thermal imager and visual imaging device looking vertically shows that the results of 18 experiments of the system over a wide range of lighting conditions is accurate within 3% [8]. A label distribution learning for common complexity scenes was proposed for crowd counting in public based on video surveillance [9]. The existing crowd counting approaches based on regression models learn a mapping between class labels and low-level features. Experimental result confirmed the effectiveness of label distribution learning crowd counting method and the robustness to various data sets contains imbalanced and insufficient training data. Two main approaches were covered in recent survey on crowd density estimation and counting for visual surveillance. They are direct approach (object based target detection) and indirect approach (corner points, pixel, and texture-based analysis) [10]. The task is becoming complex and difficult when detecting people with the presence of occlusions due to highly denser crowd [11]. Therefore count estimation is performed only on blobs labeled as groups. Counting is done for tracking group as follows:

Estimate the count for the current frame of the group being tracked in intersected area.
Update the estimate of the group tracker for the blob tracked, if not group tracker is initialized for the group with initial estimate of the count.
Sum up the count estimates for all groups in the scene by compute the total number of people in the scene, along with the people present. A frame-by-frame basis is done in real-time. This method ensures a simple solution to the problem encounter in group counting of people, though it fails in some cases.
(1) Density determines a group estimated count. Since the number of people occupying the same area is less than the average. When significant gaps are created, the technique will overestimate the count.
(2) If changes occur in configuration with this method or there is dynamics of the explicit group, even though the number of people remains the same, the projected area it occupies may change, [12].
Fixed head plane at a constant height of 160 cm is used in this method. Although relatively stable results can be produced with conservative estimate in some cases still height of a group may be different significantly, which affects the count accuracy. In order to deal with these challenges, a more flexible methodology is proposed to generate count estimates with consideration given to the shape of the group as presented in detail in the consequent section.

Adaptive algorithms developed were to ensure accurate counting for both indoor and outdoor counting using video image counting. Background Subtraction considered is based on colour and texture and is robust algorithm for variation in shadows and conditions of light. Mostly many works recently by-pass the task of individual detection even with the present pattern recognition techniques and computer vision advancement which can save time spent on processing. In order to create an efficient system, this paper focused on automatic counting system to find a quick method of sensing, counting and collecting data using image sensing device.

3. Methodology

Crowd density estimation and counting basically comprises of direct counting method and indirect counting method. Indirect counting method as adopted comprises of pixel analysis, texture analysis and corner points analysis.

1 Lighting systems

The most critical and essential aspect in image processing is lighting system used to receive a quality image. This provides homogeneous illumination for quality lighting set-up to make the information from images sufficient for any machine vision application [13].

2 The images from video camera are taken for analysis. Background of the image is estimated for segmentation. Then information is passed through a decision making algorithm for tracking and counting the people to stop the counting process.

3 Processes of image segmentation involves the use of MATLAB Image processing

Video camera has been introduced here for automatic people counting. The images from video camera are processed on computer (RAM 4.00GB; Processor; Intel (R) Celeron CPU 2.16GHz) via USB connection for analysis. Details of the process have been discussed in the following sections.

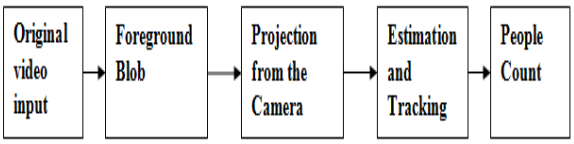


Fig 1: Flow Chart of People Counting System

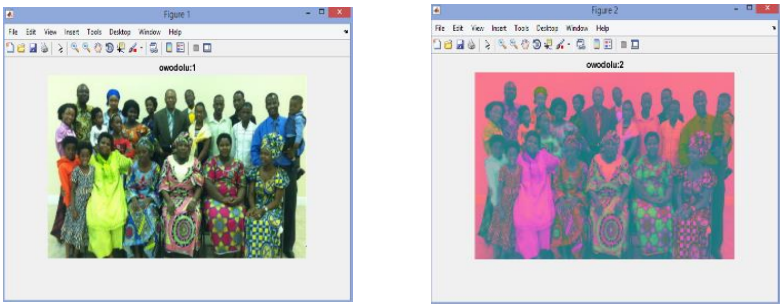
The algorithm, include estimation received for every foreground 'blob' in image segment which make total estimate for the scene which also is the sum of the estimates for every blob. Ground truth annotation is done to train the system, by explicitly people labeling as represented by every blob formed in image. For this reason, every frame generates many instances of ground truth. Feature extraction is done subsequently to group segmentation which is used to achieve normalization across scenes by weighing the features extracted from pixel by pixel.

The categories of features used for counting are:

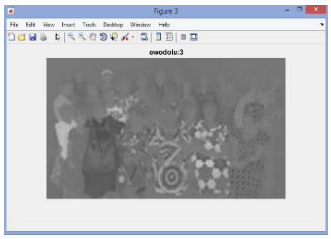
1. Size or magnitude of interested segments extracted from a relevant image.
2. Shape as related to the orientation and descriptors of the image segments.
3. Edges is measured using a binary edge detector. It is relatively change in pixel intensities across an image,
4. Key points are any other interesting points detected in an image such as corners

Thus, normalization of the features is important in order to reduce effects of perspective.

Foreground segment features. Moreover the foreground segment is obtained by the background subtraction .The image formation diagram is shown below.

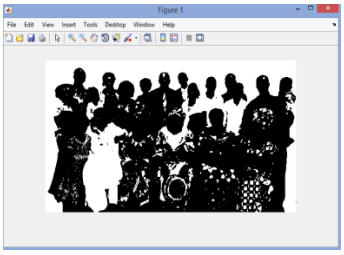


a. Reading of the Image b. changing the color space

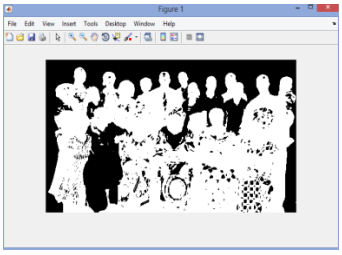


c. Equalizing brightness to get skin area

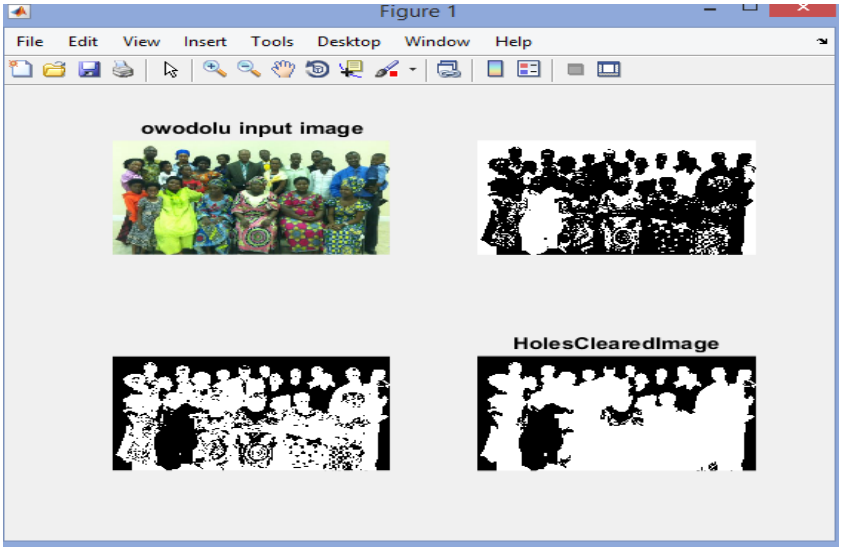
d. Image conversion rgb2gray



e. Converting Gray Scale to Binary Image



f. Complementing the Binary Image



g. Image processing flow display

Fig 2(a-g): **Image Processing**

4. Discussion

The new methodology proposed for the system contains several steps:

1. Background extraction which uses improved algorithm to get a pure background.
2. Background subtraction which uses background subtraction algorithm, the foreground is separated from the background and forms a foreground mask.
3. The system detects blobs that having more than one in them.

4. Segmentation. These include: image reading, morphological opening to background, background image differencing, balancing of image contrast, image thresholding and real image formation.

The morphology opening is composed of erosion and dilatation. Erosion and a dilatation can be made using the same structure of element based on identity. Image is required at the starting of this people counting system and for this reason image has been taken from video image sensing device (camera) and transformed into gray-scale image for analyzing. Frame differencing is the first steps of people counting algorithm [14]. Frame differencing is the process of making order of pixel absolute differencing between the two consecutive or simultaneous frames which in turns results in a new image which depicts all observed differences between this two consecutive frames. Motion can be detected by this image difference. There must be modifications between the consecutive frames if it is not an empty image formed. Therefore in the field of the video camera there is motion. Background estimation is another important process of people counting system. A reference image for estimating background part of the scene is created by background estimation algorithm. Detecting and tracking moving objects in the background image is necessary and this is used to separate the foreground and the background [15]. During the days intensity of light of the sun varies and for this reason some objects can be added or removed in the scene. For this reason estimation of the background should be updated time to time otherwise people counting algorithm will fail to detect the variations. Basically, the background image is to detect objects in motion and also track them and this is used to separate the foreground and the background.

The differences between these two consecutive frames from the operation results in a new image. The background image must be updated because the background estimation is dynamic. Also, the morphological operation can remove small objects created by noise likewise the binary image. For example, if the people counting system is placed in the entrance of one building, the good algorithm for people counting will bring about good result. In fact, all the objects on the scene is to be identified in order to track objects, which is the first step and all their features are then calculated. This process is known as a blob analysis. The Tracking and Counting is then performed.

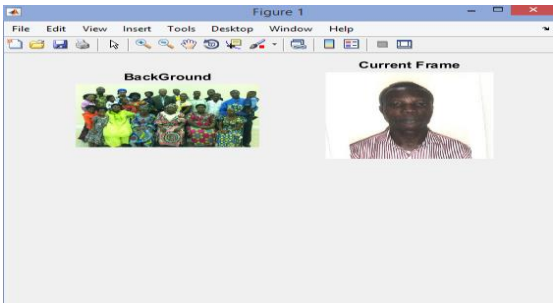


Fig 3: Frame differencing

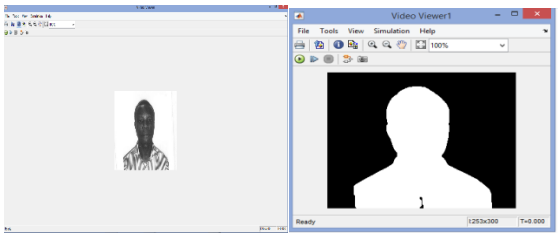


Fig 4: Segmentation and Blob formation

The reference image is updated when there is no motion. In other words, if there is existence of motion in the video camera frame, the background image will not be updated but will be in estimation of the background. In the estimation of the background, the algorithm is applied for separating the foreground and the background .At this point, large variation between the images of the video camera and the present background is represented by the foreground. Algorithm for frame differencing is quite similar with this process but have some differences. As we have frame differencing algorithm faces some difficulties to separate the background and the foreground of the image especially for current and previous frames due to the tendency to select the edges of objects in the foreground

which makes the image analysis more difficult subsequently. Standing objects can be detected by differencing algorithm which is another limitation of this algorithm. Therefore, objects are detected by background subtraction process and motion is detected by differencing frame in people counting system. Erosion is the next morphological operation which is used for eroding away the boundaries of the several regions of the foreground. As a result, objects of the foreground region will become smaller (some of them will entirely be disappeared) and holes in objects will be bigger. Combination of two basic operations Erosion and Dilatation are called opening operation and the primary objective of this operation is to remove noise as well as separation of blobs that are linked with small layer. The important steps of the image processing algorithm are the Blobs detection for efficient tracking of the objects in scene. Typically, area (number of pixels which compose the blob), perimeter, and location and blob shape are the blobs features usually calculated. Segmentation quality maintains the performance of the blob analysis algorithm. After that is counting of people.

5. Conclusion

The image sensing device technology or people counting system involves image input, frame differencing background estimation, segmentation, tracking and counting stages. The paper studied the people counting methodology in a specific location or place. MATLAB is the programming tool or interface on computer that is adaptable for counting implementation in real time processing. This method is an alternative to old or manual counting system .This counting system can be used in various places and also for further research.

References

[1] M. Ashkanani, Ali Roza, Ali Sobhy M Naghavipour, and Hadi ‘‘A Design Approach of Automatic Visitor Counting System Using Video Camera,’’ 2015, Vol 10, pp. 62-67

[2] K. Kopaczewski, M. Szczodrak and A. Czyzewski ‘‘A method for counting people attending large public events,’’2015, 74: 4289

[3] J. Han ‘‘Employing an rgb-d sensor for real-time tracking of humans across multiple re-entries in a smart environment, IEEE Trans.,’’ 2012, Consum. Electron. 58 255–263.

[4] S. Ikemura, H. Fujiyoshi ‘‘Real-time human detection using relational depth similarity features, in: Asian Conference on Computer Vision,’’ 2010, pp. 25–38.

[5] Lucia Maddalena, Alfredo Petrosino, and Francesco Russo ‘’People counting by learning their appearance in a multi-view camera environment,’’ 2014, Vol. 36, pp.125-134.

[6] S. Bahadori, L. Iocchi, G. Leone, D. Nardi ‘‘Real-time people localization and tracking through fixed stereo vision,’’ Appl.Intel.,2007,Vol.26,pp83–97.

[7] Xuemin Hu, Hong Zheng, Yuzhang Chen, Long Chen ‘‘Dense crowd counting based on perspective weight model using a fisheye camera,’’ 2015, Vol.126, pp.123-130

[8] D. Ryan, S. Denman, S. Sridharan, C. Fookes, ‘‘an evaluation of crowd counting methods, features and regression models,’’ Comput. Vis. Image Und. 2014, Vol. 130 pp.1–17.

[9] I.J. Amin, A.J. Taylor, F. Junejo, A. Al-Habaibeh, R.M. Parkin) ‘’Automated people-counting by using low-resolution infrared and visual cameras,’’2008, Vol.41, pp.589-599

[10] Zhaoxiang Zhang, Mo Wang, Xin Geng Crowd counting in public video surveillance by label distribution learning, 2015, Vol.166, pp.151-163

[11] Sami Abdulla ,Mohsen Saleh, Shahrel Azmin Suandi Haidi Ibrahim Recent survey on crowd density estimation and counting for visual surveillance, 2015, Vol.41,pp.103-114

[12] A. Bevilacqua, L.D. Stefano and P. Azzari, ‘‘People tracking using a time-of-flight depth sensor,’’ in 2006 IEEE International Conference on Video and Signal Based Surveillance,pp.89–93.

[13] M. Enzweiler, A. Eigenstetter, B. Schiele, and D. Gavrila. ‘‘Multi-cue pedestrian classi- fication with partial occlusion handling’’, in 2010, IEEE Conference on Computer Vision and Pattern Recognition, pp. 990–997.

[14] F. Fleuret, J. Berclaz, R. Lengagne, and P Fua., Multicamera people tracking with a probabilistic occupancy map, 2008, IEEE Trans. Pattern Anal. Mach. Intell., 30 267–282.

[15] W. Choi, C. Pantofaru, and S. Savarese ‘‘A general framework for tracking multiple people from a moving camera,’’ 2013, IEEE Trans. Pattern Anal. Mach. Intell. 35, 1577–1591.