IOP Conf. Series: Materials Science and Engineering **413** (2018) 012001 doi:10.1088/1757-899X/413/1/012001

Development of a System for Counting of People Using MultiCamera and Sensors

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Abstract. There has always been the issue of knowing the number of people present in a place such as symposiums, workshops, religious centres. Manual methods have often been employed. During the use of manual methods, the ushers are required are to stand along the pathways, this can then result to congestion in the pathway or even cause the speaker to lose focus. This paper focuses on to solving the problem of overcrowding and at the same time counting of people available in a place per time. In the paper, image sensing camera were used, the sensing device coupled with the camera were used to capture the image of people in a learning environment. MATLAB/SIMULINK software were used for the experiment. The result showed that the method is 85.4 % accurate with the ground-truth of 254 and TP of 217. Keywords: Multi-Camera; System; Counting; Sensors

1. Introduction

Crowd counting with the computer vision technique in the public has now become focus in research. The basic issue is how to count different people in crowd. Presently, the approaches available for counting crowd are based on monitoring videos which are primarily categorized into three. Firstly, is based on human head or body detection. Secondly, is construction of models for head or body which are used to match similar objects with images detected. Thirdly, is based on classifiers which are used by other studies for human body, face and head detection, with many samples collected with useful features are extracted for training classifier. In addition, there is need for accurate counting of people in a crowded environment. Abdulla et al., (2015) report that at Parade music event which happened at Germany in 2010, 21 people were recorded dead and over 500 recorded injured in that stampede. Ikemura et al (2010) report that image sensing device has the ability to count people by capturing their images. In view of that, this paper focuses on application of image sensing device due to its rapid development, efficiency and possibility to count people accurately, these wide applications make it useful in different sectors. The method of counting and data collection will help the administrators know the number of people in attendance in every meeting for proper planning. Also, this counting system is important due to its diverse applications like access control, surveillance, crowd flow monitoring, management of event and behavior analysis (Luna et al., 2017). Given the needs, these applications are increasingly becoming essential in this era without any doubt especially for detecting and preventing potentially hazardous situations. Crowd counting based systems targeted at counting people indoor and outdoor places automatically. A case study of Faith Tabernacle where we have crowd over 50000 people and Covenant University, Ota is selected. Accurate counting of people and data collection will enable the administrators to have data of people in attendance for proper planning. Owodolu et al., (2018) Likewise, image sensing device captures images. In brief, high density traffic flow of people is time consuming. In this paper, our counting system is based on computer vision with Simulink tool box. Computer vision is an inter- related field which uses computer for videos or digital image processing. Hu et al., (2015) report that from engineering perspective, it automates tasks that the human based visual system does. Automatically computer vision extracts analyses and understands applicable information from a sequence of images or a single image. This image processing comprises of segmentation, background extraction and blobs detection etc. and can be done in MATLAB. The processes are presented and explained in the subsequent sub-headings in this paper and show that, by this processes people can be counted effectively. The sub-headings include: literature review, methodology, analysis and discussion and conclusion.

2. Literature Review

Abdulla et al., (2015) report that in these decades, the population of people is increasing geometrically worldwide. The growth which indirectly resulted to increased number of people or crowd is due to the urbanization and movement globally. The gathering of crowd can be in close places such as stadium, building halls, airports or open areas such as sport events religious centers, parks and walkways. The reason for gathering has major effect on the crowd large scale behaviours and properties. So, counting is an area of concern in many researches such as science, safety, psychology, public services and computer vision. Abdulla et al., (2015) report that crowd turbulence is one of the reasons for crowd disasters which happens from pressing, pushing, stampede or crowd crushes, and eventually resulting to total loss of emotional control. Such examples of disasters as illustration of this problem are seeing in Colombia Water Festival stampede 2010 where over 380 people died. Likewise, crowd crush of Love Parade music event which happened at Germany in 2010 where 21 people recorded dead and over 500 recorded injured in that stampede. Early work involved locating people by looking for heads in the vertical histograms of the blobs, where the number of peaks was assumed to correspond to the number of heads. Meanwhile there have been different methods to the problem of counting people in crowded environments (Ryan et al., 2014). Also, proposed a system which provides an estimate based on the number of foreground pixels and edge pixels. Fourier transform technique was used to identify motion of the crowd. It is restricted to motion only in the vertical direction in the image. Crowd density estimation is done using elementary techniques such as estimating the area of the image segments which correspond to moving crowds, or using the perimeter of the region occupied by the crowd. Although the system works well for scenes with few people, it is incapable of accurately determining density in case of occlusions and illumination changes.

3. Methodology

Both software and hardware's were used to carry out the experiment. The software includes MATLAB. While the hardware used include: lighting system, Personal Computer, USB cord and High-resolution cameras. Multi-cameras (Three PMW-400K and Six PMW-EX3) have been introduced here for automatic people counting. The images from video camera are processed on compute both software and hardware's were used to carry out the experiment. The software includes MATLAB. While the hardware used include: lighting system, Personal Computer, USB cord and High-resolution cameras. Multi-cameras (Three PMW400K and Six PMW-EX3) have 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. The images (data) applied in counting system were collected at Faith Tabernacle and Covenant University Ota.

3.1 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 sufficient information from images for vision application.

The methodology for the system contains several steps:

1. Background extraction which uses improved algorithm to extract a current or 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 have more than one in them.
4. Segmentation. These include: image reading, morphological opening to background, background image differencing, balancing of image contrast, image threshold and real image formation. Thus, normalization of the features is important in order to reduce effects of perspective. Moreover, the foreground segment is obtained by the background subtraction

From Multimedia File block video taken is converted intensity and displayed screen. The link between video and Optical Flow provides detected motion. Noise was decreased in image for best detection by using 2-D Mean. The three running mean check boxes were selected to track mean value. The mean value in a sequence of inputs over a period of time can also be tracked by the mean block.

4. Results and Discussion

Figure 1: **Shows Image Counting with Bounding Boxes and the Blobs formation**

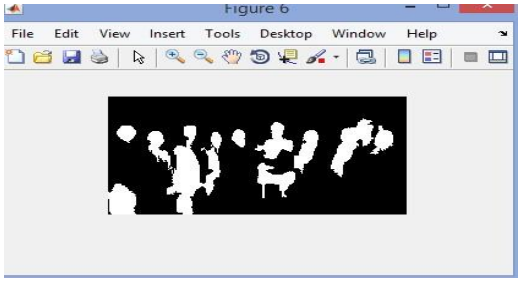

Figure 2: Blobs formation

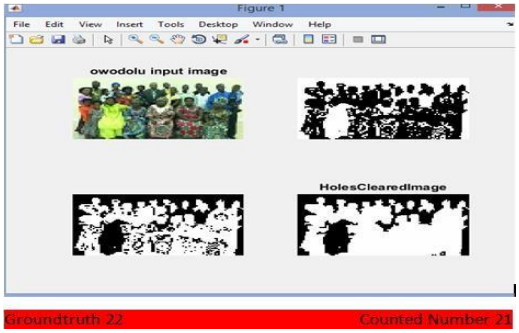

Figure 3: Shows Crowd Counting Images and Results

Table 1: Shows Crowd Counting Number and the Corresponding Image Size

	Crowd Counting Number Variation			
Image Size	Real Number	True Positive	False Positive	False Negative
302X710	47	35	16	12
130X244	9	9	2	0
149X234	15	10	2	5
152X374	34	33	2	1
164X255	29	19	3	10
126X315	17	17	6	0
137X345	34	31	8	3
367X561	18	18	8	0
509X582	12	12	6	0
86X380	32	26	9	6
198X325	7	7	3	0

Table 1 shows the number of real number of people on ground =254, true positive (TP) =217, false positive (FP) =65, false negative (FN)=37. TP is the number of foreground pixels that correctly detected. FP is the average of false alarms per frame or the number of background pixels that are incorrectly detected as foreground. While FN is the average of false misses which is the number of foreground pixels that are incorrectly detected as background. Pixel with size 302x 710 has highest real number of 47 people, true positive equal 35 people, false positive equal 16 people and false negative of 12 people. Image with size 130x244 has real number of 9 people, true positive of 9 people, false negative equal 0 and false positive equal 2 people which makes it more accurate than the other ones.

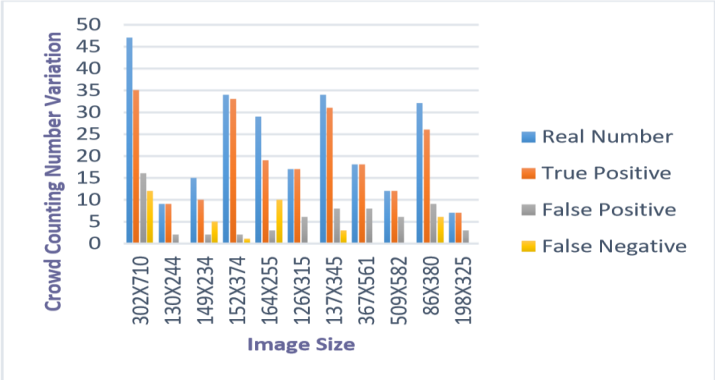

Figure 4: Shows Crowd Counting Number Variation versus Image Size

There is variation in number of people counted. This is as a result of limited images used for system identification This is further displayed in the Figure 5 below

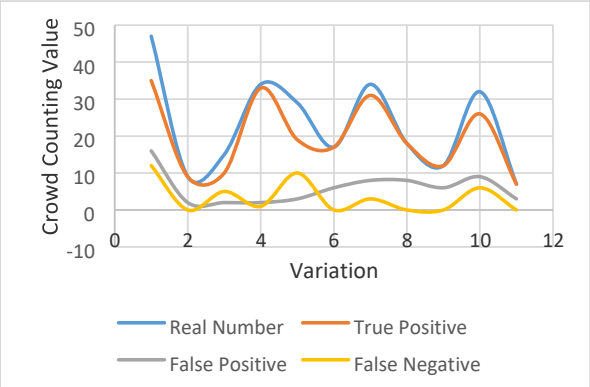

Figure 5: Shows variation in the Crowd Counting

Performance Evaluation

There are various standard measures for the comparison of the candidate binary change mask to the ground truth. These include the following.

1. True positives (TP): This is the number of foreground pixels that correctly detected.
2. False positives (FP): This is the average of false alarms per frame or the number of background pixels that are incorrectly detected as foreground.
3. False negatives (FN): This is the average of false misses which is the number of foreground pixels that are incorrectly detected as background.

Moreover, the statistical measurement used is accuracy to find how well the segmentation process excludes or identifies foreground pixels. Mathematically, this can be expressed as follows:

$$\text{Overall Accuracy} = \frac{\text{Total Processed Counting}}{\text{Total Actual Counting}} \text{ X } 100$$

$$\frac{217}{254} \; x\,100 = 85.4\%$$

5. Conclusion

Computer vision and Simulink library in MATLAB were used as the programming tool boxes or interface on computer that is adaptable for counting implementation processing. The method used was an improvement of an existing image sensing and counting of people in a crowded environment. The image of people was captured at Faith Tabernacle and Covenant University environment with image sensing device for the period. Also, algorithm system was developed and adapted to Viola Jones existing image sensing model for image processing. The non-clarity and high camera resolution resulted to poor counting in some areas which caused computational problem. The overall accuracy of the counting methodology is 85.4%.The true positive is 217 which is greater than the false negative of 37 and false positive of 65 of people. The total ground truth is 254 people. This method can be adopted as alternative to manual counting system.

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