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Automatic Counting and Sorting of Balls – An Image Processing Approach

Abahan Sarkar[1] , Ram Kumar [2], A Mohammad[1], B K Roy [1]

Department of Electrical Engineering[1]
Department of Electronics and Communication Engineering[2]
National Institute of Technology, Silchar – 788010, INDIA

abahan55@gmail.com, ramkumar.purnea@gmail.com, bkr.nits@gmail.com

***Abstract-* Automatic and reliable counting of moving objects in real time can be done using image processing. Manual counting is genuinely arduous without expert employee and can be erroneous sometimes, particularly when the numbers of moving objects are authentically gamey. Thus, automatic technique may become essential when the process of object counting involves longer time duration. Using Image processing, the automatic counting of the moving objects can be applied to processes which operates perpetually even for 24x7, e.g.- numeration of ball bearings, marbles, pencils etc. engendered in a factory. The present work proposes the counting of liberatingly falling balls and measuring its diameter and area in authentic time by thresholding the images. Our machine vision system consists of National Instruments keenly intellective camera 1744 and NI programming software, LabVIEW 2009.**
***Keywords*: Automation, Image Processing, Thresholding, Gravity, Balls, Lab VIEW**

I. INTRODUCTION

Image processing is a tool to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some compatible information from it. Image processing is a rapidly developing technology and it is consequential for amendment of pictorial information for human perception as well as efficient storage and transmission. Because of the decrementing prices of digital cameras, image processing and analysis applications are within a price category that was reserved for frugal sensor and quantification arrangements only a few years ago.

The different steps that are seen mainly in image processing are: Image Acquisition, Image Enhancement, Image Compression, Image Segmentation, Object Description and Recognition. Human vision system is a robust, flexible and easy-to train inspection system, but it is not accurate and reliable when we need measurements which are fast, repetitive, precise and detailed which introduces the need of machine vision. The processing capability of machine vision system gives it unquestioned superiority when it comes to inspecting the fast moving objects. Although human inspectors can keep pace with visual inspection demands but machine vision systems ensure repeatable results and can run continuously. The camera-based automatic vision system has two basic components: Digital camera (Sensor) and Image processor. For our purpose, we used NI smart camera 1744, which acts as an image sensor as well as an image processor and a computer, where we installed LABVIEW 2009. The camera takes the images and after processing those images, sends the necessary information to the computer in real time through Ethernet. The results are displayed in the monitor.

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming language used as a powerful and flexible instrumentation and analysis software system in industry and academia. LABVIEW uses a graphical programming language to create programs called Virtual Instruments or VI in a pictorial form called a block diagram. LABVIEW also includes many tools for data acquisition, analysis and display of results. The analysis library contains a multitude of functions in signal generation; signal processing, filtering and statistics. LabVIEW is available for all the major platforms and is easily portable across platforms. Each VI contains three parts: Front Panel, Block Diagram and Icon or Connector Pane.

A novel method to count people for video surveillance applications is presented in [1]. The quandary was faced by establishing a mapping between some scene features and the number of people. The results indicated that the proposed method amended the precision.

A novel approach to counting number of people that passed the view of an overhead mounted camera is demonstrated in [2]. Moving people were first detected as blobs and represented by binary masks, predicated on which possible multi-person blobs were further segmented into isolated persons according to their areas and locations. Each single person was tracked through consecutive frames utilizing a correlation-predicated algorithm and a state diagram was proposed to count people entering and leaving the scene.

Paper [3] presents an approach to the quandary of estimating the size of inhomogeneous crowds that peregrinate in different directions. A set of holistic low caliber features was extracted from each segmented region, and a function that mapped features into estimates of the number of people per segment was learned with Bayesian regression. Two Bayesian regression models were examined. The counting methods were evaluated on an immensely colossal pedestrian data set, containing very distinct camera views, pedestrian traffic, and outliers. Experimental results showed that regression-predicated counts were precise regardless of the crowd size.

A keenly intellective conveyance counting method predicated on blob analysis in traffic surveillance is presented in [4].The algorithm was composed of moving object segmentation, blob analysis, and tracking. By analysing the blob of conveyances the consequential features were extracted. In integration, the speed of each conveyance and the conveyance permeate a predefined area was calculated by analysing blobs of conveyances surveillance. They withal analyzed the procedure of video-predicated traffic congestion system and divided it into graying, binarization, denoising and moving target detection. The system first read video and converted them into gray scale images. They additionally put forward a Boundary block detection algorithm with noise reduction to identify the moving objects.

A system for counting the number of the cars with an improved virtual gate method is presented in [5]. First, the foreground area passing through a line was extracted using GMM-based background modelling. Second, the velocity field in the foreground regions were computed by an improved optical flow estimation method, which enabled the estimation of the dense velocity field of the cars. Then, they separated the velocity field into different groups by using threshold constraints and perform integration on each group along a virtual gate. According to the integration results, the number of the pedestrians and the cars was estimated.

In [6] ,they adopted background subtraction, modified edge-following, connected component to develop automatic extraction of moving objects in a video sequence. Additionally, the number of moving objects at an interval was efficaciously counted. In the proposed method, pixels at a concrete position of successive image frames were first processed by the modified iterative threshold cull technique to determine the background gray-level value. Pixels at all positions employed such an iterative technique to establish the background. Secondly, a pristine image was subtracted by this background to obtain a difference image that was integrated with the differential image between an pristine image and its precedent neighbouring image to yield an image with many edge points of moving objects. Third, the robust edge following scheme manipulated this edge-point image to engender the closed-form objects that were then conducted by the morphological operation to yield consummate objects. The practical implementation revealed that the proposed method can precisely and reliably estimate the traffic amount.

A consummate system for accurately and efficiently counting conveyances in a highway surveillance video is presented in [7]. The proposed approach employed conveyance detection and tracking modules. In the detection module, an automatically trained binary classifier detected conveyances while providing robustness against viewpoint, poor quality videos and clutter. Efficient tracking was then achieved by a simplified multi hypothesis approach. First an over-consummate set of tracks were engendered considering every observed detection within a time interval. As needed, hypothesized detections were engendered to coerce perpetual tracks. Finally, a scoring function was acclimated to disunite the valid tracks in the over consummate set. Their tracking system achieved precise results in significantly challenging highway surveillance videos.

The Video based vehicle detection was an important method of collecting traffic parameter is presented in [8]. Its aim was moving object detection. In order to overcome the shortcomings of traditional background subtraction based on gray, a background subtraction based on YCbCr color space was proposed to detect moving object and iteration operations to determine the threshold of partition image. The paper proposed grads maximum to find the clearest and the most integrated vehicle image, which provided the basis for vehicle count. Experimental results on real-world throughway sequences showed that the proposed method made it possible to accurately segment the image, and was very simple and fast. An automated traffic monitoring system using real time vision is discussed [9].

From the survey of reported work it is clear that many automation techniques are used in the field of counting.

In this report, an effort is made to devise a technique to detect and calculate the number of balls as well as its diameter for freely falling under gravity. For this, a LabVIEW based algorithm interfacing with NI-1744 [10] is designed to identify the freely falling balls and count the same in actual time.

The paper is organized as follows: After introduction in Section I, Section II discusses the associated problem. Section III deals with proposed solution. Results and Discussions are given in Section IV. Finally, Section V gives the conclusion.

II. PROBLEM STATEMENT

Our present problem is to count the number of balls and figure the radius of that counted balls and sorting them according to their diameter falling freely under gravity in real time. The balls are to be identified using image sensor which is NI smart camera and the software LABVIEW is used to implement the image processing algorithm in order to count the balls freely falling under gravity in real time .The following section explains the proposed solution.

III. PROBLEM SOLUTION

To achieve set objective discussed in previous section, a technique is proposed in this paper using image processing techniques in LabVIEW platform. To perform the above task, mentioned images need to be captured. For this purpose NI-1744 [10] smart camera is used. The image captured is communicated to PC for processing.

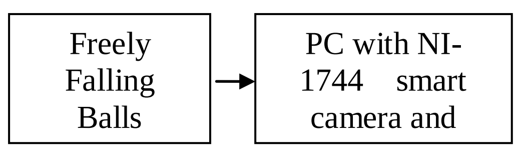

Fig. 1. Block diagram of the proposed technique

National Instrument smart camera (NI-1744) is used to take images of the packets used for processing. NI-1744 [10] have the following features:

1. 533MHz Power PC Processor, 128 system memory
2. 1280x1024 resolutions, ½ in. CCD image size, 8 bit pixel depth
3. Acquisition rate of 13fps (frame per second at max resolution)
4. 2x10/100/1000 communication interface (Ethernet, RS 232)

The experimental setup (Front View and Side View) for counting purpose is shown in the following Fig. 2 and Fig. 3. NI-1744 smart camera is placed parallel with the path of the falling balls at a considerable distance. Flowchart and Block diagram of the proposed method [11-15] and Flowchart are shown in Fig. 4 and Fig. 5.

Fig. 2. Front view of Experimental Setup

Fig. 3. Side view of Experimental Setup during experiment

A. Image Acquisition

We are acquiring images using NI vision acquisition express vi as shown in the Fig. 6. In the vision acquisition expresses vi, we perform steps for configuring the camera: 1) select acquisition source 2)select acquisition type, 3)select acquisition settings and 4)select controls and indicators as per our requisite.

B. Parameters and their impact on performance

The resolving power of images acquired from the NI smart camera is 1280*1024. The data present in the icon is excessively large and time tracking for the camera to process. To slim down the computational load on the camera the resolution of the image is changed to 150*150. This is done using Resampling VI.

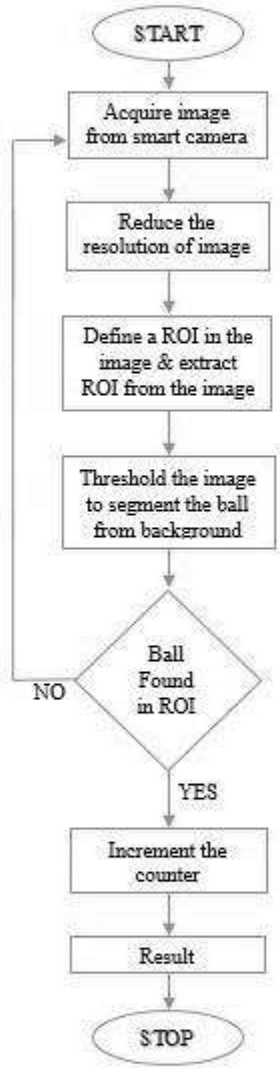

Fig. 4. Flowchart of the proposed algorithm

C. BCG Correction

To correct brightness, contrast and gamma parameters of the images are of the essence for further processing. For this we used BCG VI. Without resampling and BCG correction, the program encounters an error. This is due to the fact that the processor of the camera tries to run the image processing algorithm as fast as possible, while the algorithm has to read the whole image whose resolution is normally large. So the program required longer time to process the whole image. If we use appropriate time delay then the error gets removed but then the program fail to count balls moving with high speed.

D. Thresholding

Thresholding is a non-linear operation that converts a gray scale image into a binary image where the two levels are assigned to pixels that are below or above the specified threshold value. You can apply a threshold to data directly from the command line. Here the object is segmented from the background by histogram thresholding.

E. Circle Detection

Separates overlapping circular particles and relegates them predicated on their radius, surface area, and perimeter. Starting from a binary image, it finds the radius and centre of the circular particles even when multiple circular particles overlap using Circle VI. In accumulation, this VI can trace the circles in the destination image. It constructs and utilizes a Danielson distance map to determine the radius of each particle.

While loop are used to control the loop for counting the balls in each frame, by using shift register the number of balls counted is sent back to the loop and added with the recent number of balls counted.

What we have described so far is analyzed in the following section. Necessary discussions are also done upon the obtained results.

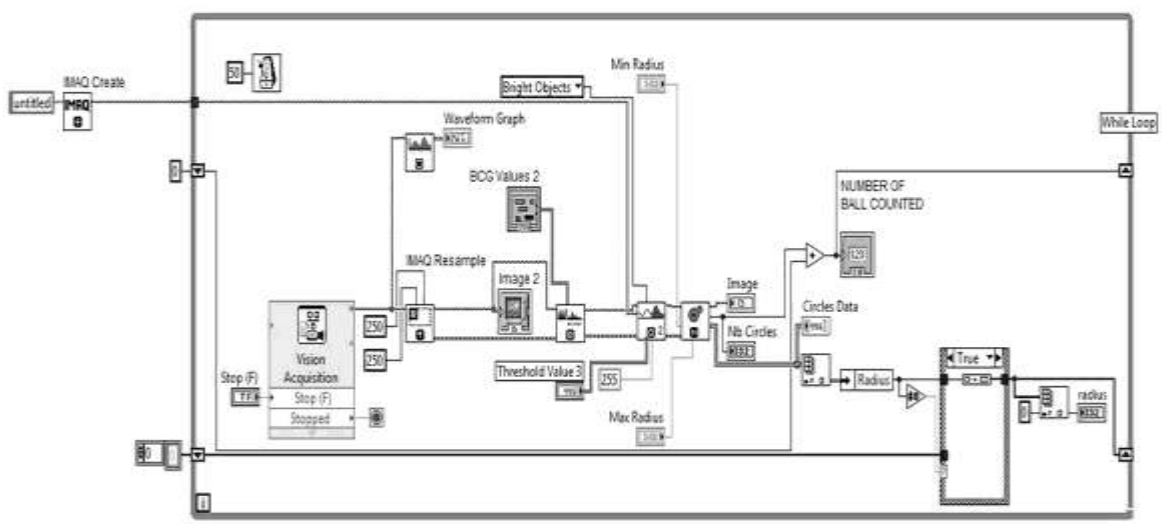

Fig. 5. Block diagram vi of the proposed Algorithm

IV. RESULTS AND DISCUSSIONS

The results obtained using LabVIEW platform for the balls falling vertically under gravity in real time using NI smart camera is shown in Fig. 6, and Fig. 7.

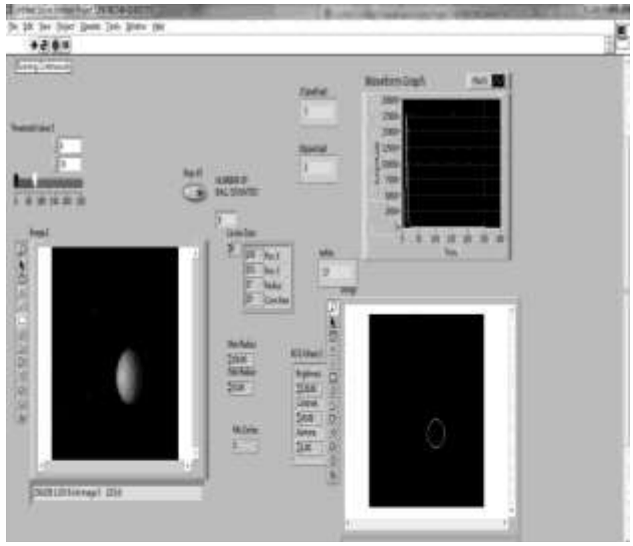

Fig. 6. Result Obtained for freely falling balls

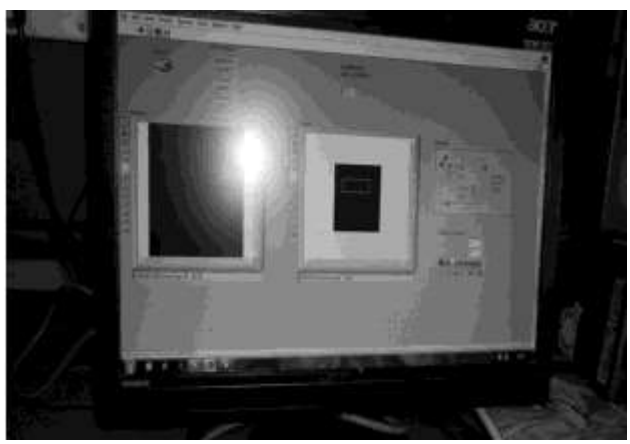

Fig. 7. Result Obtained for freely falling balls

From the results obtained in LabVIEW, it is clear that it has achieved its mentioned objective. The success of our algorithm can be seen by its ability to count the freely falling balls under gravity. We are also calculating the radius of ball which is getting counted. The technique was subjected to real time testing on more than 100 balls and the results obtained are found to be satisfactory in all cases.

V. CONCLUSION

In this paper, an image processing based technique to count the balls freely falling vertically under gravity in real time is designed using NI smart camera and LabVIEW 2009. The system efficiently counts the balls. The proposed technique is subjected to test in real time environment. In our approach, we used image segmentation to segment the ball so that only the ball appears in the image being identified and it is counted. After the ball is being identified, it is counted and radius is also calculated and sorted. We also implemented our approach to count the balls using USB camera, but the camera could not capture the image of the ball as the ball passed through the view of camera at high speed. Thus for high speed, real time counting of objects we need a machine vision system consisting of a smart camera and a real time software like LabVIEW.

In our present work, we identified, counted and calculated diameter of various balls and sorted them. Future work may include sorting of different size balls according to their diameter into different containers. For this motion control mechanism is needed to sort the balls in real time. Our work can be further improved for counting and inspection of objects in production lines in industries.

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