

July, 04 2017

# Multi-Layer Background Subtraction

F100317-00



## VIDEO COUNTING IS MOST ADVANCED

The 3x main people counting technologies are:

**Infra-red beams:** counts when a person or object passes and breaks its beam. It's low cost, but cannot discern people walking side-by-side and is adversely affected by direct sunlight.

**Thermal imaging:** counts by detecting human body heat. Adversely affected by ambient temperature, where hot weather heats up the whole counting zone, whilst cold gust washes out the tiny amount of heat emitted from a person's head

**Video processing:** uses image processing to recognize, track and count people. Most advanced and deliver excellent accuracy

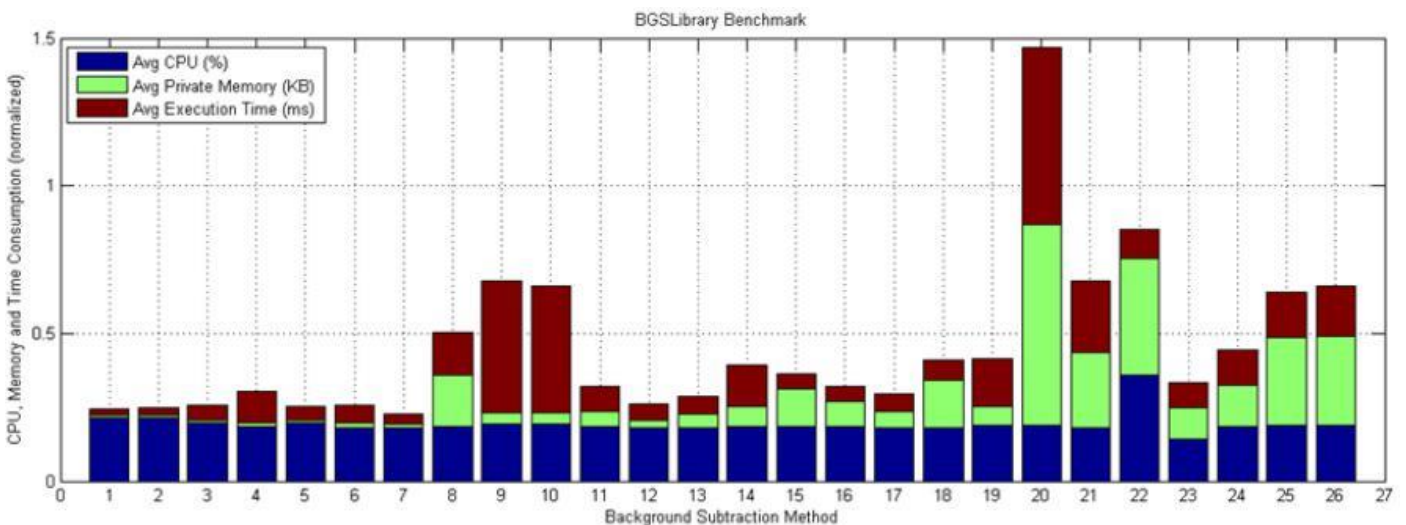
Counting by video processing is the most advanced technology. However, it's not yet perfect. It has two challenges: shadows and changes in light level. It usually requires careful fine tuning of the image processing settings to suit a particular environment. Then the next challenge comes when every store has its own unique environment, from varying lighting condition to different floor texture - resulting in time consuming configurations.

## THE MOST ADVANCED IMAGE PROCESSING ALGORITHM

There are 35 major image processing algorithms out there in the world. The most advanced algorithm, developed from lab in Switzerland, uses Multilayer Background Subtraction based on Color and Texture. This latest algorithm can solve the issues with shadows and light level changes, and can be implemented to most environments without requiring any fine tuning.

However, this algorithm is complex and computationally intensive. It requires significantly more processing power than the other algorithms (Fig. 1: FootfallCam uses algorithm #20: MultiLayerBGS).

Because of the computational requirement of this algorithm, FootfallCam Counter uses a powerful processor (CPU) together with graphic card (GPU) to run this algorithm in real time.



### Legend:

- |                              |                         |                           |                                |                       |
|------------------------------|-------------------------|---------------------------|--------------------------------|-----------------------|
| 1 StaticFrameDifferenceBGS   | 7 DPAdaptiveMedianBGS   | 13 LBSimpleGaussian       | 19 T2FGMM                      | 25 LBAadaptiveSOM     |
| 2 FrameDifferenceBGS         | 8 DPPratiMediodBGS      | 14 DPGrimsonGMMBGS        | 20 MultiLayerBGS               | 26 LBFuzzyAdaptiveSOM |
| 3 WeightedMovingMeanBGS      | 9 FuzzySugenIntegral    | 15 MixtureOfGaussianV1BGS | 21 PixelBasedAdaptiveSegmenter |                       |
| 4 WeightedMovingVarianceBGS  | 10 FuzzyChoquetIntegral | 16 MixtureOfGaussianV2BGS | 22 GMG                         |                       |
| 5 AdaptiveBackgroundLearning | 11 LBFuzzyGaussian      | 17 DPZivkovicAGMMBGS      | 23 VuMeter                     |                       |
| 6 DPMeanBGS                  | 12 DPWrenGABGS          | 18 LBMixtureOfGaussians   | 24 DPEigenbackgroundBGS        |                       |

### Computer Configuration:

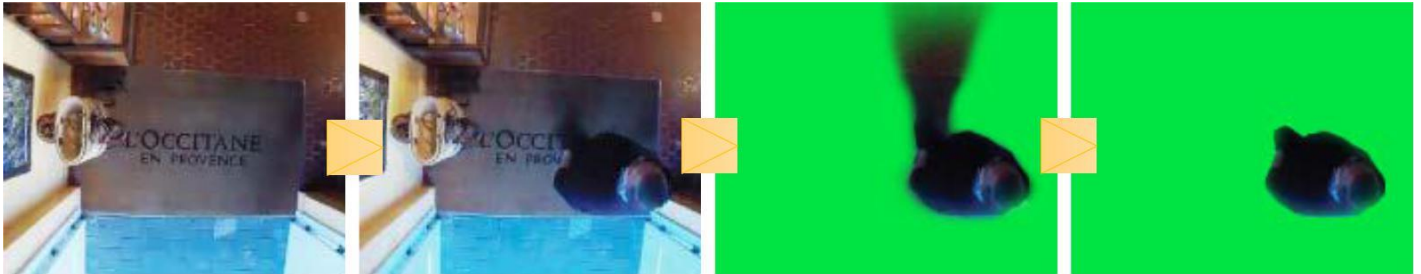
Machine: Intel Core i5-2410M CPU 2.3Ghz  
RAM: 4,00GB DDR3  
OS: Windows 7 x64 Home Premium SP1

### Input:

BMC dataset - EvaluationPhase - Street - 212  
Image resolution: 640x480 - 24bits  
Number of images: 1499

## WHAT IS MULTILAYER BACKGROUND SUBTRACTION BASED ON COLOUR AND TEXTURE ALGORITHM?

Image processing is an analysis of a picture where the background is being digitally removed in order to recognize and track the object of interest (for people counting, this is a moving person). This latest algorithm uses both color and texture patterns to identify the person, producing far superior accuracy than when using color pattern alone. This also overcomes the challenge of changing environment, for example moving tree shadows.



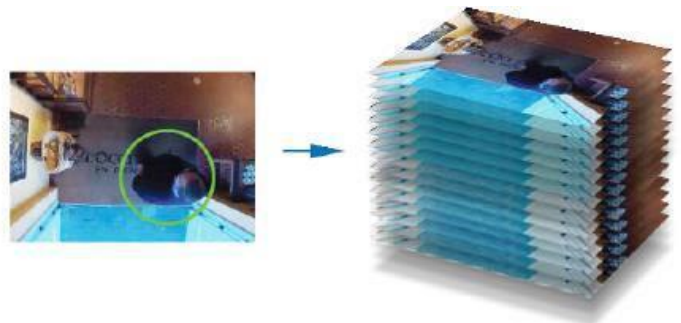
Background is the area that has remained the same in a series of successive frames/pictures, for example a brown carpet.

When a person then walks across the carpet, the area changes in the picture – it's no longer brown, but now in the color of the person's hair and shirt.

Image processing removes all the other background area, and identifies the person.

The shadow cast by a passing person or a tree, though changes the color on the floor, but it hasn't changed the pattern of the floor, hence it will not be counted.

In addition, it keeps 15x layers of different version of the background, and constantly updates these different versions. This way, it can cope with varying background conditions, for example due to light changes at different times of day. With this multilayer background subtraction, it can accurately identify the foreground object with a definitive outline boundary.



**\*Dr J. Yao and Dr J-M Odobez, Multi-layer background subtraction based on color and texture. Martigny, Switzerland.**

Compare this image with multilayer background to accurately identify the foreground object.

## NEW: WI-FI COUNTING

### Further Insights with Wi-Fi Enabled Devices

Wi-Fi enabled devices are getting common in the emerging market like UK, Germany, Spain and etc. The latest statistics shows that there are around 70% of your shoppers, carrying a mobile phone.

FootfallCam counter is a Wi-Fi hotspot itself. It gives you additional business metrics such as outside traffic, store front conversion, dwell time, returning customers, cross shoppers, etc. by distinguishing the shoppers based on the unique Wi-Fi signal emitted from their mobile phone. With the assumption that not everyone is carrying a mobile phone, we normalize it with highly accurate video counting data.

### Wi-Fi Signals from Mobile Phones

Mobile phones constantly send out signals as they search for Wi-Fi networks nearby. These signals include the phone's MAC address (a unique identifier associated with a specific device) and other information like signal strength that we use to determine rough location. FootfallCam counter detects the Wi-Fi signals emitted by the mobile phone without requiring it to be registered or connected to any Wi-Fi network. This can be done automatically so the shoppers wouldn't be aware of this.

### Records Wi-Fi Signals and Sends Them to the Secure Server

Using your existing Wi-Fi infrastructure or our compact plug-and-play sensor, we record signals and send them to the cloud. For privacy, every MAC address will be encrypted before it is being sent and stored in the server, preventing unauthorized users from accessing to these data. Because shoppers don't need to actually connect to your Wi-Fi network or install a mobile app, you can measure their activity without interrupting their shopping experience.

### Easy Access via Web and Email

Login to our web based control panel to access reports and graphs with real time data. Schedule reports to be emailed to you every Monday morning, helping you to keep track on the latest analytics and optimize your business value.