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AABS Technique for Detection of Moving Objects.

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Abstract
Image and Video Processing has a wide range of applications among various communities. Real Time moving object detection has become an important task in the Image and Video processing applications like robotics and video surveillance systems. There are various techniques in order to detect moving objects. In this paper we bring forward a hardware and software implementation of detection of moving objects using Background Subtraction technique. And we also bring forward the details of the moving objects which are detected, by using the Image reconstruction. For this purpose the following steps are executed – 1) A background image is stored in the SRAM Memory. 2) Low-pass filter is applied to both background image and the foreground images. 3) Foreground images are subtracted from the background image in order to identify the moving object. 4) Image processing techniques are applied to identify the moving object. 5) Image reconstruction techniques are used to obtain the details of the moving object. Interfacer is used either to store the resultant images in the memory or to display them on the screen.
Keywords – Background Subtraction Technique, Moving Object Details, Moving Object Detection, RGB to Gray Scale, Shadow Removal Technique.

I. Introduction

Image and Video Processing has a wide range of applications among various communities. Image and video processing has its own importance in these applications. These applications implement Image and Video Processing under Several Real-time Constrains. The direct execution of hardware algorithms in an FPGA provide speed-up factors typically between 10 and 100 times in comparison with the same algorithm implemented in software, which uses conventional microprocessors. The algorithms implemented in hardware run faster than the same type algorithm when executed using software's. Additionally, typical issues of embedded systems like hardware /configware/software partitioning problems can be solved using the solutions of general FPGA. Moving Object Detection is an important technique implemented in Image processing. and Video processing.

Computer vision is a field that includes methods for acquiring, processing, analyzing, and understanding images and, in general, high-dimensional data from the real world in order to produce numerical or symbolic information. Few of the Computer vision Systems are used for Navigation, Detecting Events, as Controlling Process, Automatic Inspection and more. Most of the computer vision algorithms implement conventional processors and use Von Neumann Model. Von Neumann Model systems implement SIMD approach. SIMD stands for 'Single Instruction and Multiple Data', as the same instruction is used multiple times for processing multiple data.

In Real Time Embedded System, processing an image or videos at a rate of 30 fps (frames per second) is simple. But processing an image or frame at the rate of 150 fps is difficult. As these images or videos consists of large amount of information. This large amount of information cannot be stored and processed on the Embedded Hardware, at the same time. The common approach for dealing with this large information is by storing the images and afterward processing them in a non-real time approach. This large amount of information is stored in the memory which is not the part of the processor and then processed later.

II. Von Neumann Architecture

Von Neumann architecture is also known as the Von Neumann Model or the Princeton Architecture.

Von Neumann, also known as Princeton Architecture, based architectures implement SIMD Technique. SIMD stands for Single Instruction Multiple Data. In this technique same operation is performed over multiple data resulting in multiple independent results. The main drawback of this architecture is low performance for implementing real time embedded systems in terms of power consumption and cost. Apart from that, these types of approaches has serious problems for implementing in embedded system due to the computational resources constrains (e.g. memory and power supply).

III. Moving Object Detection Techniques

Motion Detection is an essential processing component for many video applications. These video applications demand few properties. Properties like compact, low power consumption, compact and lightweight design and high speed computation.

Generally there are three ways for detecting motion in image sequences.

1. Background Subtraction
2. Temporal Difference
3. Optical Flow

Out of these three motion detection algorithms, the most commonly used algorithm is Background Subtraction Algorithm. Brief description of the 3 algorithms is given below..

3.1 Background Subtraction. In this approach the moving regions are detected by subtracting the current frame from the reference frame. This reference frame is known as Background Frame. This approach offers good performance. And this is a low cost algorithm and is also very useful for detecting moving objects.

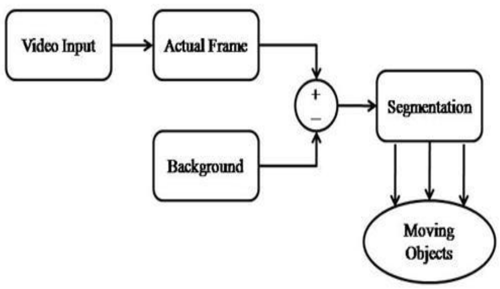

Figure 1: Overview of Background Subtraction Architecture.

3.2 Temporal Difference. Generally this is approach is referred to as temporal difference of two successive frames. In this approach the same principal of Background Subtraction is implemented. The only difference between these two approaches is the background. The background frame in this approach is the previous frame. This approach offers good performance and this is a low cost algorithm. However this approach has problems in detecting the actual shape of the object.

3.3 Optical Flow. This is the third type of approach. In this approach the input to the method is an image or frame stream. This image is expressed in terms of function, like E(x,y,t). X and Y are the spatial coordinates while't' is treated as the time function. Therefore the function E(x,y,t) represent the intensity of the pixel located at (x,y) coordinates at the time 't'. Therefore this approach is based on the fact that the object motion information is contained in the brightness changes of the image. This approach offers good performance. The drawback of this approach is that this is a complex algorithm to implement and it requires high memory resources.

IV. Background Subtraction Algorithm

By looking at the above figure we can explain the Algorithm, Firstly, each image of sequence is subtracted from background image, that is reference frame. The resulting image is segmented in order to produce a binary image which highlights the moving region from regions which are stationary. Result of Background Subtraction Technique will be a binary image. Pixels tagged with '0' are related to background. While pixels tagged with '1' are related to objects which are in motion. As show in the below image the background is represent with a dark pixel while the moving object pixels are represented by a white pixel.

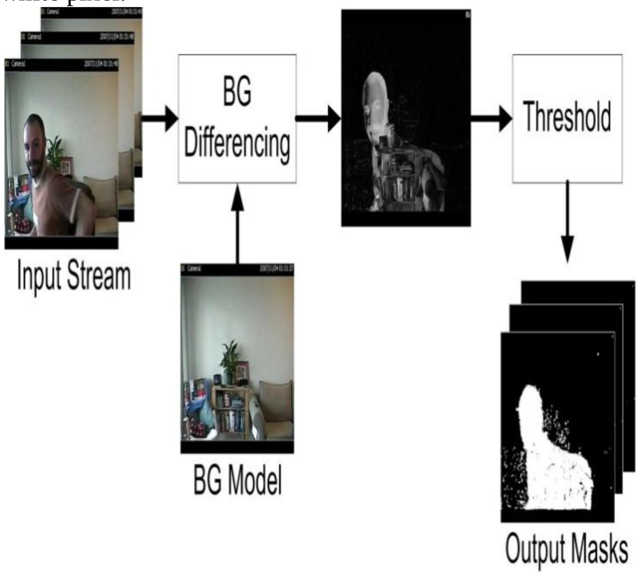

Figure 2: Background Subtraction Algorithm Detecting Moving Objects.

Output of the Background Subtraction Technique consists of some additional pixels. And these pixels are not the part of the interested object. Some of these non interested pixel values can be removed by applying some threshold to the Background Subtraction Resultant Image.

In detail architecture of the Background Subtraction Technique is shown below.

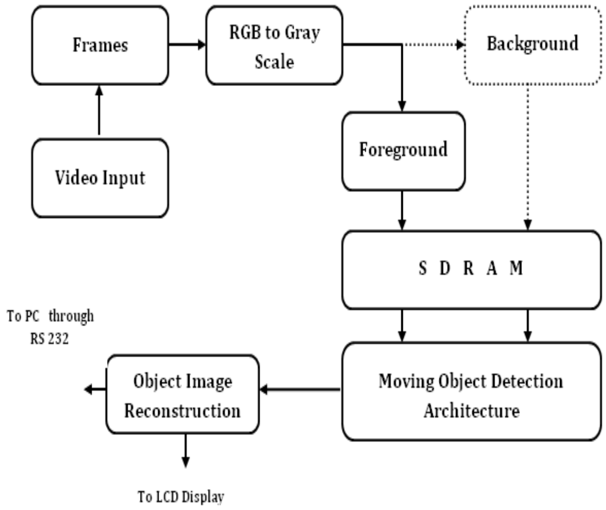

Figure 3: Over All Architecture of Background Subtraction Technique.

The entire architecture can be explained in 5 simple steps.

1. RGB to Gray Scale Reduction.
2. Background Storage.
3. Motion Detection.
4. Shadow Removal Technique.
5. Object Reconstruction.

1.1. RGB to Gray Scale Reduction. We first implement this algorithm on a gray scale frames. Video capturing device, like CMOS Sensor captures the video and further this video will be converted to frames, which needs to be processed. An appropriate Controller controls the CMOS Sensor in capturing the image and transfers the image to the next stage for processing. The image from the image capturing device will be an RAW image with RAW data. The next block will identify the information from the RAW data into RGB form. In simple words, the RAW information will be analyzed in the form of intensity values of 3 colors, Red Green Blue – basically know as R Component, G Component, B Component. These are stored in SRAM cells. For the analyzing outputs we deal with gray scale images. The next block will convert these RGB values into the Gray Scale Values, Pixel by Pixel. These Gray Scale images are stored in SRAM cell on an FPGA kit for further processing These Grey Scale images are used as Background (reference) image and foreground images.

1.2. Background Storage. The images (both the foreground and background) images will be stored in the SRAM Memory Cells. Camera provides one pixel per clock cycle. The data will be stored using two pixels per memory position. Therefore the system stores one pixel per clock cycle, but the memory position is updated every two clock cycles. This approach will exhibit some latency in order to store the background image. This is the stage where the processing images are transferred and stored onto the hardware board. Due to the memory limitations on the hardware board only two images can be stored on to the SDRAM cell at a time. Before transferring background and foreground images onto the hardware board, these images are resized and then stored on SDRAM cells. And Background Subtraction Algorithm is implemented onto these two stored images.

1.3. Motion Detection Architecture. This is the main block of the entire Background Subtraction Algorithm Technique. It is in this block that the background subtraction will be carried out. This block takes foreground image and background image as the input and processes these images in order to identify the Moving Object.

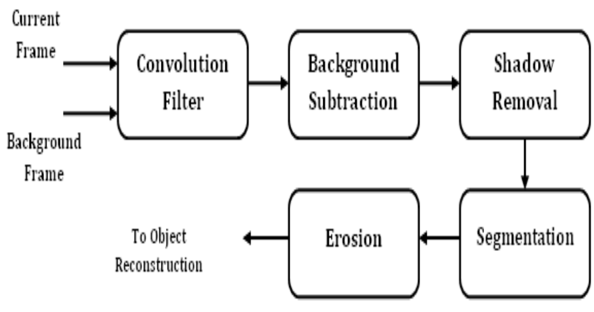

Figure 4: Motion Detection Architecture

The Block consists of few sub blocks as shown in the above figure. The output from this Moving Object Detecting Block can be displayed on the screen and can also be saved in Personal Computer as well. The sub blocks are Convolution Filter, Background Subtraction, Segmentation, and Erosion. Both the current and background images are passed through the low pass filter, which is used as a convolution filter. Filter removes the unwanted pixels, and allows in concentrating on the particular pixels which will be processed. In Background Subtraction sub block the current image is compared with the background image. Foreground image is subtracted from the Background image.

This subtraction will high light any moving objects. The output of this subtraction will be a binary image. The pixels tagged with '1' belong to the moving object and pixels tagged with '0' belong to the background.

1.4. Shadow Removal Technique. This is the technique where the shadows can be eliminated for the results obtained from background subtraction, thereby giving us the exact shape of the moving object. To accomplish this purpose, True color image has to be converted to HSV form. HSV image is a 3 dimensional image which contains Hue, Saturation, and Value of the True Color image, as the 3 different planes in a dimension. Even a shadow in an image consists of some pixel values. From these pixel data a shadow can be analyzed. By implementing upper threshold and lower threshold to the pixel values of the image, shadow can be eliminated from the resultant image. Thereby indentifying only the object of interest.

Image Segmentation sub block partitions the binary image into multiple segments and changes the representation of the image in order to recognize the object in an easier way.

Morphology applied to the segmented image. Dilation is applied to the resultant image. Dilation is the process of maximizing the intensity values of the pixels of region of interest from the images.

Erosion is a morphological technique. Erosion is the process of removing the unwanted noise and highlighting the information which is required. There by removing the unwanted noise from the image. After Erosion the image is either displayed on the screen through the RS 232 controller or can be transferred to PC as well.

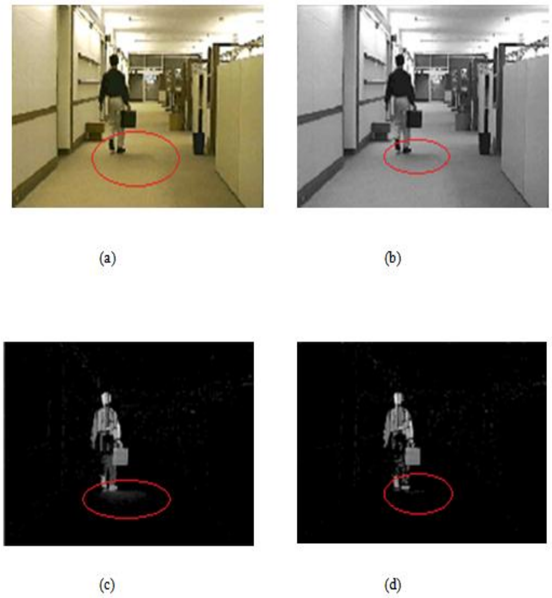

Figure 5: (a). Foreground Image (b). Gray Scale Image. (c). Background Subtracted Image. (d). Shadow Removed after background subtraction.

1.5. Image Reconstruction. In this block, morphology techniques are applied to the resultant image. By implementing the morphology, erosion and dilation techniques the pixel values of the region of interest will be magnified and the values of the unwanted pixels will be reduced. The resultant image consists of only a shadow form of moving object. By comparing the results with the actual foreground frame, moving object details can be identified. The spatial coordinates of the shadow form of the object from the image will give us the coordinates of the object of interested, when compared with the actual foreground frame.

There are few advantages of using Background Subtraction Technique over the other techniques. This technique consumes very less power when compared with the other techniques. When we discuss about the performance, this technique provide high performance than any other techniques. Memory required implementing this technique less when compared with other techniques like Temporal Difference and Optimal Flow Technique consumes power and memory. And in Temporal Difference Technique the background image and foreground image keeps changing. After processing, foreground image is treated as background image for the next frame and the new frame is treated as the foreground image.

In Optimal Flow technique, each image is treated as matrix, or as an array or as a grid as a function of time, thereby asking for more memory to save each and every image. This technique comparatively consumes very less about of area.

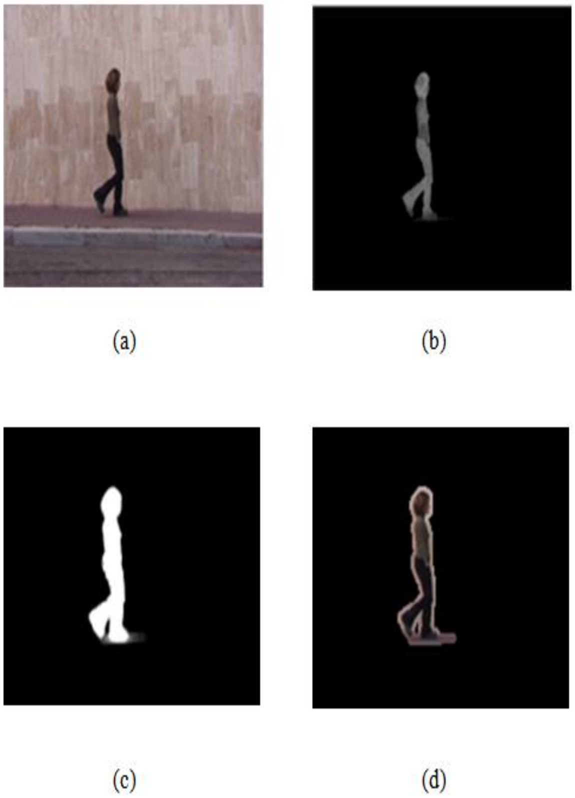

Figure 6: A frame from the video input.
(a). Foreground Image (b).Foreground Subtracted from Background (c). Morphology applied to Background Subtracted Image (d). Reconstructed Image

This technique has a wide range of application in Image and Video Processing. Few of the application are listed here. High Level computer vision tasks such as robot navigation, collision avoidance, path planning and video surveillance. This technique is also implemented in Computer guided surgery, in study of anatomical structure, and in an important application like Face Recognition (Human Interface Application)

V. Conclusion

Background Subtraction Technique is a better algorithm with compared with the other two algorithms, in detecting moving objects. Due to its unique technique of selecting the background image, it is less complex and consumes less amount of memory as background image will be stored once at the time of initializing. Since Background Image will not be stored again and again computation time required for this process is less.

By implementing Morphological Techniques the exact shape of the moving object can be acquired. Moving Object can be detected. Blurriness can be further reduced. And in depth details of the moving object can be acquired. Due to the memory limitations on the FPGA board entire algorithm could not be implemented on the hardware module. Moving object can be detected directly from the hardware module.

The response on the hardware for performing Background Subtraction process on the background frame and foreground frame is much faster when compared with the response on implementing the same algorithm on software.

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