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Fast Background Subtraction Algorithm for Moving Object Detection & Tracking In FPGA

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ABSTRACT

The capability of extracting moving object from a video sequence captured using a static camera is a typical first step in visual surveillance. The idea of background subtraction is to subtract or difference the current image from a reference background model. This paper proposes a new method to detect moving object based on background subtraction. First of all, we establish a reliable background updating model based on statistical and use a dynamic optimization threshold method to obtain a more complete moving object. Among all existing algorithms it was chosen because of low computational complexity which is the major parameter of time in VLSI. The concept of the background subtraction is to subtract the current image with respect to the reference image and compare it with to the certain threshold values. Here we have written the core processor Micro blaze is designed in VHDL (VHSIC hardware description language), implemented using XILINX ISE 8.1 Design suite the algorithm is written in system C Language and tested in SPARTAN-3 FPGA kit by interfacing a test circuit with the PC using the RS232 cable. The test results are seen to be satisfactory. The area taken and the speed of the algorithm are also evaluated.

Index Terms

Background Subtraction, Micro blaze, Object Detection, UART, VHDL.

I.INTRODUCTION

Object detection and tracking is one the most important tasks in computer vision. In video surveillance, it assists understanding the movement patterns of people to uncover suspicious events. It is a key technology in traffic management to estimate flux and congestion statistics. Advanced vehicle control systems depend on the tracking information to keep the vehicle in lane and prevent from collisions. In physical therapy, analyzing the mobility of patients improves the accuracy of their diagnosis. Learning the shopping behavior of customers by tracking assists the architecture design in retail space instrumentation. In robotics, tracking bridges the gap between the raw visual information and environmental awareness [3]. In video summarization, it is applied to generate object-based representations and automatic content annotations. Tracking is also a fundamental technology to extract regions of interest and video object layers as defined in JPEG-2000 and MPEG-4 standards. Even though it is essential to many applications, robust object tracking under uncontrolled conditions still poses a challenge [14].

Real-life systems are required to track objects not only when the background scene is static but also when lighting changes suddenly, camera-object motion becomes large, color contrast becomes low, image noise soars to an unacceptable level, etc. In addition, the computational complexity is required to be kept minimum for real-time performance.

This paper is organized as follows in the section I. introduction to object detection in video surveillance and in the section II. Previous algorithms and disadvantages after that in section III.Proposed background modeling IV. Experimental setup V.Results and finally conclusion.

II. REVIEW OF PREVIOUS ALGORITHMS

There are several approaches for moving detection task namely, (a) the optical flow (b) the temporal difference of two (c) background subtraction.

A. Optical Flow Method

In a video frame, the field of motion vector per pixel or sub pixel is called optical flow. There are many methods for computing optical flow among which few are partial differential equation based methods, gradient consistency based methods and least squared methods [6]. The objective in optic flow calculation is to find the 2D-motion field in an image sequence. As a pixel at location (x,y,t) with intensity $I(x,y,t)$ will have

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moved by *δx,δy* and *δt* between the two frames the following image constraint equation can be given:

$I(x,y,t)= I(x+ \delta x, y+ \delta y,t+ \delta t)$

Assuming that the movement is small enough, the image constraint at I(x, y, t) with Taylor series can be derived as

$$(x+\delta x, y+\delta y\ , t+\delta t\ ) = I(x,y,t) + \frac{\partial I}{\partial x}\delta x + \frac{\partial I}{\partial y}\delta y + \frac{\partial I}{\partial t}\delta t + H.O.T$$

Where H.O.T. means those higher order terms, which are small enough to be ignored.
From these equations follows that

$$\frac{\partial I}{\partial x}\Delta x + \frac{\partial I}{\partial y}\Delta y + \frac{\partial I}{\partial t}\Delta t = 0$$

or

$$\frac{\partial I}{\partial x}\frac{\Delta x}{\Delta t} + \frac{\partial I}{\partial x}\frac{\Delta y}{\Delta t} + \frac{\partial I}{\partial x}\frac{\Delta t}{\Delta t} = 0$$

Which results in

$$\frac{\partial I}{\partial x}V_x + \frac{\partial I}{\partial y}V_y + \frac{\partial I}{\partial t} = 0$$

The main disadvantage of this Optical flow approach is hard to apply in real-time due to its high computational cost.

B. Temporal Difference Method

The Frame difference is arguably the simplest form of background subtraction. The current frame is simply subtracted from the previous frame, and if the difference in pixel values for a given pixel is greater than a threshold (Th), the pixel is considered part of the foreground. A major flaw of this method is that for objects with uniformly distributed intensity values (such as the side of a car), the interior pixels are interpreted as part of the background. Another problem is that objects must be continuously moving [7]. Let Fi-1 be the previous frame and Fi be the consecutive frame, where i= 1 to n. The pseudo code is given below:

```
For(i=1; i<n; i++)
{
If (Fi-1 - Fi ) > Th
Then accept and process the frame
Else
Reject the frame
}
```

Where Th is called as Threshold value.

Temporal differencing is very adaptive to dynamic environments, but generally does a poor job of extracting all relevant feature pixels. Due to the disadvantages of these two algorithms we go for background subtraction algorithm.

III. PROPOSED BACKGROUND MODELING

Background subtraction is a commonly used class of techniques for segmenting out objects of interest in a scene for applications such as surveillance. It compares an observed image with an estimate of the image if it contained no objects of interest. The areas of the image plane where there is a significant difference between the observed and estimated images indicate the location of the objects of interest. The name "background subtraction" comes from the simple technique of subtracting the observed image from the estimated image and thresholding the result to generate the objects of interest. Figure 1 represents the background subtraction process.

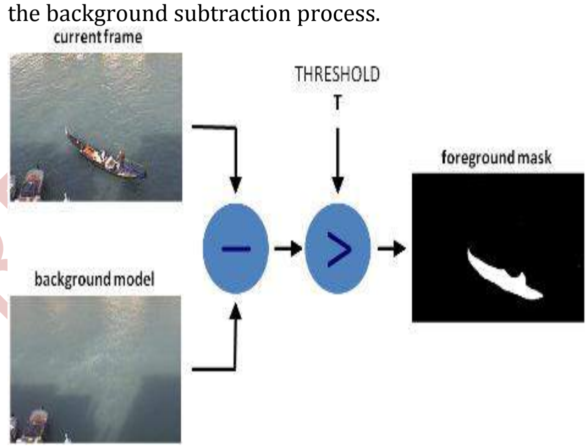

Fig 1:Example for background subtraction concept

Here we survey several techniques which are representative of this class, and compare three important attributes of them: how the object areas are distinguished from the background; how the background is maintained over time; and, how the segmented object areas are post-processed to reject false positives, etc.

In order to allow high-resolution images of the people in the scene to be acquired it is reasonable to assume that such people move about in the scene. To monitor the scene reliably it is essential that the processing time per frame be as low as possible.

Hence it is important that the techniques which are employed are as simple and as efficient as possible. For that reason the well known technique of background subtraction [15,16] was selected for this application. Background subtraction allows moving objects to be detected by taking the point-by-point absolute difference of the current image and a background image which must be acquired when there are no moving objects in the scene (See equation

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Moving(i; j) = |Image(i; j)-Background(i;j)|

When the difference value is greater than the threshold value it is considered as a foreground otherwise it is background object.

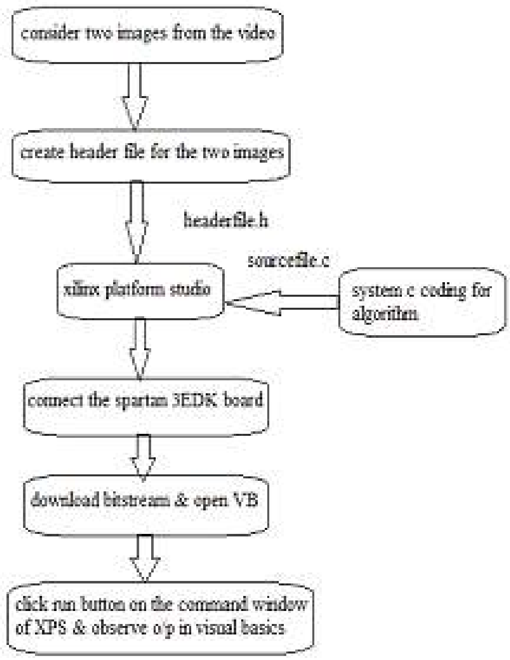

Fig 2: Flow diagram for proposed algorithm

In the first step we consider the video and convert it into frames, from that frames we can select any of two images for that two images we create a header file .And then we can write an algorithm for back ground subtraction in the XPS tool by using system 'C' language. In the XPS we are giving two inputs of headerfile.h and source file.c. XPS is a tool used to link a program to hardware like FPGA. After downloading the bit stream open the visual basics application and click run button on the command window of XPS .Finally with the help of UART port and RS232 cable we made a communication between hard ware and our PC and we can see the output image in the PC with the help of visual basics tool.

V.EXPERIMENTAL SETUP

A. Xilinx Platform Studio

The Xilinx Platform Studio (XPS) is the development environment or GUI used for designing the hardware portion of your embedded processor system. B. Xilinx Embedded Development Kit (EDK) is an integrated software tool suite for developing embedded systems with Xilinx Micro Blaze and PowerPC CPUs.

System design consists of the creation of the hardware and software components of the embedded processor system and the creation of a verification component is optional. A typical embedded system design project involves: hardware platform creation, hardware platform verification (simulation), software platform creation, software application creation, and software verification. Base System Builder is the wizard that is used to automatically generate a hardware platform according to the user specifications that is defied by the MHS (Microprocessor Hardware Specification) file.

The MHS file defines the system architecture, peripherals and embedded processors]. The Platform Generation tool creates the hardware platform using the MHS file as input. The software platform is defined by MSS (Microprocessor Software Specification) file which defines customizing operating systems (OS), libraries, and drivers and the The User Constraints File (UCF) specifies timing and placement constraints for the FPGA Design.

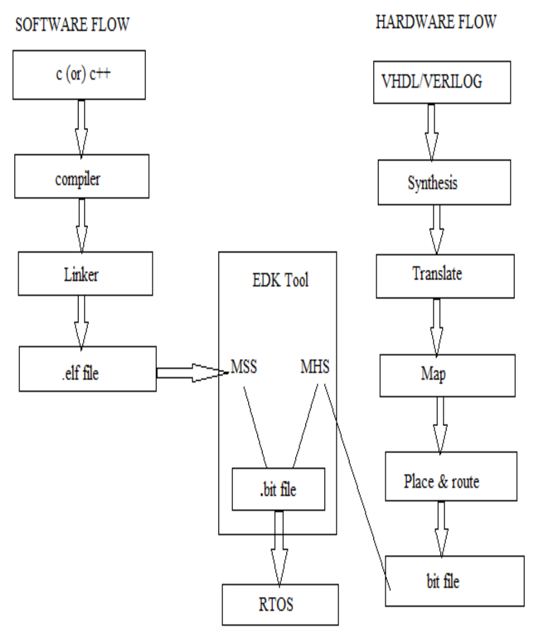

Fig 3 : Embedded Development Kit Design Flow

Downloading bit stream to FPGA

When you select Device Configuration in that Download Bit stream, XPS downloads the bit stream (download. bit file) onto the target board using iMPACT in batch mode. XPS uses the file etc/download.cmd for downloading the bit stream.

Because XPS tools are make file based, the download button calls on the make file and executes the steps necessary to create the bitstream with the ELF file populated within the bitstream.

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B. visual basics

The VB programming system packages up the complexity of windows in a truly amazing way. It provides simplicity and ease of use without sacrificing performance or the graphical features that make window such a pleasant environment to work in Menus, fonts, dialog, boxes etc are easily designed and these features require no more than a few lines of programing to control. It is one of the first languages to support event driven programming a style of program especially suited to graphical user interface. The aim in modern computer application is to have the user in charge. Instead of writing a program that plots out every step in precise order, the programmer writes a program that responds the users action like choosing a command, moving the mouse etc. Instead of writing on large program, the programmer creates an application, which is a collection of co-operating many programs. This project has been done with a virtual view of the traction of the train. It represents the animated view of the moving train with boogies with the multimedia effects etc.

The features of the visual basics are Improved performance ,Visual data access with the data control so that it is possible to create data browsing application without writing code. A new OLE (object linking and embedding) control,and a collection of common dialog boxes that streamline common user interface tasks.

Fig 4: Interpreting and Compiling in VB

IV. EXPERIMENTAL RESULTS

These are the object detection results in the visual basics tool the first two are the input images one with the object and the another one with only background. Finally in the output image we can observe the object with out background.

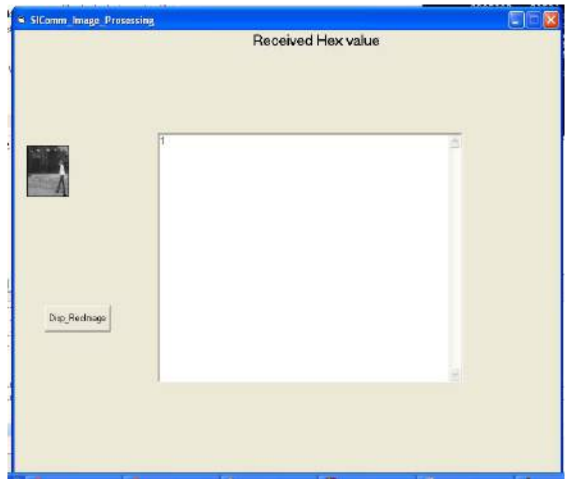

Fig 5: Input image 1

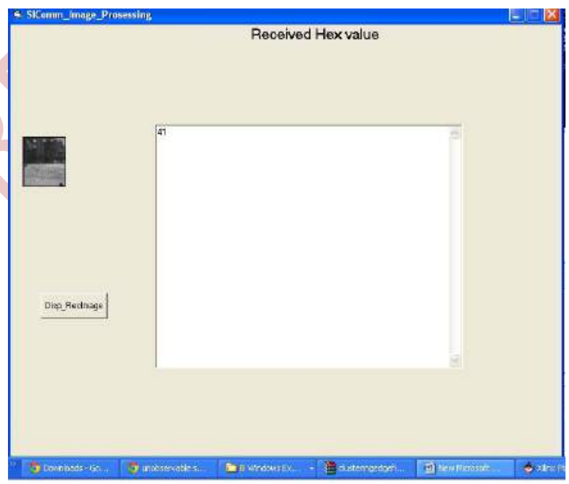

Fig 6: Input image 2

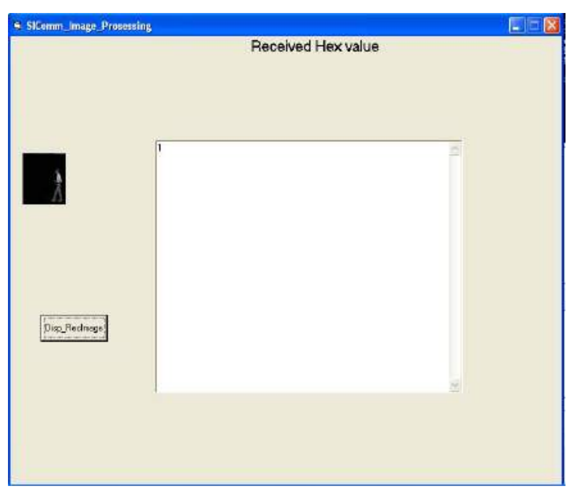

Fig 7: Output image

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Logic utilization	Used	Avaliable	Utilization
Number of slices	1800	1920	97%
Number of slice flip flops	2118	3840	55%
Number of four i/p LUTS	2971	3840	77%
Number of Bonded IOBS	62	97	63%
Number of BRAMS	4	12	33%
Number of MUXE'S	3	12	25%
Number of DCMS	4	8	50%
Number of BSCAN'S	1	4	25%

Table 1: Device Utilization Summary

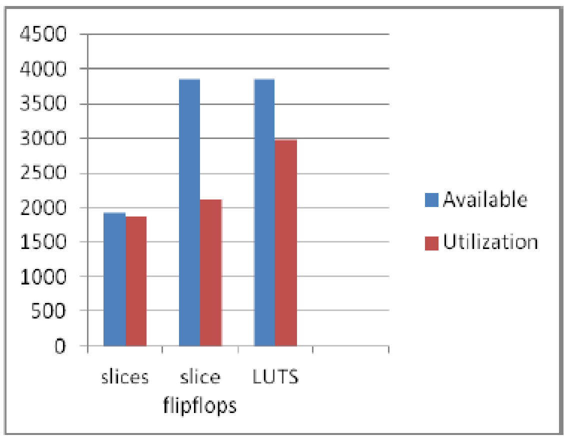

Fig 8: Area utilization

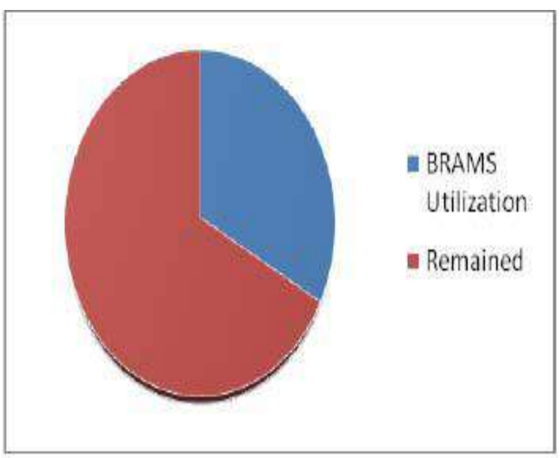

Fig 9: Memory utilization

V. CONCLUSION

In this work a moving object detection based on background subtraction algorithm was developed on a reconfigurable hardware. when compared to the other algorithms like temporal difference and optical flow methods our background subtraction gives a better performance in the utilization of memory and logic elements.

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