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Implementation of GMM for HD Video Segmentation using FPGA

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***Abstract*—Background identification is required in video processing application, such as video surveillance, traffic monitoring. Gaussian Mixture model (GMM) algorithm makes FPGA circuit to perform background identification on High definition video sequence in real time. The GMM algorithm gives good performance in both presence of illumination and multi-model background.GMM algorithm used for real time processing of HD videos and comply with OpenCV algorithm. The implementation of the Open CV GMM algorithm is implemented on Virtex5 (Digilent Genesys Virtex5-LX50T Board) Xilinx FPGA can process at a frame rate more than 60fps. Fitting, Place and Route have been carried out by Xilinx ISE Design Suite.The FPGA implementation of proposed background identification circuit provides improved speed and logic utilization.**

***Index Terms*—Field Programmable Gate Array (FPGA), Gaussian Mixture model (GMM),OpenCV(Open Computer Vision library).**

I. Introduction

Video surveillance monitor sensitive areas such as banks, shops, highways, crowded public places and borders for security purpose. The increase in computational power,storage devices of large−capacity and high speed networks which makes multi video surveillance systems cheaper and feasible. Video surveillance systems used to monitors transient and persistent objects within a specific environment. The real time Moving objects detection is a fundamental step in many vision based applications,e.g video surveillance and traffic monitoring. Moving object detection is the basic step for further analysis of video.Tracking method requires an object detection mechanism either in every frame or when the object first appears in the video. This mechanism handles moving objects segmentation from stationary background. Due to environmental conditions such as changes in illumination, segmentation of shadow object becomes difficult and significant problem. The major three methods of detecting moving objects are Optical flow, frame difference and background subtraction.

Organization of paper is as follows: In Section II, idea about GMM and its implementations. In Section III, gives idea of System implementation. Section IV, concludes with result and discussion.

II. Gaussian Mixture Model

Background subtraction technique is used to detect moving object from static background which is captured by fixed camera. This technique subtracts the current image pixel-by-pixel from a reference background image. The three methods of Background Subtraction are Eigen Background ,Non Parametric Kernel Density Estimation (KDE), Gaussian Mixture Model(GMM). Gaussian Mixture Model (GMM) Background

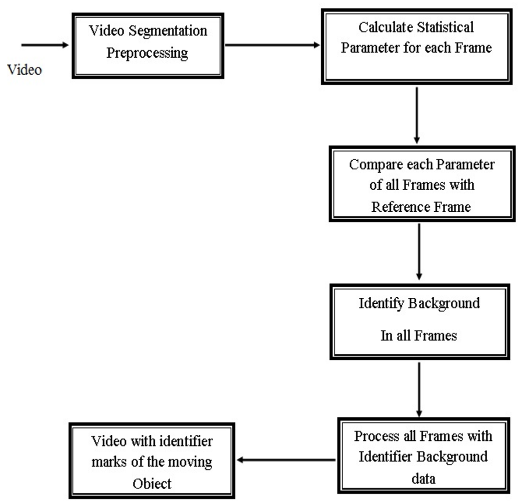

Fig. 1. *Flowchart of GMM algorithm*

subtraction was a powerful technique but it had been only successful in indoor environments. Stauffer and Grimson [1] developed a technique which represents each pixel by a mixture of Gaussians (MoG) and updates each pixel with new Gaussians. This background subtraction technique has become successful in indoor as well as outdoor environments. In this technique, the values of each pixel are calculated as a mixture of Gaussians which uses three to five Gaussians. Using the variance of each of the Gaussians of the mixture, the background and foreground pixel are classified. Pixel that do not match to the background distributions are classified as foreground pixel. This technique is very robust and has been used in the background subtraction for many computer vision works. The GMM based on statistical model for each pixel of the video sequence. It consist mixture of K Gaussian distributions, each one represented by four parameters: weight (w), mean (μ), variance (σ^2), and match sum.

III. System Implementation

The Real-Time detection of moving objects in a video sequence used in applications, such as video surveillance and traffic monitoring. For detection of moving objects major three methods Optical flow, frame difference and background subtraction are used. Background subtraction technique is mainly used when system having static background means system having fixed camera system.

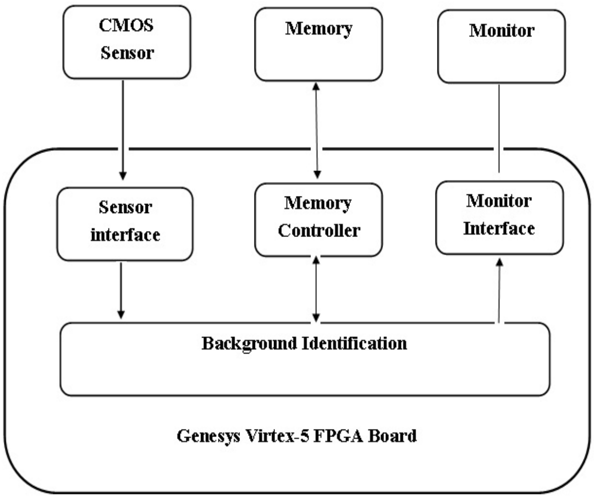

Fig. 2. *Block diagram of the proposed system.*

The hardware consists of Virtex-5 FPGA board, CMOS sensor, Personal computer(PC).The CMOS sensor will capture the each frame of video sequence and gives pixel values to background identification circuit.Background identification circuit implemented using Virtex-5 FPGA, based on Gaussian Mixture model (GMM) algorithm. The FPGA implementation of GMM algorithm is synthesized and implemented on Virtex5(DigilentGenesysVirtex5-LX50T Board) Xilinx FPGA. The Genesys circuit board is a digital circuit development platform based on a Xilinx Virtex 5 LX50T. The board consist of high-end peripherals, including Ethernet, HDMI, 64-bit DDR2 memory array, and audio,USB ports make the Genesys board best for designing complete digital systems, consist of embedded processor designs based on Xilinxs MicroBlaze.

The software part consist of Xilinx ISE, MATLAB ,OpenCV Xilinx ISE series software is used in this thesis for the implementation of the circuit in field programmable gate arrays (FPGA). In the Xilinx foundation series software, the digital design is created using the hardware description language such as VHDL. The outputs of these programs produce netlists. This netlist is converted into a bit stream file, which configures the FPGA. MATLAB is a high-level language and gives interactive environment for numerical computation, visualization, and programming. MATLAB used to analyse data, develop algorithms and create models and applications. OpenCV means Intel Open Source Computer Vision Library. It is a collection of C functions and a few C++ classes uses to implement the Image Processing and Computer Vision algorithms.

IV. Result and Discussion

Gaussian Mixture model (GMM) algorithm used as background subtraction to detect moving object in video sequences.The GMM algorithm gives good performance in both presence of illumination and multi-model background.The implementation of GMM algorithm using Virtex-5 FPGA to detect moving object.Gaussian Mixture model (GMM) algorithm makes FPGA circuit to perform real time background identification on High definition video sequence.

OpenCV mainly used for real time applications. OpenCV program is written in C and which takes the advantage of multicore processors. If the video file is saved in computer, then following input output windows are displayed.

Fig. 3. *Input Video*

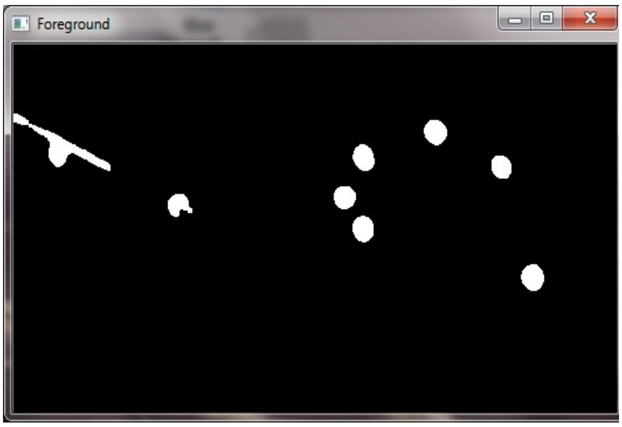

Fig. 4. *OpenCV Output Window*

If the real time video captured by Web Camera, then following input output windows are displayed.

Fig. 5. *Camera Input*

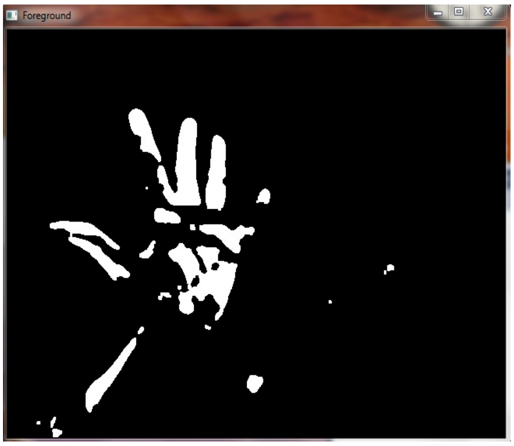

Fig. 6. *Output Window*

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