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Hardware Implementation of Background Subtraction based Moving Object Detection

Kamatchi Sundari. V
Research Scholar
Sathyabama University, Chennai, India

Manikandan.M
Associate Professor
Anna University, Chennai, India

***Abstract*— The paper given here is that the implementation of motion detection algorithm for object tracking on TMS320C6745 DSP processor. Identifying the moving objects from a video sequence is the fundamental and critical task in robotics, surveillance and many computer vision applications. Many various strategies are projected over recent years. Among the varied motion detection techniques, background subtraction strategies are common, particularly for application relying on fixed camera. There are many challenges in developing a good Background Subtraction algorithm. First, it ought to be study to the changes in illumination. Second, it ought to avoid detecting non stationary objects like papers and shadows. To achieve the implementation process code composer studio V4 from Texas Instruments has been used in this work. Our motto in this work is to implement dynamic thresholding based background subtraction on TMS320C6745 DSP processor.**

Index terms - Background Subtraction (BS), Code Composer Studio (CCS), Image Segmentation, Integrated Development Environment (IDE), Video surveillance.

I. INTRODUCTION

Background Subtraction (BS) is widely used approach for detecting moving objects of interest in video sequences in diverse applications including remote sensing, surveillance, diagnosis in medical field and underwater sensing. As a basic, the background should be a illustration of the scene with no moving objects and must be kept regularly updated so as to adapt the varying luminance conditions and geometry settings.

Several approaches are accessible to find, segment and track objects automatically in videos. Simple motion detection algorithms compare a static background with the current frame of a video scene pixel by pixel. The idea behind BS is to build a background model and compares this model with current frame to detect area where significant difference occurs. In short, the aim of the background subtraction is to tell apart foreground moving object(s) from background. In real situations background could contain static objects, moving objects like waves on the water, trees jolted by the wind, fumes etc. Additionally once static object starts moving; background subtraction algorithmic program detects the item in motion. Code Composer Studio (CCS) provides Integrated Development Environment (IDE), which has the software tools for building and debugging programs for the DSP processor kit. CCS includes tools for code generation, such as a C Compiler, an assembler, and a linker. It has graphical capabilities and supports real time debugging.

A. Related work

A "semantic object" is a collection of image pixels that corresponds to the real objects in successive image planes of a video sequence. In this context, we define a region as a homogenous area (one or multiple pixels) according to a pre-defined quantitative criterion such as grey level, color, texture, motion or any of the combinations [1,2,3]. In [4]C. Gu and M. C. Lee have attempted a supervised initial segmentation and unsupervised tracking. Other image segmentation schemes such as graph search method [5,6] can also be used to reduce the amount of user intervention. In a different approach from blobs, Bregler in [7] represented each pixel in each motion image by its optical flow characteristics according to certain features of the flow vector. The colour spaces that are typically used in video tracking and surveillance are YCbCr [8] and HSV [9]. According to [12], a background subtraction technique must adapt to gradual or fast illumination changes (changing time of day, clouds, etc), motion changes (camera oscillations), high frequency background objects (e.g., tree leave or branches),and changes in the background geometry (e.g., parked cars). In [11]Stauffer and Grimson discussed the most popular pixel level algorithm named as Gaussian Mixture Model (GMM) in which the distribution of each pixel value over time as a Mixture of Gaussians (MoG), which is adaptively updated in an online manner, and then classify incoming pixels into either background or not. In [14] Background subtraction technique is implemented on TMS3206713 DSP processor by Sandip V Patil and V. V. Gohokar.

B. Organization

Section II describes the proposed system , section III gives the results obtained with our algorithm and section IV describes conclusion obtained from this research.

II PROPOSED METHOD

A. Background Subtraction

Moving objects detection is to select, recognize and analyze the underlying moving objects containing in the image or video data sequence. Most BS techniques share a common framework: they make the hypothesis that the observed video sequence is, is made up of a fixed background B in front of which moving objects are observed.

Foreground detection described by A.Mclvor [10] is a comparison process involves the comparison of observed image with an estimated image that does not contain any object of interest and this process results in two complementary sets in which the first set consists of foreground pixels and second set consists of background pixels. In a fixed threshold method moving object can be detected with

$$D_k(x,y) = \begin{cases} 1 & |Fk(x,y) - Bk - 1(x,y)| > T \\ 0 & others \end{cases} \quad (1)$$

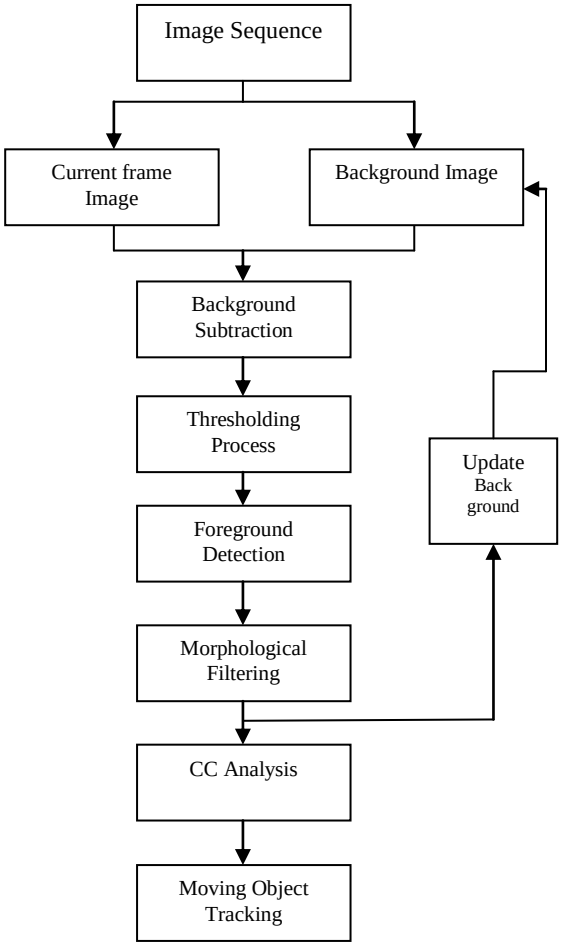

Figure.1. Block diagram of our proposed system.

Where $F_k(x,y)$ is current frame , $B_{k-1}(x,y)$ is previous frame ,$D_k(x,y)$ is difference and T is fixed threshold. This method is suitable for ideal situations and not for complex environments. This problem is solved by dynamic thresholding (Anastasios Dimou, Olivia Nemethova and Markus Rupp [11]) in which threshold value is T+ΔT and its mathematical expressions are

$$\Delta T = \lambda \frac{1}{MxN} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} |F(i,j) - B(i,j)| \quad (2)$$

$$D_k(x,y) = \begin{cases} 1 & |Fk(x,y) - Bk - 1(x,y)| > T + \Delta T \\ 0 & others \end{cases} \quad (3)$$

Background detection is a potential method of motion detection, flow chart of our method is given in figure. 1. Considering the first frame as the initial background image, foreground is detected (3) by subtracting background image from current image and is followed by dynamic thresholding process. i.e. if the difference is more than the threshold value , corresponding pixel value is taken as one otherwise zero. Then smoothen the output image with morphological operation. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring component is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. The objective of the connected component analysis is to detect the large sized connected foreground region or object. This is one of the important operations in motion detection. The pixels that are collectively connected can be clustered into changing or moving objects by analyzing their connectivity.

B. Moving object Detection using TMS320C6745 DSP processor.

The C6745 is a Low-power digital signal processor based on C674x DSP core [15]. It consumes significantly lower power than other members of the TMS320C6000™ platform of DSPs. The C6745 DSP core uses two level cache based architecture. The Level 1 program cache (L1P) is a 32KB direct mapped cache and the Level 1 data cache (L1D) is a 32KB. The Level 2 program cache (L2P) consists of a 256KB memory house that is shared between program and data space. L2 conjointly includes a 1024KB ROM. L2 memory may be organized as mapped memory, cache, or combinations of the two. The peripheral set includes: a 10/100 Mb/s Ethernet MAC (EMAC) with a Management Data Input/output (MDIO) module; two integrated circuit (I2C) Bus interfaces; 3 multichannel audio serial port (McASP) with 16/9 serializes and FIFO buffers; 2 64 bit general purpose timers each configurable (one configurable as watchdog); a configurable 16 bit host port interface up to 8 banks of 16 pins of general purpose input/output with programmable interrupt/event generation modes, multiplexed with alternate peripherals; three UART interfaces (one with RTS and CTS); 3 enhanced high-resolution pulse width modulator (eHRPWM) peripherals; 3 UART interfaces; 3 (eCAP) module peripherals which can be configured as 3 capture inputs or 3 auxiliary pulse width modulator (APWM) outputs; 2 32-bit enhanced quadrature pulse peripherals; and 2 external memory interfaces: an asynchronous and SDRAM external memory interface (EMIFA) for slower memories or peripherals, and a higher speed memory interface (EMIFB) for SDRAM.

Key features of TMS320C6745 DSP processor are (i) enhanced memory access controller 3 (EDMA3) (ii) Fixed/Floating Point VLIW DSP Core (iii) three configurable 16550 type UART Modules. The GPIO Mux registers are used to select the operation of shared pins on the c674XX and the pins can be individually selected to operate as “Digital I/O” or connected to “Peripheral I/O” signals (via the GPxMUX egisters). If designated for “Digital I/O” mode, registers are provided to configure the pin direction via

GPxDIR registers. TMS320C6745 has 30 general purpose I/O lines.

CCS v4 is a major new release of Code Composer Studio that is based on the Eclipse open source software framework [16]. The Eclipse software framework was originally developed as a development tool primarily for Java application development and an open framework for making development tools. It is becoming very popular in the embedded development community and is now being used or adopted by many different vendors. Code Composer streamlines the design process with a lot of intuitive interface combined with leading C code density and powerful debugging capabilities. Major upgrades embody optimizations and enhancements centered on improving design flow, simplifying debugging and verification and rushing time-to market where as keeping system prices low.

Block diagram for Hardware used is given in figure.2. and figure.3. shows the DSP kit used in our work.

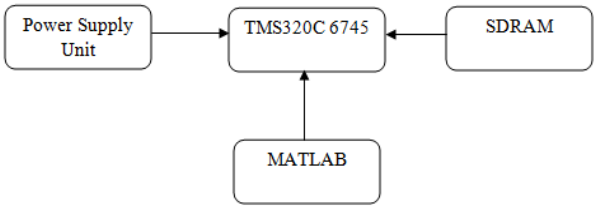

Figure.2. Hardware Block diagram

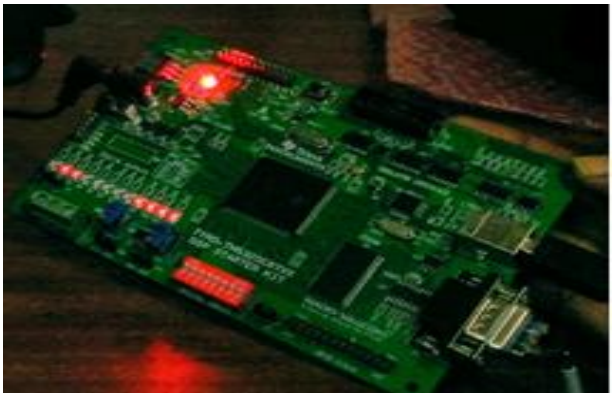

Figure.3. TMS320C6745 DSP processor Kit

Proposed algorithm is implemented with TMS320C6745 DSP processor. The coding for the object detection is developed using C language in CCSv4 which is launched into the target by means of XDS100 Emulator. The image to be detected is transmitted and received using MATLAB coding with the help of RS232cable. Finally the output is displayed on the monitor screen and is stored in SDRAM.

III. EXPERIMENTAL RESULTS

This algorithmic program is enforced in MATLAB R2010a. Video sequence named water surface.avi [17] is taken for our experiment in which human body is considered as moving object. Figure.4. and 5 shows the simulation results for different frames.

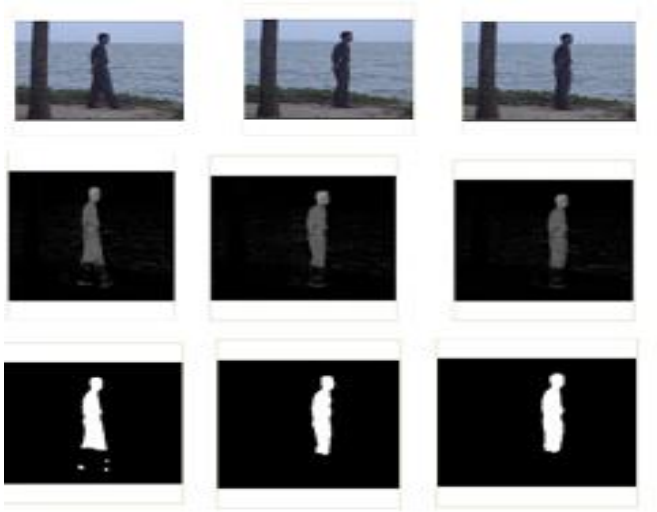

Figure.4. First row are input video frames, second and third row are their respective frame difference and cc analysis outputs.

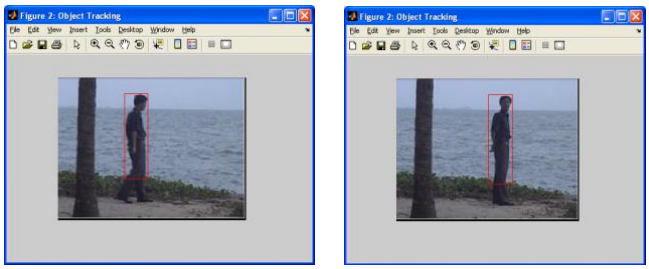

Figure.5. Simulation results for object tracking.

Figure shown below is the snapshot of result obtained during hardware implementation with TMS320C6745 DSP processor.

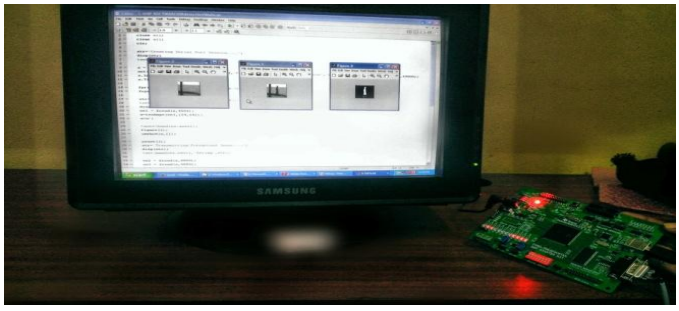

Figure.6. Snapshot of Hardware implementation process.

IV.CONCLUSION

The task presented here is an efficient motion detection based on background subtraction using frame difference with thresholding and mathematical morphology. It will be enhanced with futures of connected component analysis and morphological filtering for tracking of moving objects. This paper conjointly illustrates the design and implementation of a moving object detection system based on the High-performance, Low-power digital signal processor

based on C674x DSP core. This moving objects detection system with optimal algorithm based on dynamic thresholding models may be applied into video surveillance system, autonomous robots, and other involving embedded vision applications.

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V.Kamatchi Sundari is currently Associate Professor at MNM Jain Engineering College, Chennai, Tamilnadu, India. She is pursuing her PhD from Sathyabama University, Chennai, Tamilnadu, India. Her research areas include **Image & Video Processing,** Implementation of computer vision algorithms in FPGA. She is life member of **IETE** and **ISTE**.

Dr. M. Manikandan is currently Associate Professor at Anna University, Chennai, Tamilnadu, India. He completed his **Masters** from Madras University and **PhD** from Anna University. His areas of interest includes **Image & Video Processing**, Computer Vision, and Wireless Networks. He is life member of **IETE** and **ISTE**.