FaceID: Benchmarks for Face Detection Algorithms Using Cell Processor

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Abstract. This poster presents a method for face detection, tracking using single camera. It uses matrix of classifier parameters, optimization of storage (data types), cascade of strong classifiers with less stages, and vectorization of first level stage of strong classifiers to obtain the better performance on Cell Broadband Engine Technology. The face detection uses the algorithm implemented on PS3 with OpenCV Library, based on Viola Jones and joint haar-like features. The algorithm was optimized considering the limited memory on each synergistic processor element (PPE) and access to main memory through DMA (Direct Access Memory). The face detection application was developed thinking about real time surveillance system and video analysis.

1. Introduction

The object detection has been used for identification systems of people and interaction with several environments such as domestic environment and offices. The security and commodity can be obtained through gestures and voice commands, personalized for each profile [1]. Many applications such as human-computer interfaces, collaboration environments, video conference, computer games, public vigilance and information security with biometric identification are interested in face detection.

The object detect algorithm was proposed initially by Viola Jones [2]. Other related work [3] proposed the use of combined characteristics at classifiers (joint haar-like features) what provides reduction in the number of characteristics for classifiers and increases the performance comparing with Viola Jones algorithm.

In this poster, we present a method for face detection algorithm using Cell Broadband Engine (Cell B.E.) processor. This method uses a vectorized implementation with specific techniques targeted for Cell B.E.programming to achieve better performance on the processing time.

Our full system involve the module of face detection, tracking, adjust to recognition and recognition.

The main goal of this poster will be the presentation of face detection algorithm on PS3 with OpenCV Library. The others major goals are:

- Definition of Case Study and major contribution;
- Face Detection Algorithm and Vectorization Approach;
- Results and Brief Conclusion.

2. Overview of Case Study: OpenCV on Cell

This poster presents the OpenCV library on Cell SDK 3.1. The Cell IDE works on top of Eclipse with C/C++ support and provides a common interface for development and for running applications using the IBM full-system Simulator for Cell Broadband Engine. The module of object detection uses the algorithm derived by Viola Jones model proposed on OpenCV. We executed the face detection application using the simulator, simulating a real machine (PS3).

According to Kahle [4], the Cell B.E. platform provides specific architectural characteristics (PowerPC Multithreaded and 8 synergistic processor elements - SPEs) that define the new Cell Programming Model based on vector processing and access to main memory by Direct Memory Access (DMA). These factors require complex and efficient algorithms that provide high performance and low energy consumption.
The implementation of algorithms that explore parallelism and instruction pipeline, especially using Cell B.E. programming, depends on aspects related with the standard of memory accesses and reorganization of data in memory.

The challenge of this work was to develop the face detection algorithm using a vector implementation and tackle with the limited memory on SPE’s by the use DMA.

3. Face Detection Algorithm and Vectorization Approach

Our Face Detection Algorithm is related with the following concepts: integral images for features calculations, learned algorithm (based on AdaBoost) and cascade of classifiers.

The OpenCV library implements the face detection version with Viola Jones. This algorithm was developed to provide weak classifiers of rectangle features.

The vectorization of weak classifiers on SPE was composed with calculations of integral images of rectangle features.

\[ D = P_4 + P_1 - (P_2 + P_3) \]

The optimization on SPE is focused on calculation of integral image divided on 4 sub windows of detection.

The major contribution of vectorization approach was provided flexibility and optimization of SPE memory. The following questions were modified on face algorithm:

- Vectorization of first stages of strong classifiers of cascade classifiers.
- Data Dynamic Allocation of classifiers’ parameters (strong, weak and features).
- Distributed Processing of Integral Images by Queues.

The vector implementation depends of strong classifier at initial stage that present the bigger weight than others weights. This approach provides 4 float-point instructions per cycle and integral image organization on continue blocks of data.

4. Results

We compared the performance of the same cascade classifiers between modified Haar-like algorithm (called OpenCV al) and OpenCV default. Our algorithm obtained more 3, 44% of performance than original OpenCV algorithm running on P4.

![Figure 02: Vectorized Implementation](image)

5. Conclusion

We concluded the following considerations: the classifier of OpenCV default presents the window detection 24 x 24 and OpenCV modified presents the window detection 20 x 20. Then, the time processing is high. And the utilization of small buffers provided the efficiency of limited memory on SPE.

Finally, we compared the performance between 1 SPE and PPE. The SPE performance is 4 times faster than PPE.

6. References


