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Comparative Study of CAMSHIFT and RANSAC Methods for Face and Eye Tracking in Real-Time Video

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ABSTRACT

Real-Time Facial and eye tracking is critical in applications like military surveillance, pervasive computing, Human Computer Interaction etc. In this work, face and eye tracking are implemented by using two well-known methods, CAMSHIFT and RANSAC. In our first approach, a frontal face detector is run on each frame of the video and the Viola-Jones face detector is used to detect the faces. CAMSHIFT Algorithm is used in the real- time tracking along with Haar-Like features that are used to localize and track eyes. In our second approach, the face is detected using Viola-Jones, whereas RANSAC is used to match the content of the subsequent frames. Adaptive Bilinear Filter is used to enhance quality of the input video. Then, we run the Viola-Jones face detector on each frame and apply both the algorithms. Finally, we use Kalman filter upon CAMSHIFT and RANSAC and compare with the preceding experiments. The comparisons are made for different real-time videos under heterogeneous environments through proposed performance measures, to identify the best-suited method for a given scenario.

KEYWORDS

Adaptive Bilinear filter, CAMSHIFT, Eye Tracking, Face Tracking, Haar-Like Features, Kalman Filter, RANSAC, SURF Features

INTRODUCTION

Face Detection / Tracking pose a major challenge for computer vision. It has always been a very challenging task for researchers. The main motivation comes from the fact that the face recognition process is passive and there is no intrusive system to verify and identify people. Face detection is also the first step in the face recognition process. Facial features should be extracted in the best possible way so as to recognize and track faces in real-time. If the first step to detect face goes ineffective then the face recognition process may be inaccurate and require a lot of time. Faces are highly variable. Face analysis is very easy for humans. Understanding the human visual system might help us to understand human brain to a certain extent. Some of the challenges in face detection and tracking are occlusion, clutter, light variation, shadowing, pose variation, low or poor resolution. Many new algorithms and improvement to the existing ones have been proposed in face detection and tracking. The most widely used procedures to track objects in real-time are CAMSHIFT and RANSAC. Many real -tracking systems have been developed with more enhanced techniques using CAMSHIFT and RANSAC as their core algorithms. Both Algorithms have trade-offs. Hence, we chose these two

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algorithms for our study. Thus, we are going to compare and cross-analyze these two algorithms under various scenarios and extremities to identify the behavior of both the algorithms. We perform validation of both the algorithms in different scenarios so that we can effectively enhance the existing procedures to improve the performance of the algorithms. In this work, we study various issues like lighting variations, occlusion, and facial deformation while carrying out face and eye tracking using both CAMSHIFT and RANSAC algorithms. Initially, we apply both the procedures CAMSHIFT and RANSAC to a raw input video without applying any filters and observe the performance of these algorithms. Then, we apply Adaptive Bilinear Filter (ABF) to the input videos to enhance the quality and remove noise in the incoming video frames as a pre-processing step. Finally, we apply Kalman Filter to both CAMSHIFT and RANSAC and compare with the previous work involving the application of CAMSHIFT and RANSAC without the usage of any filters. ABF and Kalman Filters are used everywhere from image to video processing. We applied these techniques and evaluated based on the parameters we devised, to enable the researchers to choose an apt technique for their research purpose in a given scenario. The main objective of this work is to compare and analyze the best method for face & eye tracking using quantitative parameters like frames per second, face & eye tracking time, the average hit rate for face & eyes and average maximum latency. The validation of different procedures used in face and eye tracking using various performance metrics can provide considerable enhancement in its applications like biometrics, medicine, video surveillance etc., thus improving its accuracy. The following experiment is done in OpenCV-2.4.8. We also use Boost C++ libraries to obtain the timers for performance analysis.

RELATED WORK

Computer Vision plays an important role in many applications, especially in artificial intelligence and pervasive computing. The Continuously Adaptive Mean Shift Algorithm or CAMSHIFT (Arceneaux IV, Schedin, & White, 2010) is an adaptation of the Mean Shift algorithm for object tracking and is used for head and face tracking. Random sample consensus, or RANSAC (Martin & Robert, 1981), is an iterative method for estimating a mathematical model from a data set that contains outliers. The current procedures for face detection and tracking have many challenges such as malfunction due to pose Variations, lighting variation and shadowing, blur due to fast motion, occlusion and clutter, facial deformation, facial resolution in videos, quick and large in-plane and out-of-plane head rotation.

(Lu, Dai, & Hager, 2006) Showed a new object tracking approach based on the analysis of a two-dimensional image distribution histogram calculated from two colorimetric channels automatically selected on criteria of representativeness. This approach is a prolongation of the CAMSHIFT algorithm applications (continuously adaptive mean shift) in order to track object presenting strong modifications of shape and light. (Lae-Kyoung Lee, 2011) presented an approach to solve the problem of real-time face detection and tracking in a complex environment. The method consists of two phases.

The first phase is based on skin color detection and Haar-Like features to enhance face tracking reducing the computational cost. In the next phase, an extended CAMSHIFT algorithm is involved in the construction of multi-dimensional histogram. This extended CAMSHIFT algorithm makes face tracking robust against appearance changes and similarity in color of the multiple targets and hence enhances the efficiency in gesture recognition. Viola and Jones (Viola & Jones, 2004) presented a method to improve CAMSHIFT algorithm because the Original CAMSHIFT fails in the case of multi-coloured targets where color alone cannot be used to distinguish the targets. In addition, CAMSHIFT also fails with shape and orientation changes and total occlusion. In this method, a background-weighted histogram was constructed which differentiates between targets and the background. Kalman filter was combined along with CAMSHIFT to avoid being trapped by the local maximum. Therefore, this real-time algorithm can cope up with temporal occlusion involving a small computational cost. Experiments by (Liu, Sun, Yang, Li, & Wu, 2014) combining CAMSHIFT and Kalman filter has reduced the number of iterations and improved precision. Similarly, (Liang,

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