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Comprehensive Insights into Evaluation and Benchmarking of Real-time Skin Detectors: Review, Open Issues & Challenges, and Recommended Solutions

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Abstract: Evaluation and benchmarking of real-time skin detectors remain challenging because of multiple evaluation attributes that must be considered. Numerous evaluation and benchmarking techniques have been proposed, but they exhibit several limitations. Fixing multiple attributes based on benchmarking approaches by using other attributes limits reliable real-time skin detection. This paper presents comprehensive insights into the evaluation and benchmarking of real-time skin detectors on the basis of two critical directions. Current evaluation criteria highlight conflicting issues and benchmarking techniques to identify weak points, and possible solutions are discussed. The findings are as follows: (1) open issues and challenges to evaluation and benchmarking are emphasized; and (2) decision making using multiple criteria such as reliability, time complexity, and error rate within a dataset is used for evaluating and benchmarking real-time skin detectors to come up with solutions for future directions.

Keywords: Multi-Criteria Analysis, Evaluation and Benchmarking, Skin Detector, Multi-criterion Decision Making

1. Introduction

Real-time skin detection based on artificial intelligence algorithms are practical and effective techniques for segmentation; numerous researchers have applied different adaptation strategies for soft computing techniques (Sisodia and Shrish 2011; Shruthi and Harsha 2013; Zaidan, A.A. et al. 2014b, 2014c). However, two key problems are encountered by developers of real-time skin detection techniques. One problem is on how skin detection approaches are evaluated on the basis of multi-criteria evaluation and how novel skin detection approaches are benchmarked against existing approaches. Evaluation and benchmarking in this particular area are thus considered challenges and gaps in the existing literature.

To evaluate real-time skin detectors, the following three main requirements should be measured first: reliability, time complexity, and error rate within the dataset (Ramachandra, R. and Busch, C. 2017). Reliability should be high, time complexity for obtaining output images should be low, and error rate resulting from the training datasets should be low. Duffner, S. and Odobez, J.M., (2014); Szkudlarek, M. and Pietruszka, M., 2015; Lu, C. and Mandal, M. (2015) proposed the procedure of time complexity. SanMiguel, J.C. and Suja, S., (2013); Ballerini, L. et al. (2013); Stergiopoulou, E. et al. (2014); Mahmoodi, M.R. (2015) proposed a dataset criterion for determining the error rate but did not propose a method. Each of these researchers also proposed a reliability criterion but did not specify a particular level to compare with that of other criteria. The major challenge to the development of skin detection techniques is that the developers focus on either increasing the reliability while maintaining a low error rate or decreasing the time complexity only. Such approach affects the results of the skin detection system in most cases and cannot obtain high reliability and low rate (time complexity or error rate within the dataset) simultaneously. Therefore, future investigations need to highlight the conflict between the criteria and define their procedure reflected in the evaluation and benchmarking process. A comprehensive review of literature is also essential to determine the limitations of adopting the aforementioned criteria for studies on real-time skin detection.

Existing evaluation and benchmarking rely on only available criteria and methods to measure reliability. For example, RapidMiner tool disregards the time complexity and performs the benchmarking process by testing only the reliability of the skin detection technique (Satyanarayana, A. 2013; Jovic, A. et al. 2014; Al-Odan, et al. 2015). Therefore, future investigations need to consider all current tools to determine their limitations.

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