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Shot classification and replay detection for sports video summarization

Key words: Extreme learning machine; Lightweight convolutional neural network; Local octa-patterns; Shot classification; Replay detection; Video summarization

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Motivation

1. Management and handling of massive sport content is very challenging. Automated sports video content analysis requires effective segmentation and classification of shots into different views (i.e., long, medium, close-up, and out-field).
2. Existing shot classification methods are limited in certain ways; e.g., they are genre-specific, computationally complex, and dependent on deviations in camera, illumination conditions, game structure, shot speed, occluded objects, broadcasters, etc.
3. Existing replay detection oriented summarization approaches have various limitations, e.g., computational complexity of logo detection, dependency on logos (size, design, and position), variations in replay speed and frame transition, and dependency on editing effects.

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Main contributions

1. We present an effective and lightweight shot classification method that can reliably be used to classify shots into long, medium, close-up, and out-field views.
2. We propose a feature descriptor, local octa-pattern (LoP), for effective representation of video frames.
3. We present an effective replay detection based video summarization method that can accurately classify the replay and non-replay (live) frames in sports videos.
4. The proposed framework is robust to variations in camera, illumination conditions, editing effects, frame transitions, sports genre, shot length, shot type, broadcasters, logos, etc.

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Proposed framework

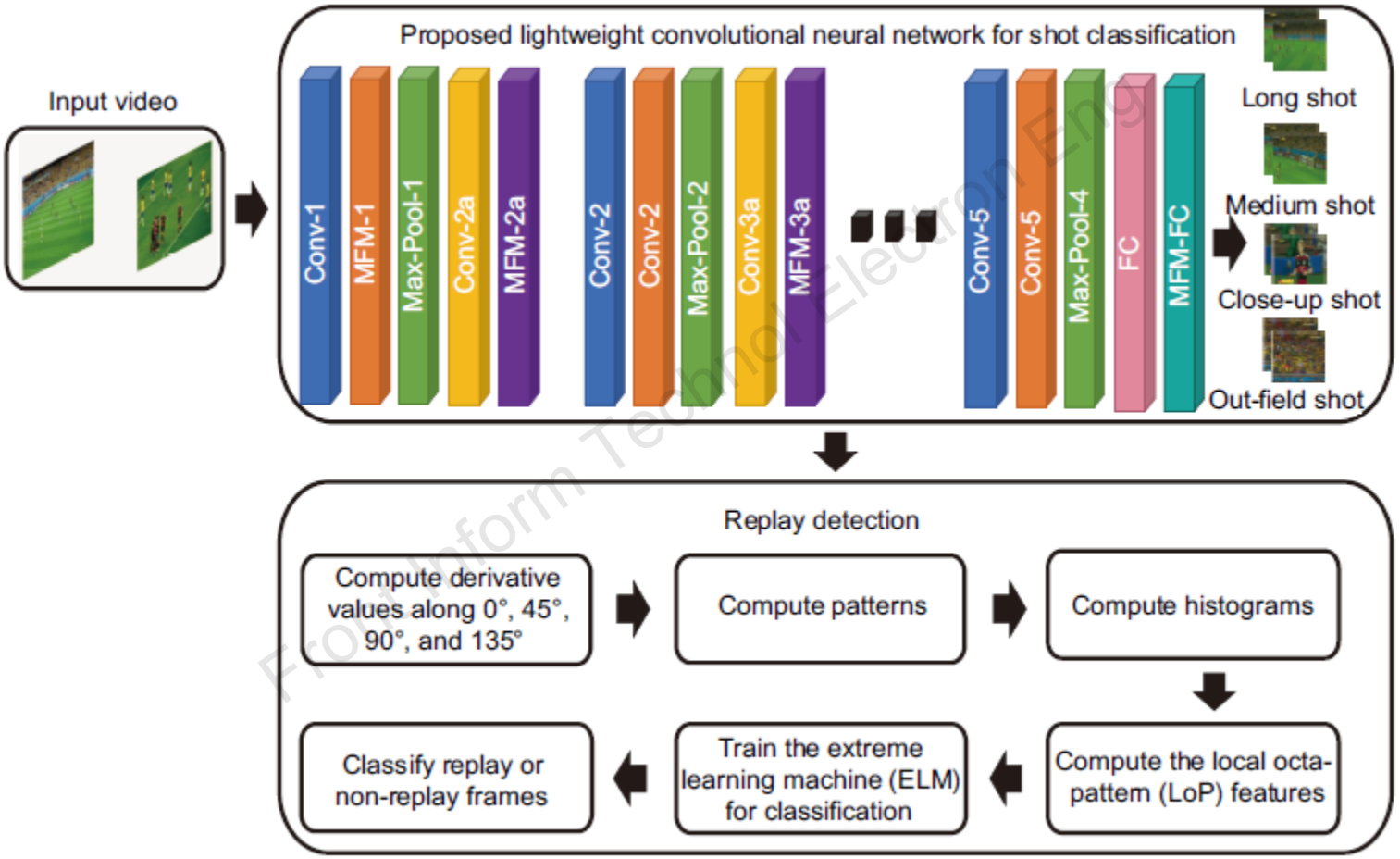


Fig. 1 Architecture of the proposed framework

Dataset

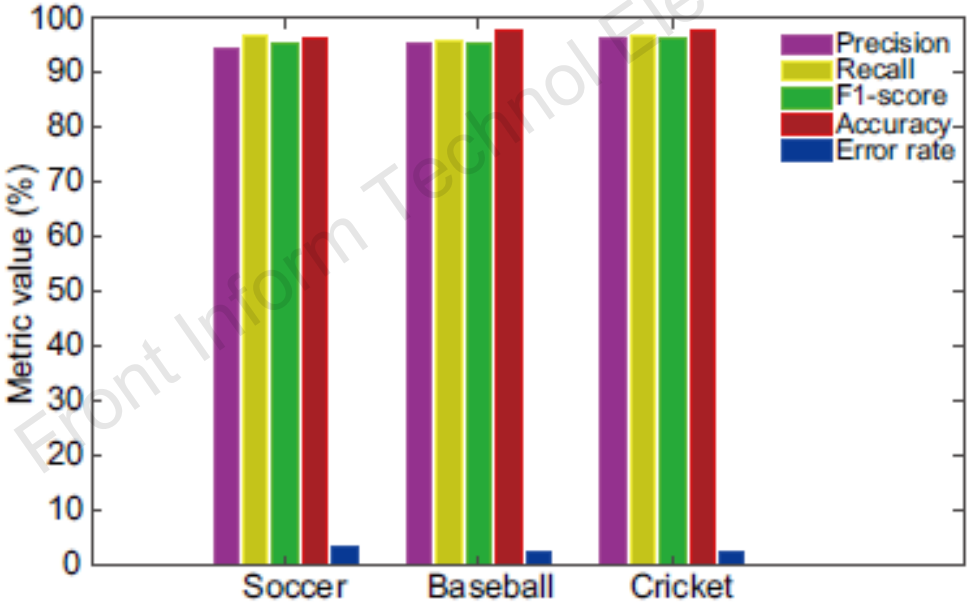
The performance of our proposed framework is evaluated on YouTube sports videos of three kinds of sports genre (soccer, baseball, and cricket). Our diverse dataset includes 50 videos of 100-h duration.



Fig. 3 Live and replay frames in sports videos of our dataset

Experimental results

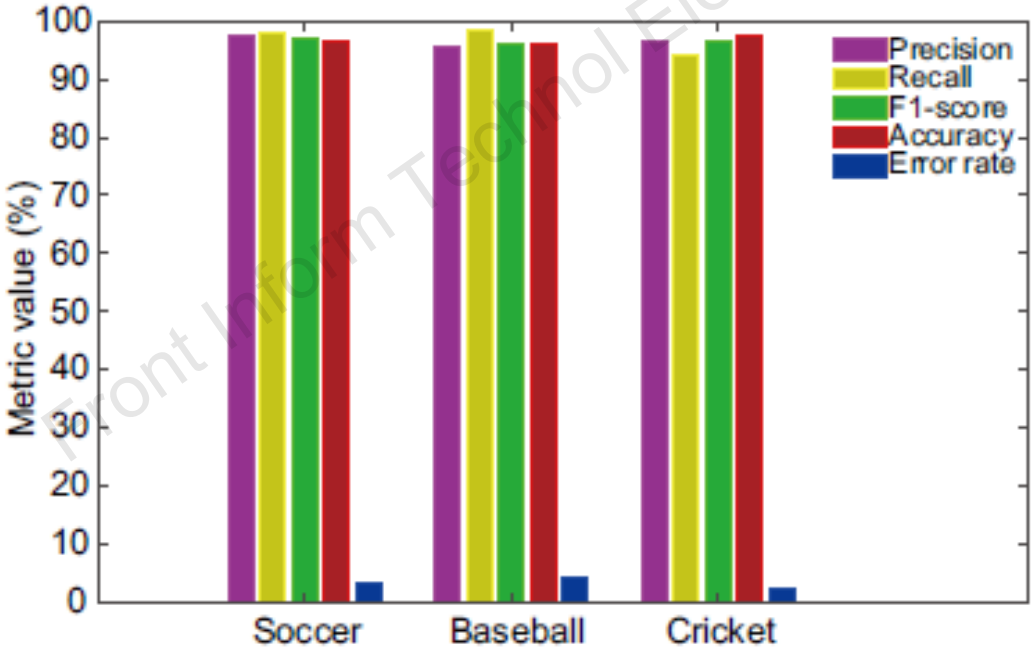
Performance evaluation of the shot classification method



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Experimental results (Cont'd)

Performance evaluation of the replay detection method



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Experimental results (Cont'd)

Performance comparison with existing methods

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Table 2 Comparative analysis of shot classification methods

Shot classification method	Sports genre	Precision (%)	Recall (%)
Kapela et al. (2017)	Field sports	82.5	84.2
Javed et al. (2020)	Field sports	94.6	96.2
Minhas et al. (2019)	Field sports	90.6	91.3
Fani et al. (2017)	Soccer	90.6	91.3
Proposed method	Field sports	95.2	96.6

Experimental results (Cont'd)

Performance comparison with existing methods

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Table 3 Comparative analysis of replay detection methods

Replay detection method	Sports genre	Precision (%)	Recall (%)
Javed et al. (2019)	Field sports	95.09	95.94
Javed et al. (2016)	Field sports	92.97	94.70
Choroś and Gogol (2016)	Field sports	86.19	64.35
Proposed method	Field sports	96.30	96.90

Conclusions

1. An effective summarization framework based on shot classification and replay detection for field sports videos has been proposed.
2. The effectiveness of our framework has been illustrated in terms of average precision and recall of 95.2% and 96.6% for shot classification, and 96.3% and 96.9% for replay detection, respectively.
3. The possibility exists for incorrect replay detection due to unsuccessful detection of successive logo frame sets.
4. In the future, we plan to further enhance the performance of our replay detection method.

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Ali JAVED received the BS degree with honors and 3rd position in Software Engineering from UET Taxila, Pakistan, in 2007. He received his MS and PhD degrees in Computer Engineering from UET Taxila in 2010 and 2016, respectively. He received Chancellor's Gold Medal in MS Computer Engineering degree. He is serving as an Associate Professor in Software Engineering Department at UET Taxila. Previously, he served as an Assistant Professor in Software Engineering Department at UET Taxila. He has served as a Postdoctoral Scholar in SMILES Lab at Oakland University, USA in 2019 and as a visiting PhD scholar in ISSF Lab at University of Michigan, USA in 2015. He is a recipient of various research grants from HEC Pakistan, National ICT R&D Fund, NESCOM, and UET Taxila. He has also served as an HOD in Software Engineering Department at UET Taxila in 2014. He was selected as an Ambassador of Asian Council of Science Editors from Pakistan in 2016. He is also a member of Pakistan Engineering Council since 2007. His areas of interest are digital image processing, computer vision, video content analysis, machine learning, multimedia signal processing, and multimedia forensics.

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