Magnifying Spontaneous Facial Micro Expressions for Improved Recognition

Pratikshya Sharma[1], Sonya Coleman[1], Pratheepan Yogarajah[1], Laurence Taggart [2], Pradeepa Samarasinghe [3]

School of Computing, Engineering & Intelligent Systems[1], School of Nursing[2], University of Ulster, Northern Ireland

Department of Information Technology [3], Sri Lanka Institute of Information Technology, Sri Lanka

ABSTRACT

We investigate if amplifying micro facial muscle movements as a pre-processing phase, by employing Eulerian Video Magnification (EVM), can boost performance of Local Phase Quantization with Three Orthogonal Planes (LPQ-TOP) to achieve improved facial MER across various datasets. In addition, we examine the rate of increase for recognition to determine if it is uniform across datasets using EVM. Ultimately, we classify the extracted features using Support Vector Machines (SVM). We evaluate and compare the performance with various methods on seven different datasets namely CASME, CAS(ME)^2, CASME2, SMIC-HS, SMIC-VIS, SMIC-NIR and SAMM. The results obtained demonstrate that EVM can enhance LPQ-TOP to achieve improved recognition accuracy.

OBJECTIVE

- To present an extensive analysis to demonstrate the effectiveness of employing EVM with LPQ-TOP on a variety of datasets.
- To provide an insight on the competency of LPQ-TOP as micro facial feature extraction technique.
- Demonstrate the robustness of our approach by adopting more datasets than any other experiment.

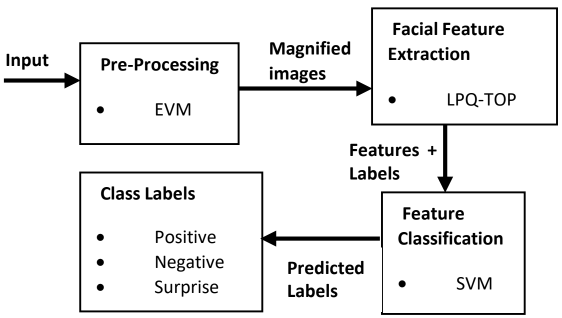

Fig 1. Micro expression recognition framework

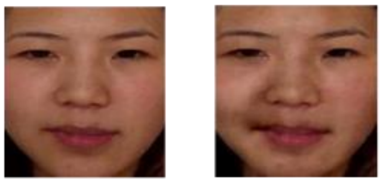

Fig 2. Happy Expression[25], before(left) and after(right) magnification. (©Xiaolan Fu)

METHODOLOGY

- The methodology adopted for our work is demonstrated in Figure 1.
- It includes the following steps: pre-processing, feature extraction and feature classification.
- We have augmented a video magnification method and LPQ-TOP [16][22] feature extraction technique.
- The magnification factor α is set to 26 in equation 1

$$(1+\alpha)\,\delta(t) < \frac{\lambda}{8} \qquad (1)$$

- LPQ-TOP method is used for extracting features from the magnified frames.
- Calculates four frequency points for each pixel.
- Determines phase information using binary quantizer.
- Builds histogram to represent the resulting codes.
- The final feature vector obtained is used to train a Support Vector Machine (SVM) [4].
- SVM is said to be effective for small datasets with higher dimensions hence, this classification method was chosen for our work as the datasets and method employed match these criteria.

RESULTS

- The result obtained after applying magnification process is shown in Figure 2.
- An enhancement in recognition performance after magnification is evident, however there is an absence of uniformity on the rate of enhancement on all seven datasets.
- An increase of 13.34% in the accuracy has been observed for the CASME2 dataset after introducing magnification which is a significant rise.
- The rate of increase using SMIC-NIR and SMIC-VIS differs by approximately 1% i.e., the method has uniform increase in recognition accuracy on these two SMIC datasets.
- An average increase in recognition accuracy of ~6.14% across all datasets is achieved using the novel framework.
- A significantly improved recognition accuracy of 88.2% is obtained for CASME and is the highest accuracy achieved using the LPQ-TOP with EVM compared to all other datasets.

TABLE I. ACCURACY % USING LPQ-TOP

Dataset	Our Accuracy % (LPQ-TOP)		
	No Magnification	With Magnification	% Increase
CASME	83.45	88.2	4.75
CASME2	61.16 [18]	74.5	13.34
CAS(ME)^2	63.6	68.5	4.9
SAMM	70.4	72.07	1.67
SMIC-VIS	65.6	73.8	8.2
SMIC-NIR	63.3	70.42	7.12
SMIC-HS	62.8	65.8	3

TABLE II. ACCURACY % COMPARISON FOR CASME, CASME2, CAS(ME)^2, SAMM & SMIC

Dataset	Our Work	Other Authors	
	LPQ-TOP + mag	Accuracy %	Method
CASME	88.2	80.2	MMPTR [26]
CASME2	74.5	78.14	HIGO + mag [27]
		63.97	HOG + mag [27]
		60.73	LBP-TOP + mag [27]
CAS(ME)^2	68.5	64.07	NMP [31]
SAMM	72.07	70.18	CNN [32]
SMIC-VIS	73.8	81.69	HIGO + mag [27]
		77.46	HOG + mag [27]
		78.87	LBP-TOP + mag [27]
SMIC-NIR	70.42	67.61	HIGO + mag [27]
		64.79	HOG + mag [27]
		67.61	LBP-TOP + mag [27]
SMIC-HS	65.8	68.29	HIGO + mag [27]
		61.59	HOG + mag [27]
		60.37	LBP-TOP + mag [27]

CONCLUSION

- LPQ-TOP when fused with EVM shows an impressive performance boost on some datasets.
- The results show an impressive average increase of ~6.14% but lacks an orderly increase of recognition accuracy.
- Magnification helped LPQ-TOP to efficiently extract required facial micro features.
- This work has successfully realized performance comparison between LPQ-TOP (with and without EVM) and various other approaches.
- Evidently LPQ-TOP technique is as competent as other hand-crafted methods.
- The goal of performing this work is to provide a novel pipeline for solving three class MER problem.

REFERENCES

[1] A. C. Le Ngo, Y. Oh, R. C. -. Phan and J. See, "Eulerian emotion magnification for subtle expression recognition," 2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Shanghai, pp.1243-1247, 2016.

[2] A. K. Davison; C. Lansley; N. Costen; K. Tan; M. H. Yap, "SAMM: A Spontaneous MicroFacial Movement Dataset," in IEEE Transactions on Affective Computing, vol. 9, no. 1, pp. 116- 129,2018.

[3] A.K. Davison, W. Merghani and M.H. Yap, "Objective classes for micro-facial expression recognition", Journal of Imaging, 4(10), p.119, 2018.

[4] Chih-Chung Chang and Chih-Jen Lin, LIBSVM: a library for support vector machines. ACM Transactions on Intelligent Systems and Technology, vol. 2, no. 3, p. 27, 2011.

[5] Devangini Patel, X. Hong and G. Zhao, "Selective deep features for micro-expression recognition", 23rd International Conference on Pattern Recognition (ICPR), Cancun, pp. 2258-2263, 2016.

[6] Dominic A. Trevisan, Maureen Hoskyn, Elina Birmingham, "Facial Expression Production in Autism", Autism Research 11:, International Society for Autism Research, Wiley Periodicals, Inc.,1586–1601, 2018.

[7] Ekman P, Friesen WV, "Nonverbal leakage and clues to deception", Psychiatry 32, pp. 88–106, 1969.

[8] Ekman P, "Telling Lies: Clues to Deceit in the Marketplace, Politics, and Marriage", (Revised Edition), WW Norton & Company, 2009.

[9] F. Qu, S. J. Wang, W.J. Yan, H. Li, S. Wu and X. Fu, "CAS (ME)^ 2: a database for spontaneous macro-expression and micro-expression spotting and recognition," IEEE Trans. Affect. Comput., 2017.

[10] Hao-Yu Wu, Michael Rubinstein, Eugene Shih, John Guttag, Frédo Durand, and William Freeman."Eulerian video magnification for revealing subtle changes in the world". ACM Trans. Graph. 31, 4, Article 65, July 2012.

[11] J. Endres and A. Laidlaw, "Micro-expression recognition training in medical students: a pilot study", BMC medical education, vol. 9, no. 1, p. 47, 2009.

[12] Liong, Sze-Teng et al. "Shallow Triple Stream Three-Dimensional CNN (STSTNet) for Micro-Expression Recognition." 14th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2019), 2019.

[13] Liu, Y.J., Zhang, J.K., Yan, W.J., Wang, S.J., Zhao, G., Fu, X.," A main directional mean optical flow feature for spontaneous micro- expression recognition". IEEE Trans. Affect Comput. **7**(4),299–310, 2016.

[14] M. A. Takalkar and M. Xu, "Image Based Facial Micro-Expression Recognition Using Deep Learning on Small Datasets," International Conference on Digital Image Computing: Techniques and Applications (DICTA), Sydney, NSW, pp. 1-7. 2017.

[15] P. Czapinski, S.E. Bryson, "Reduced facial muscle movements in autism: Evidence for dysfunction in the neuromuscular pathway?", Brain and Cognition, 51(2), 177–179, March 2003.

[16] Päivärinta J., Rahtu E., Heikkilä J., "Volume Local Phase Quantization for Blur- Insensitive Dynamic Texture Classification". In: Heyden A., Kahl F. (eds) Image Analysis. SCIA 2011. Lecture Notes in Computer Science, vol 6688. Springer, Berlin, Heidelberg, pp. 360–369, 2011.

[17] Peng, Wei et al. "A Boost in Revealing Subtle Facial Expressions: A Consolidated Eulerian Framework." 14th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2019), 2019.

[18] Sharma, P., Coleman, S., Yogarajah, P. & Laurence, T., "Micro expression classification accuracy assessment". IMVIP 2019: Irish Machine Vision & Image Processing, Technological University Dublin, Dublin, Ireland, August 28-30, 2019.

[19] Sze-Teng Liong, John See, KokSheik Wong, Raphael C.-W. Phan,"Less is more: Micro-expression recognition from video using apex frame", Elsevier, pp 0923-5965, 14 December 2017.

[20] T. Pfister, Xiaobai Li, G. Zhao and M. Pietikäinen, "Recognising spontaneous facial micro-expressions," International Conference on Computer Vision, Barcelona, pp. 1449-1456, 2011.

[21] Takalkar, M., Xu, M., Wu, Q. et al. "A survey: facial micro-expression recognition". Multimed Tools Appl 77, 19301–19325, 2018.

[22] V. Ojansivu and J. Heikkilä, "Blur insensitive texture classification using local phase quantization", International conference on image and signal processing. Springer, pp. 236–243, 2008.

[23] Wang, Y., See, J., Oh, Y. et al., "Effective recognition of facial micro-expressions with video motion magnification". Multimed Tools Appl 76, pp 21665–21690, 2017.

[24] Wang Y., See J., Phan R.CW., Oh YH (2015), "LBP with Six Intersection Points: Reducing Redundant Information in LBP-TOP for Micro-Expression Recognition". In: Cremers D., Reid I., Saito H., Yang MH. (eds) Computer Vision -- ACCV 2014, Lecture Notes in Computer Science, vol 9003. Springer, Cham, 2014.

[25] Wen-Jing Yan, Q. Wu, Yong-Jin Liu, Su-Jing Wang and X. Fu, "CASME database: A dataset of spontaneous micro-expressions collected from neutralized faces,"10th IEEE International Conference and Workshops on Automatic Face and Gesture Recognition (FG), Shanghai,pp. 1-7, 2013.

[26] X. Ben, P. Zhang, R. Yan, M. Yang, and G. Ge, "Gait recognition and micro-expression recognition based on maximum margin projection with tensor representation," Neural Computing and Applications, vol. 27, no. 8, pp. 2629–2646, 2016.

[27] Xiaobai Li, Xiaopeng Hong, Antti Moilanen, Xiaohua Huang, Tomas Pfister, Guoying Zhao, and Matti Pietikainen , "Towards Reading Hidden Emotions:A Comparative Study of Spontaneous Micro-Expression Spotting and Recognition Methods", IEEE Transactions On Affective Computing, Vol. 9, No. 4, October-December 2018.

[28] Xiaobai Li; Pfister, T.; Xiaohua Huang; Guoying Zhao; Pietikainen, M., "A Spontaneous Micro-expression Database: Inducement, collection and baseline," in Automatic Face and Gesture Recognition (FG), 2013 10th IEEE International Conference and Workshops on, vol., no., pp.1-6, 22-26 April 2013.

[29] Yan W-J, Li X, Wang S-J, Zhao G, Liu Y-J, et al., "CASME II: An Improved Spontaneous Micro-Expression Database and the Baseline Evaluation", PLoS ONE 9(1): e86041, 2014.

[30] Yuan Zong, Wenming Zheng, Xiaopeng Hong, Chuangao Tang, Zhen Cui, Guoying Zhao, "Cross-Database Micro-Expression Recognition: A Benchmark". CoRR abs/1812.07742, 2018.

[31] Zhao, Y., & Xu, J., "An Improved Micro-Expression Recognition Method Based on Necessary Morphological Patches". Symmetry, 11, 497, 2019.

[32] Zhao Y, Xu J. "A Convolutional Neural Network for Compound Micro-Expression Recognition". Sensors.19(24):5553, 2019.