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Feature Fusion: H-ELM based learned features and hand-crafted features for human activity recognition (Article)

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Abstract

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Recognizing human activities is one of the main goals of human-centered intelligent systems. Smartphone sensors produce a continuous sequence of observations. These observations are noisy, unstructured and high dimensional. Therefore, efficient features have to be extracted in order to perform an accurate classification. This paper proposes a combination of Hierarchical and kernel Extreme Learning Machine (HK-ELM) methods to learn features and map them to specific classes in a short time. Moreover, a feature fusion approach is proposed to combine H-ELM based learned features with hand-crafted ones. Our proposed method was found to outperform state-of-the-art in terms of accuracy and training time. It gives an accuracy of 97.62% and takes 3.4 seconds as a training time by using a normal Central Processing Unit (CPU). © 2018 The Science and Information (SAI) Organization Limited.

Author keywords

[Deep learning](#) [Feature fusion](#) [Feature learning](#) [Hierarchical extreme learning machine](#) [Human activity recognition](#)
[Kernel extreme learning machine](#)

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References (17)

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- 1 Anguita, D., Ghio, A., Oneto, L., Parra, X., Reyes-Ortiz, J.L.
 A public domain dataset for human activity recognition using smartphones

(2013) *ESANN 2013 proceedings, 21st European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning*, pp. 437-442. Cited 312 times.

<https://www.elen.ucl.ac.be/Proceedings/esann/esannpdf/es2013-84.pdf>

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Chen, Z. , Jiang, C. , Xie, L. (2019) *IEEE Transactions on Industrial Informatics*

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2 Jiang, W., Yin, Z.
Human activity recognition using wearable sensors by deep convolutional neural networks
(2015) *MM 2015 - Proceedings of the 2015 ACM Multimedia Conference*, pp. 1307-1310. Cited 89 times.
ISBN: 978-145033459-4
doi: 10.1145/2733373.2806333
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3 Anguita, D., Ghio, A., Oneto, L., Parra, X., Reyes-Ortiz, J.L.
Human activity recognition on smartphones using a multiclass hardware-friendly support vector machine
(2012) *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 7657 LNCS, pp. 216-223. Cited 307 times.
ISBN: 978-364235394-9
doi: 10.1007/978-3-642-35395-6_30
[View at Publisher](#)

4 Peterek, T., Penhaker, M., Gajdoš, P., Dohnálek, P.
Comparison of Classification Algorithms for Physical Activity Recognition
(2014) *Advances in Intelligent Systems and Computing*, 237, pp. 123-131. Cited 14 times.
<http://www.springer.com/series/11156>
ISBN: 978-331901780-8
doi: 10.1007/978-3-319-01781-5_12
[View at Publisher](#)

5 Ronao, C.A., Cho, S.-B.
Human activity recognition using smartphone sensors with two-stage continuous hidden markov models
(2014) *2014 10th International Conference on Natural Computation, ICNC 2014*, art. no. 6975918, pp. 681-686. Cited 43 times.
ISBN: 978-147995150-5
doi: 10.1109/ICNC.2014.6975918
[View at Publisher](#)

6 Xiao, W., Lu, Y.
Daily Human Physical Activity Recognition Based on Kernel Discriminant Analysis and Extreme Learning Machine ([Open Access](#))
(2015) *Mathematical Problems in Engineering*, 2015, art. no. 790412. Cited 13 times.
<http://www.hindawi.com/journals/mpe/contents.html>
doi: 10.1155/2015/790412
[View at Publisher](#)

7 Fang, H., He, L., Si, H., Liu, P., Xie, X.
Human activity recognition based on feature selection in smart home using back-propagation algorithm
(2014) *ISA Transactions*, 53 (5), pp. 1629-1638. Cited 30 times.
http://www.elsevier.com/locate/journaldescription.cws_home/524244/description#description
doi: 10.1016/j.isatra.2014.06.008
[View at Publisher](#)

8 LeCun, Y., Bottou, L., Bengio, Y., Haffner, P.
Gradient-based learning applied to document recognition
(1998) *Proceedings of the IEEE*, 86 (11), pp. 2278-2323. Cited 11055 times.
doi: 10.1109/5.726791
[View at Publisher](#)

- 9 Hinton, G.E., Salakhutdinov, R.R.
Reducing the dimensionality of data with neural networks
(2006) *Science*, 313 (5786), pp. 504-507. Cited 6565 times.
doi: 10.1126/science.1127647
[View at Publisher](#)
-
- 10 Li, Y., Shi, D., Ding, B., Liu, D.
Unsupervised feature learning for human activity recognition using smartphone sensors
(2014) *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 8891, pp. 99-107. Cited 25 times.
<http://springerlink.com/content/0302-9743/copyright/2005/>
ISBN: 978-331913816-9
[View at Publisher](#)
-
- 11 Tang, J., Deng, C., Huang, G.-B.
Extreme Learning Machine for Multilayer Perceptron
(2016) *IEEE Transactions on Neural Networks and Learning Systems*, 27 (4), art. no. 7103337, pp. 809-821. Cited 402 times.
<http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5962385>
doi: 10.1109/TNNLS.2015.2424995
[View at Publisher](#)
-
- 12 AlDahoul, N., Md Sabri, A.Q., Mansoor, A.M.
Real-Time Human Detection for Aerial Captured Video Sequences via Deep Models
(Open Access)
(2018) *Computational intelligence and neuroscience*, 2018, p. 1639561. Cited 4 times.
doi: 10.1155/2018/1639561
[View at Publisher](#)
-
- 13 Huang, G.-B., Zhou, H., Ding, X., Zhang, R.
Extreme learning machine for regression and multiclass classification
(2012) *IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics*, 42 (2), art. no. 6035797, pp. 513-529. Cited 2706 times.
doi: 10.1109/TSMCB.2011.2168604
[View at Publisher](#)
-
- 14 Huang, G.-B., Zhu, Q.-Y., Siew, C.-K.
Extreme learning machine: Theory and applications
(2006) *Neurocomputing*, 70 (1-3), pp. 489-501. Cited 5670 times.
doi: 10.1016/j.neucom.2005.12.126
[View at Publisher](#)
-
- 15 Frank, A.J., Asuncion, A.
(2010) *UCI machine learning repository*. Cited 3163 times.
-
- 16 Yang, J.-Y., Wang, J.-S., Chen, Y.-P.
Using acceleration measurements for activity recognition: An effective learning algorithm for constructing neural classifiers
(2008) *Pattern Recognition Letters*, 29 (16), pp. 2213-2220. Cited 212 times.
doi: 10.1016/j.patrec.2008.08.002
[View at Publisher](#)

□ 17 Casale, P., Pujol, O., Radeva, P.

Human activity recognition from accelerometer data using a wearable device

(2011) *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 6669 LNCS, pp. 289-296. Cited 120 times.

ISBN: 978-364221256-7

doi: 10.1007/978-3-642-21257-4_36

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