6. Conclusion

Literature review shows that the promises of ubiquitous computing to enable user mobility across heterogenous devices and systems is yet to be fully realized. At the most, findings show that, advances to facilitate user mobility within a single home or within a particular IoT system have been made with greater success. To this end, various mechanisms such as ontological modelling, probabilistic models, learning models as well as architectural frameworks amongst others have been introduced mainly to achieve context-awareness needs. However, literature review also shows that, there still exists a research gap around issues of user-behavior inference across heterogenous devices and systems to better facilitate context-awareness during system composition and user adaptivity in the smart homes domain. Based on literature review, it was evident that the major computational challenge behind this setback is deep-rooted in the over-reliance on location data in determining context by existing solutions. We conclude that research efforts to overcome this challenge should be devoted urgently, exploiting the capabilities of deep learning algorithms and data analytics even further.

Acknowledgments

No funding injected towards the consolidation of this manuscript.

Conflict of interest

The authors have no conflicts of interest to declare.

References

[1] Ai, D., Zuo, H., Huang, J. and Yang, J., 2021, April. User Context Semantic Acquisition System Based on Multidimensional Tags in O2O Recommendation. In 2021 International Conference on Computer, Blockchain and Financial Development (CBFD) (pp. 24-28). IEEE

[2] Chen, J., Chen, Z., Zheng, L. and Chen, X., 2022, April. A Spatio-Temporal Data-Driven Automatic Control Method for Smart Home Services. In Companion Proceedings of the Web Conference 2022 (pp. 948-955).

[3] Chen, H., Finin, T. and Joshi, A., 2005. The SOUPA ontology for pervasive computing. In Ontologies for agents: Theory and experiences (pp. 233-258). Birkhäuser Basel.

[4] Chen, Z., Lu, J. and Wang, R., 2020, April. A New Algorithm for Social Inference Using Position Information. In 2020 International Conference on Big Data and Informatization Education (ICBDIE) (pp. 413-416). IEEE.

[5] Chen, L., Nugent, C. and Rafferty, J., 2013, December. Ontology-based activity recognition framework and services. In Proceedings of International Conference on Information Integration and Web-based Applications & Services (pp. 463-469).

[6] Cisco (2015). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2014–2019. http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_

[7] Debruyne, C., 2020, November. Introducing Context and Context-awareness in Data Integration: Identifying the Problem and a Preliminary Case Study on Informed Consent. In Proceedings of the 22nd International Conference on Information Integration and Web-based Applications & Services (pp. 178-183).

[8] Ding, X., Jiang, T., Zhong, Y., Huang, Y. and Li, Z., 2021. Wi-Fi-based location-independent human activity recognition via meta learning. Sensors, 21(8), p.2654.

[9] Ding, X., Jiang, T., Zhong, Y., Wu, S., Yang, J. and Zeng, J., 2022. Wi-Fi-Based Location-Independent Human Activity Recognition with Attention Mechanism Enhanced Method. Electronics, 11(4), p.642.

[10] Ding, X., Jiang, T., Li, Y., Xue, W. and Zhong, Y., 2020, June. Device-free location-independent human activity recognition using transfer learning based on CNN. In 2020 IEEE International Conference on Communications Workshops (ICC Workshops) (pp. 1-6). IEEE.

[11] Ding, X., Jiang, T., Zhong, Y., Wu, S., Yang, J. and Xue, W., 2021, March. Improving WiFi-based human activity recognition with adaptive initial state via one-shot learning. In 2021 IEEE Wireless Communications and Networking Conference (WCNC) (pp. 1-6). IEEE.

[12] Iqbal, M.W., Ch, N.A., Shahzad, S.K., Naqvi, M.R., Khan, B.A. and Ali, Z., 2021. User context ontology for adaptive mobile-phone interfaces. IEEE Access, 9, pp.96751-96762.

[13] Jaberi, M. and Ravanmehr, R., 2022. Human activity recognition via wearable devices using enhanced ternary weight convolutional neural network. Pervasive and Mobile Computing, 83, p.101620.

[14] Kulkarni, S., Tsyplikhin, A., Krell, M.M. and Moritz, C.A., 2020, December. Accelerating simulation-based inference with emerging AI hardware. In 2020 International Conference on Rebooting Computing (ICRC) (pp. 126-132). IEEE.

[15] Lee, J.W. and Helal, S., 2020, March. Modeling and Reasoning of Contexts in Smart Spaces. In 2020 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops) (pp. 1-6). IEEE.

[16] Leng, Y. and Yu, L., 2021. Hierarchical Context-Aware Recurrent Network for Session-Based Recommendation. IEEE Access, 9, pp.51618-51630.

[17] Liciotti, D., Bernardini, M., Romeo, L. and Frontoni, E., 2020. A sequential deep learning application for recognising human activities in smart homes. Neurocomputing, 396, pp.501-513.

[18] Liu, W., Zhao, X., Zhao, Z., Ju, Q., Yang, X. and Lu, W., 2021. An Empirical Study on Adaptive Inference for Pretrained Language Model. IEEE Transactions on Neural Networks and Learning Systems.

[19] Logota, E., Corujo, D., Jeon, S., Rodriguez, J. and Aguiar, R.L., 2015. The 5g internet. Fundamentals of 5G Mobile Networks, pp.29-62.

[20] Lu, C.H., 2020. Context-aware service provisioning via agentized and reconfigurable multimodel cooperation for real-life IoT-enabled smart home systems. IEEE Transactions on Systems, Man, and Cybernetics: Systems, 50(8), pp.2914-2925.

[21] Ma, P., Gao, Q. and Fan, J., 2020, November. Context Aware Feature Interaction based Recommendation System. In 2020 Fourth IEEE International Conference on Robotic Computing (IRC) (pp. 485-489). IEEE.
[22] Martindale, C.F., Christlein, V., Klumpp, P. and Eskofier, B.M., 2021. Wearables-based multi-task gait and activity segmentation using recurrent neural networks. Neurocomputing, 432, pp.250-261.
[23] Morabito, R. and Chiang, M., 2021, July. Discover, provision, and orchestration of machine learning inference services in heterogeneous edge. In 2021 IEEE 41st International Conference on Distributed Computing Systems (ICDCS) (pp. 1116-1119). IEEE.
[24] Mosavi, A., Ardabili, S. and Varkonyi-Koczy, A.R., 2020. List of deep learning models. In Engineering for Sustainable Future: Selected papers of the 18th International Conference on Global Research and Education Inter-Academia–2019 18 (pp. 202-214). Springer International Publishing. Spoladore, D.; Mahroo, A.; Trombetta, A.; Sacco, M. ComfOnt: A Semantic Framework for Indoor Comfort and Energy Saving In Smart Homes. Electronics 2019, 8, 1449.
[25] Ngankam, H.K., Pigot, H. and Giroux, S., 2022. OntoDomus: a semantic model for ambient assisted living system based on smart homes. Electronics, 11(7), p.1143.
[26] Ocampo, R., Cheng, L., Jean, K. et al., 'Towards a Context Monitoring System for Ambient', First International Conference on Communications and Networking in China, Beijing, China, October 2006.
[27] Oladipo, I.D., AbdulRaheem, M., Awotunde, J.B., Bhoi, A.K., Adeniyi, E.A. and Abiodun, M.K., 2021. Machine learning and deep learning algorithms for smart cities: a start-of-the-art review. IoT and IoE Driven Smart Cities, pp.143-162.
[28] Oppermann, R. (Ed.) (1994). Adaptive User Support: Ergonomic Design of Manually and Automatically Adaptable Software. Hilldale, New Jersey: Lawrence Erlbaum.
[29] Rocha, A.P., Almeida, N., Ketsmur, M. and Teixeira, A., 2020, December. A Smart Home for All Supported by User and Context Adaptation. In 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-Exclusion (pp. 11-16).
[30] Roussey, C., Pinet F., Ah Kang M. and Corcho O. (2011). "An Introduction to Ontologies and Ontology Engineering" Springer-Verlag London Limited 2011.
[31] Schmid, J., Schneider, M., HöB, A. and Schuller, B., 2019, November. A deep learning approach for location independent throughput prediction. In 2019 IEEE International Conference on Connected Vehicles and Expo (ICCVE) (pp. 1-5). IEEE.
[32] Seghier, N.B. and Kazar, O., 2021, September. A Context-Aware Service Discovery Framework Based on Mobile Agent. In 2021 International Conference on Recent Advances in Mathematics and Informatics (ICRAMI) (pp. 1-6). IEEE.
[33] Sousa, J.P. and Garlan, D., 2002, August. Aura: an architectural framework for user mobility in ubiquitous computing environments. In Working Conference on Software Architecture (pp. 29-43). Springer, Boston, MA.
[34] Spoladore, D., Mahroo, A., Trombetta, A. and Sacco, M., 2019. ComfOnt: a semantic framework for indoor comfort and energy saving in smart homes. Electronics, 8(12), p.1449.
[35] Xiao, Y. and Watson, M., 2019. Guidance on conducting a systematic literature review. Journal of planning education and research, 39(1), pp.93-112.
[36] Zipf, A. and Jöst, M., 2006. Implementing adaptive mobile GI services based on ontologies: Examples from pedestrian navigation support. Computers, Environment and Urban Systems, 30(6), pp.784-798.

Authors Profile

Phumzile Nomnga, is a Lecturer in the Department of Computer Science at the University of Fort Hare and is concurrently pursuing a PhD in the same institution. His research focus encompasses several areas, notably the Internet of Things (IoT), Artificial Intelligence (AI), Mobile Networks, and Big Data Analytics.

Prof. K Sibanda is a well-experienced Walter Sisulu University academic, whose research interests are in Artificial Intelligence with a bias to machine learning. He is a member of the Artificial Intelligence for development Africa. In his career, he has supervised to completion 5 PhD and 19 MSc in Computer Science students. Most of his research revolves around machine learning techniques for classification, clustering and prediction. He has begun exploring such techniques for educational solutions. He believes that machine learning approaches are very robust in answering a wide range of problems including teaching and learning problems.