Scopus

Documents

Alfaqawi, M.[a b] , Habaebi, M.H.[a] , Islam, M.R.[a] , Siddiqi, M.U.[a]

Energy Harvesting Network with Wireless Distributed Computing
(2019) *IEEE Systems Journal*, 13 (3), art. no. 8636195, pp. 2605-2616.

DOI: 10.1109/JSYST.2019.2893248

[a] Department of Electrical and Computer Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[b] SensOptiX, Palaiseau, 91120, France

Abstract
Bulky processing tasks are expected to burden the limited resources of energy harvesters by draining the stored energy, and thereby, reaching rapidly to energy causality constraint. In such scenario, energy harvesters flip into sleep mode, and thereby, the execution time of the next task will be delayed until the energy harvesters revert back into active mode. To tackle this problem, this paper proposes a novel energy harvesting network (EHN) that deploys wireless distributed computing (WDC) network within the decision making process (DMP). The DMP is formulated as constrained partially observable Markov decision process in order to enable the energy harvesters to act under uncertainty. Furthermore, various challenges of WDC networks, e.g., nominating the collaborating nodes and task allocation, have been addressed herein. Unlike conventional research works on WDC networks, a system model is proposed for WDC network based on divisible load theory instead of graph theory. In addition, an adaptive task allocation algorithm is proposed to distribute the task efficiently among the collaborating nodes. Finally, the novel EHN system is analyzed and compared against the conventional research works on WDC, offloading computing, and local computing-EHN, where the proposed system is found to outperform in terms of energy and delay. © 2019 IEEE.

Author Keywords
Divisible load theory (DLT); energy harvesting network (EHN); reinforcement learning; task allocation; wireless distributed computing (WDC)

Index Keywords
Behavioral research, Computation theory, Decision making, Energy harvesting, Graph theory, Markov processes, Reinforcement learning; Adaptive task allocations, Causality constraint, Decision-making process, Divisible load theory, Energy Harvester, Partially observable Markov decision process, System modeling, Task allocation; Distributed computer systems

Funding details
P-RIGS18-003-0003
Ministry of Higher Education, MalaysiaMOHEFRGS13-073-0314

References

- Wu, Q., Li, G.Y., Chen, W., Ng, D.W.K., Schober, R.
  An overview of sustainable green 5G networks
  (2017) *IEEE Wireless Commun.*, 24 (4), pp. 72-80.
  Aug.

- Guo, S., Shi, Y., Yang, Y., Xiao, B.
  Energy efficiency maximization in mobile wireless energy harvesting sensor networks
  (2018) *IEEE Trans. Mobile Comput.*, 17 (7), pp. 1524-1537.
  Jul.

- Yang, L., Zhou, Y.J., Zhang, C., Yang, X.M., Yang, X.X., Tan, C.
  Compact multiband wireless energy harvesting based battery-free body area networks sensor for mobile healthcare
  (2018) *IEEE J. Elecctromagn., RF Microw. Med. Biol.*, 2 (2), pp. 109-115.
  Jun.

- Yu, W., Huang, Y., Garcia-Ortiz, A.
  Distributed optimal on-line task allocation algorithm for wireless sensor networks

(2018) *IEEE Sens. J.*, 18 (1), pp. 446-458.
Jan.

- Zhao, M., Yang, Y., Wang, C.
Mobile data gatheringwith load balanced clustering and dual data uploading in wireless sensor networks
(2015) *IEEE Trans. Mobile Comput.*, 14 (4), pp. 770-785.
Apr.

- Xu, J., Chen, L., Ren, S.
Online learning for offloading and autoscaling in energy harvesting mobile edge computing
(2017) *IEEE Trans. Cogn. Commun. Netw.*, 3 (3), pp. 361-373.
Sep.

- Wang, F., Xu, J., Wang, X., Cui, S.
Joint offloading and computing optimization in wireless powered mobile-edge computing systems
(2018) *IEEE Trans. Wireless Commun.*, 17 (3), pp. 1784-1797.
Mar.

- Bi, S., Zhang, Y.J.
Computation rate maximization for wireless powered mobile-edge computing with binary computation offloading
(2018) *IEEE Trans. Wireless Commun.*, 17 (6), pp. 4177-4190.
Jun.

- Cheng, Z., Li, P., Wang, J., Guo, S.
Just-in-time code offloading for wearable computing
(2015) *IEEE Trans. Emerg. Topics Comput.*, 3 (1), pp. 74-83.
Mar.

- Chen, L., Xu, J.
Computation peer offloading in mobile edge computing with energy budgets
(2017) *Proc. IEEE Global Commun. Conf.*, pp. 1-6.

- Mao, Y., Zhang, J., Letaief, K.B.
Dynamic computation offloading for mobile-edge computing with energy harvesting devices
(2016) *IEEE J. Sel. Areas Commun.*, 34 (12), pp. 3590-3605.
Dec.

- Cui, Y., Lau, V.K.N., Wang, R., Huang, H., Zhang, S.
A survey on delay-aware resource control for wireless systems-Large deviation theory, stochastic Lyapunov drift, and distributed stochastic learning
(2012) *IEEE Trans. Inf. Theory*, 58 (3), pp. 1677-1701.
Mar.

- Kandaswamy, P., Flint, J.A., Chouliaras, V.A.
System on fabrics architecture using distributed computing
(2018) *IEEE Sens. J.*, 18 (14), pp. 5929-5936.
Jul.

- Capponi, A., Fiandrino, C., Kliazovich, D., Bouvry, P., Giordano, S.
A cost-effective distributed framework for data collection in cloud-based mobile crowd sensing architectures
(2017) *IEEE Trans. Sustain. Comput.*, 2 (1), pp. 3-16.
Jan.-Mar.

- Datla, D.
Wireless distributed computing: A survey of research challenges

(2012) *IEEE Commun. Mag.*, 50 (1), pp. 144-152.
Jan.

- Datla, D.
Task allocation and scheduling in wireless distributed computing networks
(2011) *Analog Integr. Circuits Signal Process*, 49 (2).

- Kim, S., Lee, S.
Link capacity-energy aware WDC for network lifetime maximization
(2015) *IEEE Trans. Mobile Comput.*, 14 (8), pp. 1615-1628.
Aug.

- Chen, C.Y., Chu, C.P.
A novel computational model for non-linear divisible loads on a linear network
(2016) *IEEE Trans. Comput.*, 65 (1), pp. 53-65.
Jan.

- Suresh, S., Huang, H., Kim, H.J.
Scheduling in compute cloud with multiple data banks using divisible load paradigm
(2015) *IEEE Trans. Aerosp. Electron. Syst.*, 51 (2), pp. 1288-1297.
Apr.

- Maghsudi, S., Hossain, E.
Distributed user association in energy harvesting small cell networks: A probabilistic bandit model
(2017) *IEEE Trans. Wireless Commun.*, 16 (3), pp. 1549-1563.
Mar.

- Zhang, Q., Kassam, S.A.
Finite-state Markov model for Rayleigh fading channels
(1999) *IEEE Trans. Commun.*, 47 (11), pp. 1688-1692.
Nov.

- Pandana, C., Liu, K.J.R.
Near-optimal reinforcement learning framework for energy-aware sensor communications
(2005) *IEEE J. Sel. Areas Commun.*, 23 (4), pp. 788-797.
Apr.

- Ozel, O., Yang, J., Ulukus, S.
Optimal broadcast scheduling for an energy harvesting rechargeable transmitter with a finite capacity battery
(2012) *IEEE Trans. Wireless Commun.*, 11 (6), pp. 2193-2203.
Jun.

- Zhang, X., Wang, C., Tao, L.
An opportunistic packet forwarding for energy-harvesting wireless sensor networks with dynamic and heterogeneous duty cycle
(2018) *IEEE Sens. Lett.*, 2 (3).
Sep.

- Poupart, P.
Approximate linear programming for constrained partially observable Markov decision processes
(2015) *Proc. 29th AAAI Conf. Artif. Intell.*, pp. 3342-3348.

- Sungsoo, P., Daesik, H.
Optimal spectrum access for energy harvesting cognitive radio networks
(2013) *IEEE Trans. Wireless Commun.*, 12 (12), pp. 6166-6179.
Dec.

- Ahmad, S.H.A., Lui, M., Javidi, T., Zhao, Q., Krishnamachari, B.
  Optimality of myopic sensing in multichannel opportunistic access
  (2009) *IEEE Trans. Inf. Theory*, 55 (9), pp. 4040-4050.
  Sep.

Correspondence Address
Alfaqawi M.; Department of Electrical and Computer Engineering, International Islamic University MalaysiaMalaysia; email: mohammedalfaqawi@gmail.com

Publisher: Institute of Electrical and Electronics Engineers Inc.

ISSN: 19328184
Language of Original Document: English
Abbreviated Source Title: IEEE Syst. J.
2-s2.0-85071394062
Document Type: Article
Publication Stage: Final
Source: Scopus