node being tested has the average time needed to carry out the node selection process until it is connected to the selected node, namely 9.968 seconds.

ACKNOWLEDGMENTS

The authors are grateful to the BPPM of Engineering Faculty, Brawijaya University, for the Associate Professor's Doctoral Grant that funded this publication. Also, the authors are obliged to Laboratory of Design and Prototype, Department of Electrical Engineering, Faculty of Engineering, Brawijaya University for the data collection.

REFERENCES

[1] Anonym, "Fundamentals of indoor air quality in buildings", *https://www.epa.gov/indoor-air-quality-iaq/fundamentals-indoor-air-quality-buildings*, October 16, 2015.

[2] TSI Incorporated, "*Indoor Air Quality Handbook, A Practical Guide to Indoor Air Quality Investigations*", GA, Fairmont Press, *Inc*., 2013.

[3] J. Soparia and N. A. Bhatt, "Survey on comparative study of wireless sensor network topologies", *International Journal of Computer Applications. Department of Information Technology CSPIT Changa*, Vol. 81, pp. 40-43, 2014.

[4] A. Alshahrani, N. M. Namazi, M. Abdouli, and A. S. Alghamdi, "A configurable routing protocol for improving lifetime and coverage area in wireless sensor networks", *Wireless Sensor Network, Scientific Research Publishing Inc*., Vol. 9, pp. 311-332, September 29, 2017. DOI: 10.4236/wsn.2017.99018.

[5] M. A. Khan and S. Hussain, "Energy efficient direction-based topology control algorithm for WSN", *Wireless Sensor Network, Scientific Research Publishing Inc*., Vol. 12, pp. 37-47, March 27, 2020. DOI: 10.4236/wsn.2020.123003.

[6] S. S. Jawaligi and G. S. Biradar, "Single mobile sink based energy efficiency and fast data gathering protocol for WSN", *Wireless Sensor Network, Scientific Research Publishing Inc*., Vol. 9, pp. 117-144, April 28, 2017. DOI: 10.4236/wsn.2017.94007.

[7] D. K. Bangotra, Y. Singh, A. Selwal, N. Kumar, P. K. Singh, and W. C. Hong, "An intelligent opportunistic routing algorithm for wireless sensor networks and its application towards e-Healthcare", *Sensors-MDPI*, Vol. 20, No. 3887, pp. 1-21, 2020. DOI:10.3390/s20143887.

[8] Thuman, Albert and Younger, William J., "*Handbook of Energy Audits*", Lilburn, 2007.

[9] Sensirion, "Datasheet SHT1: humidity and temperature sensor", Sensirion, 2008.

[10] A. Sudarmaji, A. Kitagawa, and J. Akita, "Design of wireless measurement of soil gases and soil environment based on Programmable System-on-Chip (PSOC)", *Sensors and Transducers*, Vol. 186, No. 3, pp. 93-103, 2015.

[11] D. Vouyioukas and A. Karagiannis, "Homecare monitoring technologies and applications, telemedicine techniques and applications", *Prof. Georgi Graschew* (*Ed.*), *ISBN: 978-953-307-354-5*, *InTech*., 2011.

[12] K. Babber and R. Randhawa, "A cross-layer optimization framework for energy efficiency in wreless sensor networks", *Wireless Sensor Network, Scientific Research Publishing Inc*., Vol. 9, pp. 189-203, June 28, 2017. DOI: 10.4236/wsn.2017.96011.

[13] P. Branch, B. Li, and K. Zhao, "A LoRa-based linear sensor network for location data in underground mining", Telecom-MDPI, Vol. 1, pp. 68–79, 2020. DOI:10.3390/telecom1020006.

[14] T. F. Arya, M. Faiqurahman, dan Y. Azhar, "Aplikasi wireless sensor network untuk sistem monitoring dan klasifikasi kualitas udara", *Jurnal Sistem Informasi* (*Journal of Information System*), Vol. 14, Issue 2, pp. 74-82, October 2018.

[15] M. Elsharief, M. A. Abd El-Gawad, H. Ko, and S. Pack, "EERS: Energy-Efficient Reference node Selection algorithm for synchronization in industrial wireless sensor networks", *Sensors-MDPI*, Vol. 20, No. 4095, pp. 1-13, 2020. DOI:10.3390/s20154095.

[16] V. Boonsawat, J. Ekchamanonta, K. Bumrungkhet, and S. Kittipiyakul, "Xbee wireless sensor networks for temperature monitoring", *Proceedings of the 2nd ECTI-Conference on Application Researcha and Development* (*ECTI-CARD 10*), 2010.

[17] P. D. Prasetyo Adi and A. Kitagawa, "ZigBee Radio Frequency (RF) Performance on Raspberry Pi 3 for Internet of Things (IoT) Based Blood Pressure Sensors Monitoring", *International Journal of Advanced Computer Science and Applications* (*IJACSA*) , Vol. 10, No. 5, pp. 18-27, 2019.

[18] J. M. Parenreng and A. Kitagawa, "Resource optimization techniques and security levels for wireless sensor networks based on the ARSy framework", *Sensors*. Vol. 18, No. 1594, pp. 1-15, 2018. DOI:10.3390/s18051594.

[19] P. D. Prasetyo Adi and A. Kitagawa, "Performance evaluation WPAN of RN-42 Bluetooth based (802.15.1) for sending the multi-sensor LM35 data temperature and RaspBerry pi 3 model B for the database and internet gateway", *International Journal of Advanced Computer Science and Applications* (*IJACSA*), Vol. 9, No. 12., pp. 612-620, 2018.

[20] Y. S. Yu and Y. S. Chen, "A measurement-based frame-level error model for evaluation of industrial wireless sensor networks", *Sensors-MDPI*, Vol. 20, No. 3978, pp. 1-18, 2020. DOI:10.3390/s20143978.

[21] K. A. Kulkarni and M. S. Zambare, "The impact study of houseplants in purification of environment using wireless sensor network", *Wireless Sensor Network, Scientific Research Publishing Inc*., Vol. 10, pp. 59-69, March 31, 2018. DOI: 10.4236/wsn.2018.103003.

[22] W. Chen, D. Sun, C. Han, J. Yang, F. Gong, and W. Wang, "Macrodiversity reception with distributed hard-decision receivers for maritime wireless sensor networks", *Sensors-MDPI*, Vol. 20, No. 3925, pp. 1-18, 2020. DOI:10.3390/s20143925.

[23] Y. J. Mon, C. M. Lin, and I. J. Rudas, "Wireless Sensor Network (WSN) control for indoor temperature monitoring", *Acta Polytechnica Hungarica*, Vol. 9, No. 6, pp. 17-28, 2012.

[24] M. S. BenSaleh, R. Saida, Y. H. Kacem, and M. Abid, "Wireless sensor network design methodologies: A survey", *Hindawi-Journal of Sensors*, pp. 1-13, 2020. https://doi.org/10.1155/2020/9592836.

[25] B. G. Kilberg, F. M. R. Campos, C. B. Schindler, and K. S. J. Pister, "Quadrotor-based lighthouse localization with time-synchronized wireless sensor nodes and bearing-only measurements", *Sensors-MDPI*, Vol. 20, No. 3888, pp. 1-17, 2020. DOI:10.3390/s20143888.

[26] Y. P. Lin, H. Mukhtar, K. T. Huang, J. R. Petway, C. M. Lin, C. F. Chou, and S. W. Liao, "Real-time identification of irrigation water pollution sources and pathways with a wireless sensor network and blockchain framework", *Sensors-MDPI*, Vol. 20, No. 3634, pp. 1-24, 2020. DOI:10.3390/s20133634.