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Article • Gold Open Access

Source type

Journal

ISSN

2158107X

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10.14569/IJACSA.2023.0141113

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Secure IoT Routing Through Manifold Criterion Trust Evaluation using Ant Colony Optimization

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The paper presents a simplified yet innovative computational framework to enable secure routing for sensors within a vast and dynamic Internet of Things (IoT) environment. In the proposed design methodology, a unique trust evaluation scheme utilizing a modified version of Ant Colony Optimization (ACO) is introduced. This scheme formulates a manifold criterion for secure data transmission, optimizing the sensor's residual energy and trust score. A distinctive pheromone management is devised using trust score and residual energy. Concurrently, several attributes are employed for constraint modeling to determine a secure data transmission path among the IoT sensors. Moreover, the trust model introduces a dual-tiered system of primary and secondary trust evaluations, enhancing reliability towards securing trusted nodes and alleviating trust-based discrepancies. The comprehensive implementation of the proposed integrates mathematical modeling, leveraging a streamlined bioinspired approach of the revised ACO using crowding distance. Quantitative results demonstrate that our approach yields a 35% improvement in throughput, an 89% reduction in delay, a 54% decrease in energy consumption, and a 73% enhancement in processing speed compared to

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Shruthi, B.M. , Raju, C. (2023) *International Conference on Applied Intelligence and Sustainable Computing, ICAISC 2023*

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- 1 Olanrewaju, R.F., Khan, B.U.I., Hashim, A.H.A., Sidek, K.A., Khan, Z.I., Daniyal, H.

The internet of things vision: A comprehensive review of architecture, enabling technologies, adoption challenges, research open issues and contemporary applications

(2022) *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 26 (1), pp. 51-77. Cited 4 times.

<https://www.akademiabaru.com/submit/index.php/araset/article/view/4467/3310>

doi: 10.37934/araset.26.1.5177

[View at Publisher](#)

-
- 2 Gangwar, R.K., Kumari, S., Pathak, A.K., Gutlapalli, S.D., Meena, M.C.
Optical Fiber Based Temperature Sensors: A Review

(2023) *Optics*, 4 (1), pp. 171-197. Cited 8 times.

www.mdpi.com/journal/optics

doi: 10.3390/opt4010013

[View at Publisher](#)

[View PDF](#)

-
- 3 Ghosh, S.K., Sinha, T.K., Xie, M., Bowen, C.R., Garain, S., Mahanty, B., Roy, K., (...), Mandal, D.

Temperature-Pressure Hybrid Sensing All-Organic Stretchable Energy Harvester

(2021) *ACS Applied Electronic Materials*, 3 (1), pp. 248-259. Cited 21 times.

pubs.acs.org/journal/aaembp

doi: 10.1021/acsaelm.0c00816

[View at Publisher](#)

-
- 4 Krishna Prasad, N.V., Venkata Prasad, K., Ramesh, S., Phanidhar, S.V., Venkata Ratnam, K., Janardhan, S., Manjunatha, H., (...), Srinivas, K.

Ceramic Sensors: A mini-review of their applications

(2020) *Frontiers in Materials*, 7, art. no. 593342. Cited 17 times.

journal.frontiersin.org/journal/materials

doi: 10.3389/fmats.2020.593342

[View at Publisher](#)

□ 5 Rahmani, A.M., Bayramov, S., Kiani Kalejahi, B.
Internet of Things Applications: Opportunities and Threats
(2022) *Wireless Personal Communications*, 122 (1), pp. 451-476. Cited 27 times.
<https://www.springer.com/journal/11277>
doi: 10.1007/s11277-021-08907-0
View at Publisher

□ 6 Siddiqui, S.A., Ahmad, A., Fatima, N.
IoT-based disease prediction using machine learning
(Open Access)
(2023) *Computers and Electrical Engineering*, 108, art. no. 108675.
<https://www.journals.elsevier.com/computers-and-electrical-engineering>
doi: 10.1016/j.compeleceng.2023.108675
View at Publisher

□ 7 Kim, H.-S., Park, Y.-J., Kang, S.-J.
Secured and Deterministic Closed-Loop IoT System Architecture for Sensor and Actuator Networks (Open Access)
(2022) *Sensors*, 22 (10), art. no. 3843. Cited 3 times.
<https://www.mdpi.com/1424-8220/22/10/3843/pdf?version=1652950179>
doi: 10.3390/s22103843
View at Publisher

□ 8 Yun, J., Ahn, I.-Y., Song, J., Kim, J.
Implementation of sensing and actuation capabilities for IoT devices using oneM2M platforms
(2019) *Sensors (Switzerland)*, 19 (20), art. no. 4567. Cited 17 times.
<https://www.mdpi.com/1424-8220/19/20/4567/pdf>
doi: 10.3390/s19204567
View at Publisher

□ 9 Kapitsaki, G.M., Achilleos, A.P., Aziz, P., Paphitou, A.C.
Sensoman: Social management of context sensors and actuators for IoT (Open Access)
(2021) *Journal of Sensor and Actuator Networks*, 10 (4), art. no. 68.
<https://www.mdpi.com/2224-2708/10/4/68/pdf>
doi: 10.3390/jsan10040068
View at Publisher

□ 10 Stolojescu-Crisan, C., Crisan, C., Butunoi, B.-P.
An iot-based smart home automation system (Open Access)
(2021) *Sensors*, 21 (11), art. no. 3784. Cited 84 times.
<https://www.mdpi.com/1424-8220/21/11/3784/pdf>
doi: 10.3390/s21113784
View at Publisher

□ 11 Pereira, F., Correia, R., Pinho, P., Lopes, S.I., Carvalho, N.B.
Challenges in resource-constrained iot devices: Energy and communication as critical success factors for future iot deployment (Open Access)
(2020) *Sensors (Switzerland)*, 20 (22), art. no. 6420, pp. 1-30. Cited 44 times.
<https://www.mdpi.com/1424-8220/20/22/6420/pdf>
doi: 10.3390/s20226420
View at Publisher

View PDF

- 12 Khan, B. U. I., Olanrewaju, R. F., Anwar, F., Mir, R. N., Oussama, A., Jusoh, A. Z. B.
Internet of Things—The Concept, Inherent Security Challenges and Recommended Solutions
(2019) *Smart Network Inspired Paradigm and Approaches in IoT Applications*, pp. 63-86. Cited 2 times.
[12] in Springer, Singapore
-

- 13 Khan, B.U.I., Olanrewaju, R.F., Anwar, F., Mir, R.N., Najeeb, A.R.
A critical insight into the effectiveness of research methods evolved to secure IoT ecosystem
(2019) *International Journal of Information and Computer Security*, 11 (4-5), pp. 332-354. Cited 6 times.
<http://www.inderscience.com/ijics>
doi: 10.1504/IJICS.2019.101908
View at Publisher
-

- 14 Ferrara, P., Mandal, A.K., Cortesi, A., Spoto, F.
Static analysis for discovering IoT vulnerabilities (Open Access)
(2021) *International Journal on Software Tools for Technology Transfer*, 23 (1), pp. 71-88. Cited 32 times.
<http://springerlink.metapress.com/app/home/journal.asp?wasp=e2ggqmluwmc226vrfl1y&referrer=parent&backto=linkingpublicationresulsts,1:101563,1>
doi: 10.1007/s10009-020-00592-x
View at Publisher
-

- 15 Celdrán, A.H., Sánchez, P.M.S., Castillo, M.A., Bovet, G., Pérez, G.M., Stiller, B.
Intelligent and behavioral-based detection of malware in IoT spectrum sensors (Open Access)
(2023) *International Journal of Information Security*, 22 (3), pp. 541-561. Cited 7 times.
<https://www.springer.com/journal/10207>
doi: 10.1007/s10207-022-00602-w
View at Publisher
-

View PDF

- 16 Attkan, A., Ranga, V.
Cyber-physical security for IoT networks: a comprehensive review on traditional, blockchain and artificial intelligence based key-security (Open Access)
(2022) *Complex and Intelligent Systems*, 8 (4), pp. 3559-3591. Cited 27 times.
<https://www.springer.com/journal/40747>
doi: 10.1007/s40747-022-00667-z
View at Publisher
-

- 17 Kumar, U., Navaneet, S., Kumar, N., Pandey, S.C.
Isolation of DDoS Attack in IoT: A New Perspective (Open Access)
(2020) *Wireless Personal Communications*, 114 (3), pp. 2493-2510. Cited 10 times.
<http://www.springerlink.com/content/0929-6212>
doi: 10.1007/s11277-020-07486-w
View at Publisher
-

- 18 Josey, T.B., Misbha, D.S.
Man-in-the-Middle Attack Mitigation in IoT Sensors with Hash Based Multidimensional Lamport Digital Signature ([Open Access](#))

(2023) *Lecture Notes in Electrical Engineering*, 1003, pp. 47-56.
<https://www.springer.com/series/7818>
ISBN: 978-981199988-8
doi: 10.1007/978-981-19-9989-5_5

View at Publisher
-
- 19 Khan, B.U.I., Anwar, F., Olanrewaju, R.F., Pampori, B.R., Mir, R.N.
A Novel Multi-Agent and Multilayered Game Formulation for Intrusion Detection in Internet of Things (IoT) ([Open Access](#))

(2020) *IEEE Access*, 8, art. no. 9099822, pp. 98481-98490. Cited 13 times.
<http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6287639>
doi: 10.1109/ACCESS.2020.2997711

View at Publisher
-
- 20 Sharma, R., Arya, R.
Secure transmission technique for data in IoT edge computing infrastructure ([Open Access](#))

(2022) *Complex and Intelligent Systems*, 8 (5), pp. 3817-3832. Cited 8 times.
<https://www.springer.com/journal/40747>
doi: 10.1007/s40747-021-00576-7

View at Publisher
-
- 21 Panahi, U., Bayılmış, C.
Enabling secure data transmission for wireless sensor networks based IoT applications ([Open Access](#))

(2023) *Ain Shams Engineering Journal*, 14 (2), art. no. 101866. Cited 14 times.
http://www.elsevier.com/wps/find/journaldescription.cws_home/724208/description#description
doi: 10.1016/j.asej.2022.101866

View at Publisher
-
- 22 Refaee, E., Parveen, S., Begum, K.M.J., Parveen, F., Raja, M.C., Gupta, S.K., Krishnan, S.
Secure and Scalable Healthcare Data Transmission in IoT Based on Optimized Routing Protocols for Mobile Computing Applications ([Open Access](#))

(2022) *Wireless Communications and Mobile Computing*, 2022, art. no. 5665408. Cited 18 times.
<https://www.hindawi.com/journals/wcmc/>
doi: 10.1155/2022/5665408

View at Publisher
-
- 23 Khan, B.U.I., Anwar, F., Rahman, F.D.B.A., Olanrewaju, R.F., Goh, K.W., Janin, Z., Rahman, M.A.
SGM: Strategic Game Model for Resisting Node Misbehaviour in IoT-Cloud Ecosystem ([Open Access](#))

(2022) *Information (Switzerland)*, 13 (11), art. no. 544.
<http://www.mdpi.com/journal/information/>
doi: 10.3390/info13110544

View at Publisher

View PDF

- 24 Quy, V.K., Nam, V.H., Linh, D.M., Ngoc, L.A.
Routing Algorithms for MANET-IoT Networks: A Comprehensive Survey ([Open Access](#))

(2022) *Wireless Personal Communications*, 125 (4), pp. 3501-3525. Cited 23 times.
<https://www.springer.com/journal/11277>
doi: 10.1007/s11277-022-09722-x

[View at Publisher](#)
-
- 25 Majid, M., Habib, S., Javed, A.R., Rizwan, M., Srivastava, G., Gadekallu, T.R., Lin, J.C.-W.
Applications of Wireless Sensor Networks and Internet of Things Frameworks in the Industry Revolution 4.0: A Systematic Literature Review

(2022) *Sensors*, 22 (6), art. no. 2087. Cited 201 times.
<https://www.mdpi.com/1424-8220/22/6/2087/pdf>
doi: 10.3390/s22062087

[View at Publisher](#)
-
- 26 Aslan, B., Yavuzer Aslan, F., Sakalli, M.T.
Energy Consumption Analysis of Lightweight Cryptographic Algorithms That Can Be Used in the Security of Internet of Things Applications ([Open Access](#))

(2020) *Security and Communication Networks*, 2020, art. no. 8837671. Cited 12 times.
<https://www.hindawi.com/journals/scn/>
doi: 10.1155/2020/8837671

[View at Publisher](#)
-
- 27 Aaqib, M., Ali, A., Chen, L., Nibouche, O.
IoT trust and reputation: a survey and taxonomy ([Open Access](#))

(2023) *Journal of Cloud Computing*, 12 (1), art. no. 42. Cited 3 times.
<https://journalofcloudcomputing.springeropen.com>
doi: 10.1186/s13677-023-00416-8

[View at Publisher](#)
-
- 28 Liu, Y., Wang, J., Yan, Z., Wan, Z., Jantti, R.
A Survey on Blockchain-Based Trust Management for Internet of Things ([Open Access](#))

(2023) *IEEE Internet of Things Journal*, 10 (7), pp. 5898-5922. Cited 18 times.
<http://ieeexplore.ieee.org/servlet/opac?punumber=6488907>
doi: 10.1109/JIOT.2023.3237893

[View at Publisher](#)
-
- 29 Liu, X., Yu, J., Yu, K., Wang, G., Feng, X.
Trust secure data aggregation in WSN-based IIoT with single mobile sink ([Open Access](#))

(2022) *Ad Hoc Networks*, 136, art. no. 102956. Cited 7 times.
<http://www.elsevier.com/inca/publications/store/6/7/2/3/8/0/index.htm>
doi: 10.1016/j.adhoc.2022.102956

[View at Publisher](#)

[View PDF](#)

- 30 Mangalampalli, S., Karri, G.R., Kose, U.
Multi objective trust aware task scheduling algorithm in cloud computing using whale optimization ([Open Access](#))

(2023) *Journal of King Saud University - Computer and Information Sciences*, 35 (2), pp. 791-809. Cited 18 times.

www.journals.elsevier.com/journal-of-king-saud-university-computer-and-information-sciences/

doi: 10.1016/j.jksuci.2023.01.016

[View at Publisher](#)

- 31 Muzammal, S.M., Murugesan, R.K., Jhanjhi, N.Z., Hossain, M.S., Yassine, A.
Trust and Mobility-Based Protocol for Secure Routing in Internet of Things ([Open Access](#))

(2022) *Sensors*, 22 (16), art. no. 6215. Cited 11 times.

<http://www.mdpi.com/journal/sensors>

doi: 10.3390/s22166215

[View at Publisher](#)

- 32 Muzammal, S.M., Murugesan, R.K., Jhanjhi, N.Z., Humayun, M., Ibrahim, A.O., Abdelmaboud, A.
A Trust-Based Model for Secure Routing against RPL Attacks in Internet of Things ([Open Access](#))

(2022) *Sensors*, 22 (18), art. no. 7052. Cited 14 times.

<http://www.mdpi.com/journal/sensors>

doi: 10.3390/s22187052

[View at Publisher](#)

- 33 Awan, S., Javaid, N., Ullah, S., Khan, A.U., Qamar, A.M., Choi, J.-G.
Blockchain Based Secure Routing and Trust Management in Wireless Sensor Networks^T ([Open Access](#))

(2022) *Sensors*, 22 (2), art. no. 411. Cited 28 times.

<https://www.mdpi.com/1424-8220/22/2/411/pdf>

doi: 10.3390/s22020411

[View at Publisher](#)

- 34 Nagaraju, R., Venkatesan, C., Kalaivani, J., Manju, G., Goyal, S.B., Verma, C., Safirescu, C.O., (...), Mihaltan, T.C.
Secure Routing-Based Energy Optimization for IoT Application with Heterogeneous Wireless Sensor Networks ([Open Access](#))

(2022) *Energies*, 15 (13), art. no. 4777. Cited 36 times.

<https://www.mdpi.com/1996-1073/15/13/4777/pdf?version=1656551971>

doi: 10.3390/en15134777

[View at Publisher](#)

- 35 Bakhtiari, N. B., Rafighi, M., Ahsan, R.
TTLA: Two-way trust between clients and fog servers using Bayesian Learning Automata
(2022) *The Journal of Supercomputing*, 79, pp. 16152-16180.
[35]

[View PDF](#)

- 36 Rakesh, B., H, P.S.
Novel Authentication and Secure Trust based RPL Routing in Mobile sink supported Internet of Things (Open Access)

(2023) *Cyber-Physical Systems*, 9 (1), pp. 43-76. Cited 6 times.
<https://tandfonline.com/action/journalInformation?journalCode=tcyb20>
doi: 10.1080/23335777.2021.1933194

View at Publisher
-
- 37 Gladkov, A., Shiriaev, E., Tchernykh, A., Deryabin, M., Babenko, M., Nesmachnow, S.
DT-RRNS: Routing Protocol Design for Secure and Reliable Distributed Smart Sensors Communication Systems † (Open Access)

(2023) *Sensors*, 23 (7), art. no. 3738. Cited 3 times.
<http://www.mdpi.com/journal/sensors>
doi: 10.3390/s23073738

View at Publisher
-
- 38 Ramaswamy, S., Norman, J.
Social and QoS based trust model for secure clustering for wireless body area network (Open Access)

(2020) *International Journal of Electrical Engineering Education*. Cited 3 times.
<http://ije.sagepub.com/content/by/year>
doi: 10.1177/0020720920953133

View at Publisher
-
- 39 Wang, X.
Low-Energy Secure Routing Protocol for WSNs Based on Multiobjective Ant Colony Optimization Algorithm (Open Access)

(2021) *Journal of Sensors*, 2021, art. no. 7633054. Cited 6 times.
<http://www.hindawi.com/journals/js/biblio.html>
doi: 10.1155/2021/7633054

View at Publisher
-
- 40 Saleem, K., Ahmad, I. View PDF
Ant Colony Optimization ACO Based Autonomous Secure Routing Protocol for Mobile Surveillance Systems (Open Access)

(2022) *Drones*, 6 (11), art. no. 351. Cited 7 times.
www.mdpi.com/journal/drones
doi: 10.3390/drones6110351

View at Publisher
-
- 41 Nguyen, T.-H., Jung, J.J.
ACO-based traffic routing method with automated negotiation for connected vehicles

(2023) *Complex and Intelligent Systems*, 9 (1), pp. 625-636. Cited 6 times.
<https://www.springer.com/journal/40747>
doi: 10.1007/s40747-022-00833-3

View at Publisher
-

- 42 Anjinappa, G., Bangalore Prabhakar, D.
A secure IoT and edge computing based EV selection model in V2G systems using ant colony optimization algorithm
(2022) *International Journal of Pervasive Computing and Communications*
<http://www.emeraldinsight.com/products/journals/journals.htm?id=ijpcc>
doi: 10.1108/IJPCC-06-2022-0245
View at Publisher
-
- 43 El-Ghamry, A., Gaber, T., Mohammed, K.K., Hassanien, A.E.
Optimized and Efficient Image-Based IoT Malware Detection Method
(2023) *Electronics (Switzerland)*, 12 (3), art. no. 708. Cited 5 times.
www.mdpi.com/journal/electronics
doi: 10.3390/electronics12030708
View at Publisher
-
- 44 Alterazi, H.A., Kshirsagar, P.R., Manoharan, H., Selvarajan, S., Alhebaishi, N., Srivastava, G., Lin, J.C.-W.
Prevention of Cyber Security with the Internet of Things Using Particle Swarm Optimization ([Open Access](#))
(2022) *Sensors*, 22 (16), art. no. 6117. Cited 13 times.
<http://www.mdpi.com/journal/sensors>
doi: 10.3390/s22166117
View at Publisher
-
- 45 Lin, H.-C., Wang, P., Lin, W.-H.
Implementation of a PSO-based security defense mechanism for tracing the sources of DDoS attacks ([Open Access](#))
(2019) *Computers*, 8 (4), art. no. 88. Cited 8 times.
<https://www.mdpi.com/2073-431X/8/4/88/pdf>
doi: 10.3390/computers8040088
View at Publisher
-
- 46 Ramakrishnan, M.
Internet of trust things using particle-swarm optimisation (PSO-IoT)
(2021) *SSRN Electronic Journal*
[46] R. R. K and [View PDF](#)
-
- 47 Janani, K., Ramamoorthy, S.
Threat analysis model to control IoT network routing attacks through deep learning approach ([Open Access](#))
(2022) *Connection Science*, 34 (1), pp. 2714-2754. Cited 4 times.
<http://www.tandfonline.com/toc/ccos20/current>
doi: 10.1080/09540091.2022.2149698
View at Publisher
-
- 48 Hosseinzadeh, M., Tanveer, J., Masoud Rahmani, A., Yousefpoor, E., Sadegh Yousefpoor, M., Khan, F., Haider, A.
A Cluster-Tree-Based Secure Routing Protocol Using Dragonfly Algorithm (DA) in the Internet of Things (IoT) for Smart Agriculture ([Open Access](#))
(2023) *Mathematics*, 11 (1), art. no. 80. Cited 9 times.
<http://www.mdpi.com/journal/mathematics>
doi: 10.3390/math11010080
View at Publisher

- 49 Selvaraj, P., Burugari, V.K., Gopikrishnan, S., Alourani, A., Srivastava, G., Baza, M.

An Enhanced and Secure Trust-Aware Improved GSO for Encrypted Data Sharing in the Internet of Things (Open Access)

(2023) *Applied Sciences (Switzerland)*, 13 (2), art. no. 831. Cited 4 times.
www.mdpi.com/journal/applsci/
doi: 10.3390/app13020831

[View at Publisher](#)

- 50 Tanveer, M., Abbas, G., Abbas, Z.H., Waqas, M., Muhammad, F., Kim, S.
S6AE: Securing 6lowpan using authenticated encryption scheme (Open Access)

(2020) *Sensors (Switzerland)*, 20 (9), art. no. 2707. Cited 30 times.
<https://www.mdpi.com/1424-8220/20/9/2707/pdf>
doi: 10.3390/s20092707

[View at Publisher](#)

- 51 Nichols, K., Jacobson, V., King, R.
Defined-Trust Transport (DEFTT) protocol for limited domains
IETF Datatracker
[51] (accessed Jul. 30, 2023)
<https://datatracker.ietf.org/doc/draft-nichols-tsv-defined-trust-transport/>

- 52 Granjal, J., Silva, J.M., Lourenço, N.
Intrusion detection and prevention in CoAP wireless sensor networks using anomaly detection (Open Access)

(2018) *Sensors (Switzerland)*, 18 (8), art. no. 2445. Cited 31 times.
<http://www.mdpi.com/1424-8220/18/8/2445/pdf>
doi: 10.3390/s18082445

[View at Publisher](#)

- 53 Liu, F.
Majority decision aggregation with binarized data in wireless sensor networks (Open Access)

(2021) *Symmetry*, 13 (9), art. no. 1671. Cited 3 times.
<https://www.mdpi.com/2073-8994/13/9/1671/pdf>
doi: 10.3390/sym13091671

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