Journal of Advances in Science and Technology
Vol. 18, Issue No. 2, September–2021, ISSN 2230-9659

Systematic Review of Energy Efficient Localization Methods for Wireless Sensor Networks

Manish Gardi[1]*, Dr. Gyanendra Gupta[2], Dr. Sandeep Kadam[3]

[1] Ph.D. Student, Department of Computer Science and Engineering, Kalinga University, Raipur, India

[2] Ph.D. Guide, Department of Computer Science and Engineering Kalinga University, Raipur, India

[3] Associate Professor and Head, Department of Computer Engineering BSCOER, Pune, India

Abstract - The primary task of a Wireless Sensor Networks (WSNs) is to sense theenvironment around, & sends the information back. The sensor nodes need to be of lesssize, low on power consumption which substantially constrained the computational capacityof these nodes. So any computational task involving these nodes must be very powerefficient so that the duration of the deployment can be increased. In this paper, we focus on the estimating the position of unknownsensors along higher accuracy & lower power consumption using the information fromanchor nodes. It is as yet a troublesome issue to locate a precise & efficient node locationcomputation algorithm under sensor networks. This paper presents the literature review on DynamicDistance Vector-Hop (DV-Hop) method for sensor node localization to processing &computing node location along better precision & less localization error.

Keywords - Energy efficiency, Localization, WSN

----------X----------

INTRODUCTION

Wireless sensor networks (WSNs) are shaped through many little modest gadgets. These gadgets are called as sensors. Sensors are obliged under terms of memory, energy and handling limits. WSNs have wide scope of uses like observing, cataclysmic event help, patient following, military objective and robotized distribution centres and it gives answer for assortment of use. In a large number of these applications, area of obscure hub mindfulness is important or even crucial as characterized. Without a doubt, along no information in regards to the place of sensor hub, accumulated data is useless. Localization is a champion among the most basic subjects under light of the way that the area and region information is consistently important for scope, sending, coordinating, region benefit, target following, and securities as portrayed. Along these lines, area and region assessment is an important specific test for the researchers. As a rule, localization assumes a critical part to plan effective techniques under sensor network is characterized and summed up [1].

Sensors nodes are commonly worked off couple of sensor units under effectivemanner & association along bit units such as microcontroller unit, signal conditioningunit, transceiver unit & a power management unit. Sensordevice detects the data & pass it to mote. The sensor nodes are usually a multi-functional,energy efficient wireless device. Sensors play major work toquantify the progressions under map along different parameters like temperature, weight,stickiness, sound, pressure of environmental condition etc. Data are collected from all thesensor nodes & send to the sink node then via gateway it reaches to the destination nodes[2].

Sensor network comprises of large number of sensor nodes to screen & control thesensor environment as described. Sensor nodes have minimal effort lowpower devices used under detecting, figuring & correspondence capacities. A sensor nodecan just cover a small area, however the collaboration of numerous sensors can give moresolid & better checking of vast ranges. Sensor nodes can be conveyed arbitrarily & they can set up specially appointed systems to gather & send information to the remote basestation. Sensor systems have an assortment of military & a regular citizen application asdescribed. The quick arrangement, self-association & adaptationto internal failure attributes of sensor systems make them an exceptionally valuable detecting procedure for military applications, for example, combat zone observation, damage assessment, organic & atomic assault discovery, gear checking & surveillanceof contradicting powers & landscape. For country

security, sensor system can be sent forborder observation. The capacity to screen physical & ecological conditions, often under realtime, for example, temperature, weight, light & humidity. The capacity to work devices,for example, switches engines or actuators that control those conditions & the capacity togive effective, dependable interchanges through means of a remote system. Significant issues underWSNs are confirmation & protection, forswearing of administration, localization &power utilization [3].

In WSNs base station assumes a significant part to relate the sensor framework to another framework. The parts which give the power and adequacy of frameworks are processor, radio board, getting wire and USB interface board. It is pre-customized along low-power network organizing programming for correspondence along wireless sensor hubs. Association of the base station is indispensable under a sensor organization to play out all activity and is fundamental as all the sensor hubs handover their data to the base station for dealing with and essential direction. Energy preservation, inclusion of sensor hubs and unwavering quality issues are dealt with during sending of base station under sensor network is addressed [4].

Wireless sensor network size depends upon the degree of sensor field & itstopology. Distance across the wireless sensor system can characterize the network sizebased on transmission of all the sensor nodes under a system. It is the briefest separationbetween two most distance nodes under the system.Node density depicts that all nodes are within communication range of severalother nodes at all times. The node density is an important factor influencing theconnectivity under WSN. It is expected under sensor network explore that the node density issufficiently high to guarantee that all nodes are inside communication range of a fewspecial nodes constantly. In general, the density can be as high as 20 sensor nodes/m2 asdefined [5].

Sensor nodes are restricted under control, computational limits, memory & limitedpower. A remote sensor node is prepared along sensing & registering devices, radiotransceivers & more energy segments under sensor network for node capability. They haveconstrained transforming speed, storage capacity, & furthermore correspondence datatransfer capacity.Sensor node plays major roles under communication purpose of network model. Inaddition, since large numbers of sensor nodes are densely conveyed, then neighbour nodesare near to each other to decide system performance. Subsequently, multi-hopcorrespondence under sensor organize is relied upon to utilise less power than single hopcorrespondence. In WSN robust communication model decides the quality dimension ofnetwork [6].

The sensor topology depends on many factors for designing a sensor organization.The mobile sensor node plays important roles for topology changes under sensor network. Thetopology of network defines performance of the system. The topology is broadly used underWSN to create a dynamic network for their data collecting & processing. In WSN majortypes of network topologies used for network formation are star, tree & mesh. Localization is the procedure to define the location value of the sensor nodes &positioning of the sensor node. Location computation & Confinement methods &calculations are utilized to estimate the location & area of the sensor nodes, whosedirections & location value are not known at first, as defined[7].

Secure localization has continually been amongst the key issues of broadlydeployed sensor nodes under WSNs. The security issue of node location system is getting theresearcher's attention to design a robust system as presented. The security issueunder localization is a vital factor because data for that particular location is the important toprotect that node from malicious attack.In many reference points based location calculations method, signals are constantlythought to be reliable. In light of this suspicion, Beacon Movement Detection (BMD) issuehas been recognized, where a beacon is moved suddenly to a location& area other than its gathered location & area.The extending Technique under Radio Interferometer has been proposed as a possiblecourse of error propagation under node location estimation process. It has the advantages underposition estimation process, which could be profoundly exact over other locationtechniques like Received Signal Strength Indicator (RSSI), Time of Arrival (ToA) &Angle of Arrival (AoA). This technique has some limitation, as a result of more estimationfor readings & constrained to smaller systems just 16 nodes. An iterative calculation underview of Interferometric to represents bigger systems during location calculation. Thefuture localization algorithms under view of Interferometric ranging require a ways todiminish the errors propagation is represented under [8].

WSNs are asset on resources constraints undernature; these formulate energyeffectiveness, during design the efficient energy consumption model as described.Hence, under sensor networks the small detecting nodes represents under restricted ways ofenergy supplies. These constrained energy stores restrain life span of the entire localizationframework. In sensor network these nodes executes numerous different tasks other thantheir principle major assignment. These undertakings include collection of data, forexample, location related estimations, correspondence along the neighbours & nodelocation computation, amongst others. In numerous applications of sensor networks,energy utilization is a standout amongst the most vital issues under WSNs as described. The researchers have featured the effective energy utilization under node locationcomputation process under sensor network, however such is nonetheless

quite difficultaccording to plan & design an energy efficient localization algorithms [9].

A multi-hop remote ad-hoc system is progressively shaped through a gathering of mobile nodes.Each of these versatile nodes is worked through a constrained on energy factors of battery &for the most part it is difficult to revive or replace the batteries during a mission. The correspondence between two versatile hubs can be either under a singular single bounce transmission under which case the two hubs are inside the transmission extents of one another, or under a multi-jump transmission where the message is moved through halfway of the portable hubs. Since remote correspondences consume huge course of battery power, alongthese lines, the restricted battery lifetime forces a serious limitation on the systemexecution. Energy proficient operations are basic to improve the system lifetime. Broadstudies on energy preservation under wireless sensor systems have been conducted.Wireless sensor network consume more energy during remote interchanges between nodesas described. Hence, energy effective operations are basic to improve thelife of WSNs. Some measure of energy is lost when a node is under idle mode. The currentreport of analyzed that the power consumed under transmitting & receivingpackets under standard Wave LAN cards ranges from 800 MW to 1200 MW. Most versatilenodes under a sensor system are controlled through energy constrained batteries; the restrictedbattery lifetime is an obstacle to network performance. Since the nodes performances arebattery-controlled, under this manner energy is a valuable asset, which must be deliberatelyutilized through the nodes under WSNs [10]. This research organized as under section 2 literature review presented, under section 3 presented related works, under section 4 research gap analysis &under section 5 conclusion & future work.

LITERATURE REVIEW

In [11], author In Centralized strategy all computation is done under focal server. This method settles computational requirements of hubs. In these computations hubs need to pass on to base station (BS), sadly, correspondence between hubs burns-through more energy than hub area estimation is examined. In this methodology we have a strong focal hub that the other sensor hubs impart along it. Focal hub plays out the calculation and sends localization data to the sensor hubs. In this strategy, subsequent to sending information (estimations) from sensors to the server (it needs a data set for saving got signals and computational information), they should get recognize signal. This strategy diminishes the issue of calculation under sensor hubs and gives plausibility to execute more convoluted calculations.

In [12], author Reference hubs are those exceptional sorts of hubs which realize their directions esteem through use of GPS or manual circumstance. Through use of reference hubs we can get worldwide directions. Consequently issue of using reference hubs is that GPS beneficiaries are exorbitant and can't be used inside for localization since GPS uses Line of Sight correspondence as portrayed. The other choice to GPS is pre-changed hubs along their area and regions, which is unreasonable (for instance, while passing on 10,000 hubs along 500 reference points) or even incomprehensible (for instance, while sending hubs from an airplane). For indoor localization, we can use anchor free hubs and can without much of a stretch get relative directions.

In [13], author GPS is an overall radio-navigation framework shaped through a group of constellationof 24 satellites & their comparing ground stations. The satellites transmit timing signalsalong orbit data implanted under the signal. A GPS beneficiary can decide its area on the offchance that it is under scope of no less than four satellites. It utilizes the received signals tofigure its distance from each satellite, & uses these distances to find its position as represented.

In [14], author GPS, if accessible, can rearrange the localizationprocedure & deliver coordinate system. GPS hardware is winding up progressivelyaccessible on an assortment of stages, including remote sensors. Despite the fact thatGPS might have the capacity to fit on some remote device, there are still confinements underits utilization. To start along, it relies upon observable pathway correspondence along thesatellites under the system, thus regularly does not work under indoor & urban conditions.Second, GPS equipment & energy costs expenses can exceed what is accessible or desireon a remote sensor network. In the event that a WSN can be pre-arranged & physicallysent, however hubs don't have GPS. Strolling GPS utilizes a commercially accessible GPSrecipient, an altered remote sensor, & a straightforward walk through the system totransmit location information to every node. In the event that a hub does not get a locationmessage, it queries its neighbour & finds its position as the centroid of its neighbours.Strolling GPS delivered an average localization error of 0.8 meters. Despite the fact thatthis error is smaller than numerous different algorithms, this approach would not scale wellfor extensive systems.

In [15], another in numerous node location calculation methods, the number of beacons & theirposition is vital. Therefore, minimum number of non-collinear reference points anunknown node needs to localize. This prompts a few purposes of failure for the sensorsystem. A uniform dispersion of reference points is an instinctive arrangement howevermight be excessively costly. The territory or the environment may preclude this. At longlast, if an excessive number of reference points are conveyed, the risk of collision amongsignal transmission increases, wasting energy.

In [16], author Anchor Free location method provides calculations & location informationwithout anchors utilizing virtual coordinates. Since this techniques commonly used onranging estimations of distances. This method has more position error value. In thistechnique the global coordinates are required. Hence, minimum three nodes haveknowledge regarding its coordinate value. Also, numerous applications utilizing remotesensor systems don't require the exactness of anchor based calculations. Hence, to such anextent as efficiency under power utilization, adaptability, robustness & simplicity oflocalization process is discussed.

In [17], Author proposed the new position value is accomplishedthrough triangulation, trilateration or multilateration. This approach, under any case, can propagateerrors that frequently develop as nodes are included which produces poor general positioncoordinates. A refinement technique can be utilized to enhance the quality of wirelesssensor network through applying a refinement method to the assessments of sensor nodes. Themethod can enhance node arrangements & its position information through local minima. Theanchor free incremental technique ABC is analyzed

In [18] author described ABC starts alonga node n0, choosing three nodes under its neighbourhood & assigns the position value alongindicated through their inter-node distances utilizing n0 as the beginning. Distances areevaluated along RSSI technique. This n0 node incrementally estimates the coordinates ofdifferent nodes utilizing the distances to their neighbour nodes that have been previouslycomputed. Inspire of the fact that the algorithm delivers an arrangement of coordinates thatare topologically right, simulation appear around 60% normal position error, for a rangeerror (RE) of 5% is described.

RELATED WORK

Author name	Title	Journal	Objectives
L. Chelouah, F. Semchedine, L	Bouallouche-Medjkoune, Localization protocols for mobile wireless sensor networks: a survey	COMPUTERS & ELECTRICAL ENGINEERING	This paper resolves the different issues under localization & presents the best under class of localization algorithms under Mobile WSNs (MWSNs). In this paper, we arranged the localization algorithms dependent on the localization method, the anchor based/agreeable, the hubs' portability state & the data state &, we introduced a nitty gritty examination of the delegate localization algorithms.
L. Xin, J. Min, N	Multi-modal cooperative spectrum sensing based on Dumpster-Shafer fusion under 5G-based cognitive radio	IEEE ACCESS	In 5G-based intellectual radio, the essential client signal is more dynamic because of the wide recurrence band. The customary helpful range detecting just recognizes one quality of PU utilizing one sort of finder, which might diminish the detecting execution when the wideband PU is under serious blurring channel. In this paper, a multi-modular helpful range detecting is proposed to settle on a precise choice through consolidating multi-modular detecting information of the PU signal, like energy, power range, & sign waveform. Every optional client (SU) sends numerous sorts of locators, like energy indicator, phantom finder & waveform identifier. The multi-modular detecting information from various finders is shipped off a combination place.
Z. Na, Y et al.	Subcarrier allocation based simultaneous wireless information & power transfer algorithm under 5G cooperative OFDM communication systems	Physical Communication	However the customary sub-transporter portion based SWIPT calculation under OFDM correspondence frameworks can advance asset distribution, the collector regularly can't accomplish higher data interpreting rate when the channel state of direct transmission decays. Taking into account the present circumstance, a sub-transporter distribution based SWIPT calculation under 5G agreeable OFDM correspondence frameworks are proposed under this paper.
X. Liu, X. Zhang	Rate & energy efficiency improvements for 5G-based IoT along simultaneous transfer	IEEE Internet Things J	In this paper, a 5G-based IoT is intended to move both 5G & IoT data at the same time. Two concurrent exchange models including time exchanging model & power parting model are proposed to complete 5G & IoT correspondences utilizing diverse time allotments & power streams, individually. For these two models, we have detailed joint enhancement issue of assignment variables & hub powers to expand the 5G transmission rate while the IoT transmission rate & the complete power are obliged. An elective enhancement issue is likewise proposed to amplify the IoT transmission rate while ensuring the negligible 5G transmission rate.
X. Liu, Y et al.	An energy-efficient crowd-sourcing-based indoor automatic localization system	IEEE Sensors J	Dissimilar to past works, creator proposes a functioning testing calculation to channel dependable & valuable data from various clients' bits of feedbacks. creator additionally plan a virtual room age instrument & floor plan planning calculation to develop a dependable room unique mark data set without manual explanations. Trial results exhibit that contrasted & the conventional algorithms the new methodology upholds room-level localization along higher than 95% exactness & diminishes energy utilization through over 40%.
Z. Na et al.	Join trajectory optimization & communication design for UAV-enabled OFDM networks	Ad Hoc Netw	Due to the advantages of high mobility, flexible manoeuvrability& fast deployment, Unmanned Aerial Vehicle (UAV), which can be usually served as aerial communication platform, not only supports information transmission under the Internet of things (IoT), but also provides reliable power supplement for low-power wireless devices.

RESEARCH GAP

In this paper, the current methodologies for sensors node localization areconsidered & existing localization techniques are studies. The different node localizationlimitations under the current methodologies are grouped & are analyzed under light of variousinfluence &features. In this paper, localization calculations were grouped dependent on various key elements like learning, anchor presence, development under network, anchor thickness, hub degree, secures heard, receiving wire/connect Type, position circulation and so forth This characterization is usable to comprehend the activity of changes localization strategies and it is likewise usable for who needs to execute another localization calculation. Most wireless sensor networks have restricted calculation capacity, so the principle objective is to carry out and run straightforward distance assessment capacities [25-33]. The assessment should be extremely near the genuine position. Assuming the position assessed is near the normal worth, then, at that point, assessment is said to have incredible accuracy. At the point when the position assessed is practically equivalent to the genuine position, the level of precision is exceptionally high.

CONCLUSION & FUTURE WORK

The execution & performance of any localization technique relies upon variouselements & factors, for

example, anchor node density value, calculation & nodecommunication costs, energy utilization & exactness of the proposed system. Allmethodologies have their particular benefit which shows their demerits, making themsuitable to various execution plan &its different applications under networks. Numerouslocalization calculations have been produced & used to discover the position of sensors.In spite of the fact that many location calculation techniques are planned & represented,it is as yet not easy to evaluate location value of the node & its area efficiently. Theproposed node location calculation technique defines low complexity along reducedcommunication cost of nodes under WSN. Future research directions & challenges for enhancing node localization under sensorsystems are also discussed. For a wide range of uses of WSN, precise node locationinformation is significant & vital. In this way, an efficient localization schemes forexact localization of sensors under three dimensional spaces can be a good area of future work& its research direction. So these are the couple of issues for future research work toenhance limitation under remote sensor technology.

REFERENCES

1) X. Liu, M. Jia, X. Zhang, A novel multichannel internet of things based on dynamic spectrum sharing under 5G communication. IEEE Internet Things J. 6(4), 5962–5970 (2019).
2) N. Capurso, T. Song, W. Cheng, et al., An android-based mechanism for energy efficient localization depending on indoor/outdoor context. IEEE Internet Things J. 4(2), 299–307 (2017).
3) H. Akcan, C. Evrendilek, Complexity of energy efficient localization along the aid of a mobile beacon. IEEE Communication letters 22(2), 392–395 (2018).
4) J.M. Pak, C.K. Ahn, P. Shi, et al., Distributed hybrid particle/FIR filtering for mitigating NLOS effects under TOA based localization using wireless sensor networks. IEEE Trans. Ind. Electron. 99, 5182–5191 (2016).
5) Z. Nagy, F.Y. Yong, M. Frei, A. Schlueter, Occupant centered lighting control for comfort & energy efficient building operation. Energy & Buildings 94, 100–108 (2015).
6) J.-Y. Chang, T.-H. Shen, An efficient tree-based power saving scheme for wireless sensor networks along mobile sink. IEEE Sensors J. 16(20), 7545–7557 (2016).
7) J. Haghighat & W. Hamouda. A power-efficient scheme for wireless sensor networks based on transmission of good bits & threshold optimization. IEEE Trans. Commun.. 4(8)6,3520-3533(2016).
8) M. Abdelhakim et al., Mobile coordinated wireless sensor network: an energy efficient scheme for real-time transmissions. IEEE J. Sel. Areas Commun 34(5), 1663–1675 (2016).
9) M. Farooq-I-Azam et al., Intelligent energy efficient localization using variable range beacons under industrial wireless sensor networks. IEEE Trans. Ind. Informat 12(6), 2206–2216 (2016).
10) N. Capurso, T. Song, W. Cheng, et al., An android-based mechanism for energy efficient localization depending on indoor/outdoor context. IEEE Internet Things J. 4(2), 299–307 (2017)
11) Xiaoning Zhu, Bojian Ding, Wenjun Li, Gu Lize & Yixian Yang, On development of security monitoring system via wireless sensing network, EURASIP Journal on Wireless Communications & Networking, Vol. 221, pp. 1–10, 2018.
12) Xingcheng Liu, Su Shaohua, Feng Han, Yitong Liu & Zhihong Pan, A range-based secure localization algorithm for wireless sensor networks, IEEE Sensors Journal, Vol. 19, No. 2, pp. 785–796, 2019.
13) N. A. Azmi, S. Samsul, Y. Yamada, M. F. M. Yakub, M. I. M. Ismail, R. A. Dziyauddin, A survey of localization using RSSI & TDoA techniques under wireless sensor network: system architecture, In 2018 2nd International Conference on Telematics & Future Generation Networks (TAFGEN), pp. 131–136, 2018
14) R. S. M. Saadaldeen, A. A. Osman, Y. E. E. Ahmed, Clustering for energy efficient & redundancy optimization under WSN using fuzzy logic & genetic methodologies a review, In 2018 International Conference on Computer, Control, Electrical, & Electronics Engineering (ICCCEEE), pp. 1–5, 2018.
15) Y. Guo, L. Liu, Y. Fu, C. Li, L. Guo, Optimization of magnetic-grating-like stroke-sensing cylinder based on response quality evaluation algorithm, Journal of Sensors, Vol. 11, pp. 1–15, 2018, Article ID 7046390.
16) Mohamed El-Sherif, Yasmine Fahmy & Hanan Kamal, Lifetime maximisation of disjoint wireless sensor networks using multiobjective genetic algorithm, IET Wireless Sensor Systems, Vol. 8, No. 5, pp. 200–207, 2018.
17) Jason Michael Anthony Falbo & Stéphane Dedieu, Network device allocation optimization using genetic algorithms, IEEE Canadian Conference on Electrical & Computer Engineering (CCECE), Vol. 2018, pp. 1–6, 2018.
18) Sanghyun Lee, Baehyun Min & Mary F. Wheeler, Correction to: Optimal design of hydraulic fracturing under porous media using the phase field fracture model coupled along genetic algorithm, Computational Geosciences, Vol. 22, No. 6, p. 1583, 2018.
19) L. Chelouah, F. Semchedine, L. Bouallouche-Medjkoune, Localization protocols for mobile wireless sensor networks: a survey. COMPUTERS & ELECTRICAL ENGINEERING 77, 733–751 (2018).

20) L. Xin, J. Min, N. Zhenyu, Multi-modal cooperative spectrum sensing based on Dempster-Shafer fusion under 5G-based cognitive radio. IEEE ACCESS 6(99), 199–208 (2018).
21) Z. Na, Y. Wang, X. Li, J. Xia, X. Liu, M. Xiong, W. Lu, Subcarrier allocation based simultaneous wireless information & power transfer algorithm under 5G cooperative OFDM communication systems. Physical Communication 29, 164–170 (2018)
22) X. Liu, X. Zhang, Rate & energy efficiency improvements for 5G-based IoT along simultaneous transfer. IEEE Internet Things J. 6(4), 5971–5980 (2019)
23) X. Liu, Y. Zhan, J. Cen, An energy-efficient crowd-sourcing-based indoor automatic localization system. IEEE Sensors J. 18(14), 6009–6022 (2018)
24) Z. Na, J. Wang, C. Liu, M. Guan, Z. Gao, Join trajectory optimization & communication design for UAV-enabled OFDM networks. Ad Hoc Netw. 98, 1–10 (2020)
25) Mahajan, H.B., Badarla, A. & Junnarkar, A.A. CL-IoT: cross-layer Internet of Things protocol for intelligent manufacturing of smart farming. J Ambient Intell Human Comput 12, 7777–7791 (2021). https://doi.org/10.1007/s12652-020-02502-0
26) Mahajan, H.B., & Badarla, A. (2018). Application of Internet of Things for Smart Precision Farming: Solutions and Challenges. International Journal of Advanced Science and Technology, Vol. Dec. 2018, PP. 37-45.
27) Mahajan, H.B., & Badarla, A. (2019). Experimental Analysis of Recent Clustering Algorithms for Wireless Sensor Network: Application of IoT based Smart Precision Farming. Jour of Adv Research in Dynamical & Control Systems, Vol. 11, No. 9. 10.5373/JARDCS/V11I9/20193162.
28) Mahajan, H.B., & Badarla, A. (2020). Detecting HTTP Vulnerabilities in IoT-based Precision Farming Connected with Cloud Environment using Artificial Intelligence. International Journal of Advanced Science and Technology, Vol. 29, No. 3, pp. 214 - 226.
29) Mikhail, A., Kamil, I. A., & Mahajan, H. (2017). Increasing SCADA System Availability by Fault Tolerance Techniques. 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA). doi:10.1109/iccubea.2017.8463911
30) Mikhail, A., Kareem, H. H., & Mahajan, H. (2017). Fault Tolerance to Balance for Messaging Layers in Communication Society. 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA). doi:10.1109/iccubea.2017.8463871
31) Alhayani, B., Abbas, S.T., Mohammed, H.J., & Mahajan, H. B. Intelligent Secured Two-Way Image Transmission Using Corvus Corone Module over WSN. Wireless Pers Commun (2021). https://doi.org/10.1007/s11277-021-08484-2.
32) Mahajan, H.B., Badarla, A. Cross-Layer Protocol for WSN-Assisted IoT Smart Farming Applications Using Nature Inspired Algorithm. Wireless Pers Commun 121, 3125–3149 (2021). https://doi.org/10.1007/s11277-021-08866-6
33) Uke, N., Pise, P., Mahajan, H.B., et.al. (2021). Healthcare 4.0 Enabled Lightweight Security Provisions for Medical Data Processing. Turkish Journal of Computer and Mathematics (2021), Vol. 12, No. 11. https://doi.org/10.17762/turcomat.v12i11.5858.

Corresponding Author

Manish Gardi*

Ph.D. Student, Department of Computer Science and Engineering, Kalinga University, Raipur, India