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Ant with Artificial Bee Colony Techniques in Vehicular Ad-hoc Networks

C.Kumuthini[1], N.Thangarasu[2], K.Kavitha[1], K.Gomathy[1]
[1]Department of Computer Applications, Dr.N.G. P Arts and Science College, Coimbatore, India
[2]Department of Computer Science, Karpagam Academy of Higher Education, Coimbatore, India

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ABSTRACT

A VANET faces many problems due to dynamic changes in networks with certain requirements such as low delay, high (PDR) packet delivery ratio, low routing overhead and throughput. Numerous routing protocols have been suggested to meet the demands of Quality of Service (QoS), but none of them can consistently maintain the highest level of QoS simultaneously. The proposed method, Ant with Artificial Bee Colony Techniques, provides better performance when compared to the existing techniques. This work is compared with the latest developed Techniques in VANET to find the best path, and different performance metrics are used to check the performance. This work premeditated the comparative analysis of the quality of services made by the performance of the latest emerging techniques in VANET and will provide the best solution for the recognition problem in finding the best path based on the evaluation of the performance of Quality of Service. Simulation results imply the benefits of the proposed Ant with Artificial Bee Colony Techniques (AABC) produces better results when compared to the other conventional method and Ant Colony Techniques(ACT)in terms of high packet delivery ratio, less end-to-end delay and less energy consumption level. The performance is evaluated by using the Ns2 simulator, and the results show that the AABC successfully achieved the optimal routes.

Corresponding Author:

C. Kumuthini
Department of Computer Applications
Dr.N.G. P Arts and Science College
Coimbatore
India
Email: kumuthini@drngpasc.ac.in

1. INTRODUCTION

The node in the vehicular network desires to send the packet to another node in the network, initially making sure the available routes are in the cache. If routes are found, then check the shortest path and send the packet through the routes. If no routes are found, then broadcast the packet through all the routes and then find the best path [1]. This way is similar to the ant colony optimization technique. Just as biological ants initially disperse from their colony in various directions to find food and then return to deposit pheromones on their path to inform others, our routing approach involves Requesting ant packet dispersal throughout the network via a novel route discovery system. These packets collect information about the route, such as its total length, congestion levels, and end path reliability, as they make their way to the end user node. Upon receiving a Request ant packet, the target node sends back a Request ant (Route Reply control packet) carrying the corresponding route details to the source node, following the same route [2] [3].

When Reply Ant packets are received from different routes, the source node acquires knowledge about these routes. Analogous to the ant colony approach, the most favourable route is decided by the concentration of pheromones along that route. Similarly, we gauge the pheromone level of a route by considering elements such as the number of hops, congestion on the path, and the route's end-to-end reliability [4]. The route with the greatest pheromone accumulation is selected for the transmission of data packets. Many researchers have developed various techniques to find the best route from the source to the destination, but they produce less quality of service due to the dynamic changes in the VANET network. The proposed techniques used the Ns2 simulator to check the performance level. Due to the failure of dynamically changing vehicle movement and battery collapse, VANETs require an optimal routing techniques tree to be constructed as fast as possible, and runtime becomes an important measure [11].

2. LITERATURE REVIEW

Ant Colony Techniques (ACT) prove to be an exceptional approach for identifying efficient pathways for packet delivery in vehicular ad-hoc networks. ACT employs a method where pheromones are laid on the ground to create trails, attracting other "ants." Pheromones evaporate more swiftly on longer paths, while shorter paths become the preferred route for most other ants in search of sustenance. The applications of Ant Colony Techniques are widespread, encompassing areas such as network modelling problems, security concerns, and vehicular routing. The ultimate objective of ACO (Ant Colony Optimization) is to determine the best path- the shortest path from source to destination [8] [9].

ACO-ABC techniques for various application areas such as salesman problems, vehicular ad-hoc networks, mobile ad-hoc networks, scheduling techniques and image processing methods, etc., and the parameters considered into account as a number of iterations, a number of ants and Pheromone evaporation rate [12]. This algorithm produces high execution speed and accuracy in both local and global search modes but produces more residual energy. The hybrid algorithm is called Ant colony optimization and artificial bee colony optimization (ABC- ACO). The proposed algorithm is mainly deliberate for transmitting information from one place to another place, which is a routing process [13]. This algorithm minimizes the traffic and failure of links through the routing process by using the simulator ns2. The hybrid algorithm proves that it produces better results in terms of packet delivery ratio and delay but lacks throughput and residual energy [14]. The framework fuzzy logic ABC-based algorithm is specially designed for VANETs. The proposed method proves the quality of service efficiency when compared to another existing method in achieving higher optimization accuracy and minimum delay but with the highest energy consumption [15].

During each phase, the ants shift from one location to another, adhering to specific guidelines, including:

- Each ant is required to explore every path precisely once.
- Paths that are farther away have a reduced probability of selection.
- As an illustration, ants leave pheromone traces on paths connecting the source and destination.
- Upon concluding its expedition, an ant leaves additional pheromone marks on all paths it travelled, particularly
- if the journey was brief.
- Following each cycle, the pheromone trails gradually dissipate.

ABC algorithm is the best popular method for optimization algorithm and also they solved many of real time scenarios in vehicular ad-hoc networks but the scheduling problems remains in the VANET. According to the survey, many researchers lack in the performance of energy consumption. The proposed AABC shows that the results are outperforms when compare to the other conventional methods, ACT and solve the problem of energy consumption.

3. METHOD

In comparison to existing evolutionary algorithms, one notable advantage is that the Ant with Artificial Bee Colony (AABC) algorithm incorporates a more effective local search mechanism, enhancing the quality of solutions. The Ant colony algorithm has proven its competence in addressing intricate issues such as digital filter design [7] minimum spanning tree problems [6], and capacitated vehicle routing challenges [5][10].

The ant colony algorithm was introduced by Karaboga (2005) with the aim of tackling complex optimization problems. It is a relatively recent approach inspired by the foraging behaviour of honey bees. The main objective involves minimizing the weighted sum of transfer counts and the collective travel time of passengers through the reconfiguration of vehicles and the determination of new frequencies. Figure 1 shows the AABC techniques.

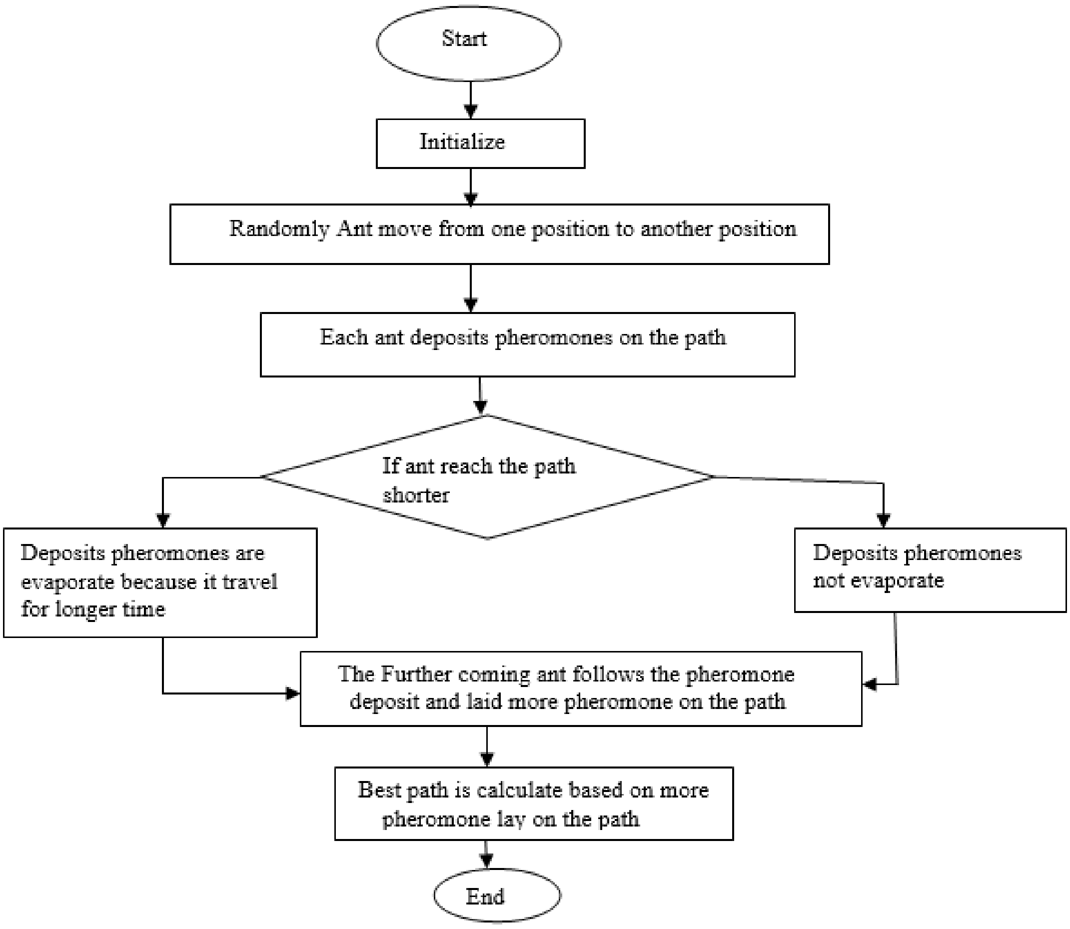

Figure 1. Overview of AABC

3.1. Behaviour of Honey Bee in Nature

The Ant with Artificial Bee Colony Techniques encompass three distinct bee types.

- OB-onlooker bees
- EB-employed bees
- SB-scout bee

The OB-onlooker bees are tasked with collecting information from the worker bees regarding the food source, including details like the distance from the hive and the path to the source. They then make decisions about the chosen source of food based on this gathered information. The worker bees are the ones responsible for discovering and exploiting available food sources. Once a worker bee has finished exploiting a food source, it transitions into a scout bee role, autonomously seeking out new food sources in a random manner.

The Ant with Artificial Bee Colony (AABC) algorithm is founded on two essential techniques such as two types of process: Variation and Selection. The variation process assesses the availability of diverse search space regions, while the selection process guarantees the utilization of past experiences. The AABC algorithm follows four different phases of the cycle: initialization phase, employed bees phase, onlooker bee's phase, and scout bee phase.

3.1.1. Initialization phase

The food source is generated as

$X^s_{n} = x^s_{min} + rand(0,1)(x^s_{max} - x^s_{min})$

x= food source
n= no of food source
s= direction of food source

rand (0, 1) = Once a worker bee has finished exploiting a food source, it transforms into a scout bee, embarking on a random search for new food sources along all boundary directions, spanning from $x^s min$ to $x^s max$.

3.1.2. Employed bees phase

The worker bees are capable of retaining the location of the most recent food source while also computing the fitness value of the current food source. This fitness value is established based on the quantity of nectar. In the event that the fitness value of the new food source surpasses the fitness value of the previous source, the bee abandons the old position and substitutes it with the new position of the food source. This process involves determining the updated position.

$v_{ij} = (x_{ij} - Y_{ij}) / x_{ij}$

v_{ij} = Updated position
x_{ij} = Recent position
Y_{ij} = New position

3.1.3. Onlooker Bees phase

The onlooker bee's phase commences once the employed bee's phase is concluded. During this stage, all employed bees communicate the updated position details to the onlooker bees within the hive. The onlooker bees assess the food sources using the information gathered from the employed bees and subsequently determine the optimal position to search for food sources.

The process involves identifying the most favourable food source position.
$BP = FiGP_{ij} / \sum^{N}_{i=1} FiGP_{ij}$

FiGP is a fitness value of the Gathered position
BP - Best Position
$\sum^{N}_{i=1}$ - No of gathered position from all employed bees.

The onlooker bees evaluate the fitness of all collected positions. Should a position exhibit greater fitness than the preceding one, the bee stores the new position in its memory while discarding the old one. Consequently, the onlooker bees make adjustments to the stored position in their memory.

3.1.4. Scout Bees phase

Once the employed bee process transitions into the scout bee phase, the sequence initiates anew, commencing with the initialization phase. This entails the generation of a fresh food source through random selection across all directions.

$X^s_{n} = x^s_{min} + rand(0,1)(x^s_{max} - x^s_{min})$

The onlooker bee employs the same route to locate the food source. When the food source is depleted, the scout bee initiates a random search for a new solution.

4. SIMULATION SETUP

The simulation is performed in a simulation area of 5500x5500m with 30 nodes.

The results are produced under the simulation study of the network using the NS2 simulator. Each input parameter for the simulation is illustrated in table 1.

Table 1. Simulation Environment for AABC

Parameter	Value
NS Version	NS-2.35
Topology size	3500m X 3500m
No of nodes	100
Data packet size	160 kb
Traffic type	CBR
Packet type	FTP
IEEE	802.11p
Simulation Time	499.00 seconds
Radio Propagation model	Two way Ground
Routing method	AABC

In this scenario each simulation was performed for 499.00 seconds. The AABC Method using IEEE 802.11p is implemented using the NS2.35 simulators. 100 nodes were selected as the participants of the network and each node movement was highly mobile. Each node equipped with 802.11p wireless module and packet size of each packet is 160kb. Distances among the vehicles are randomly selected.

5. RESULTS AND DISCUSSION

In this section, average delay time, energy consumption and packet delivery ratio are investigated with respect to certain factors such as packet sending rate, the distance between the source and the destination when the source generates the first packet etc., simulation settings, and the simulations are carried out using NS2. Simulated results of the existing conventional algorithm, the Ant Colony Algorithm and the proposed AABC are depicted. Three metrics which were used to evaluate the performance of AABC are as follows:

5.1. Packet Delivery Ratio

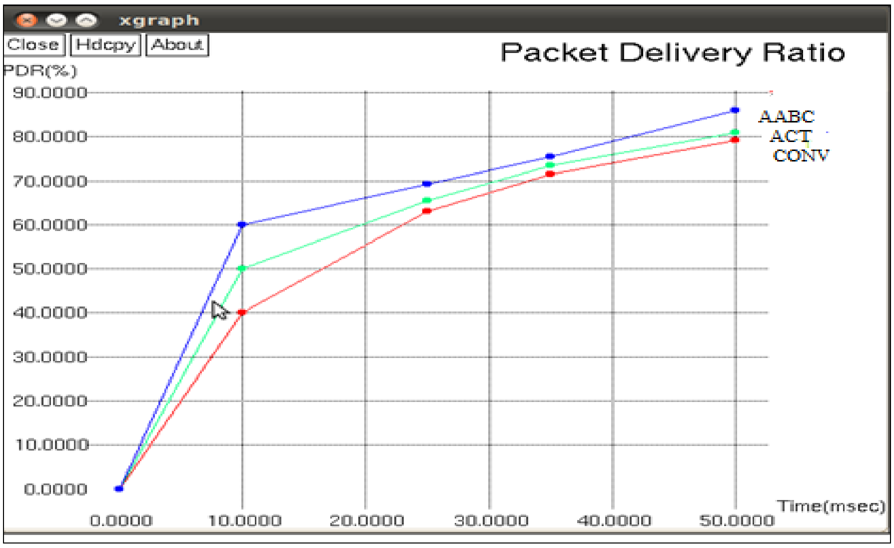

Figure 2. Packet Delivery Ratio

Figure 2 illustrates the average packet delivery ratio generated by AABC Technique and the performance is evaluated by existing ACT, CONV. The packet delivery ratio of AABC is high when compared to the existing schemes such as ACT and CONV.

5.2. Average End-to-End Delay

Average end-to-end delay is the average time taken by a data packet to arrive at the destination. The lower value of end-to-end delay indicates better protocol performance. The selected techniques to check the performance are ABC, CONV and AABC.

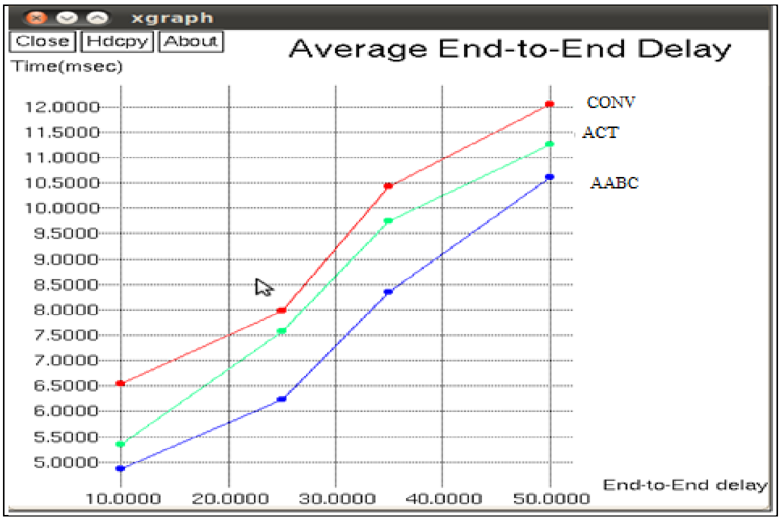

Figure 3. Average end to End Delay

Figure 3 illustrates the average end-to-end delay generated by the AABC Method and the performance made by existing ACT, CONV and proposed AABC. The end-to-end delay of AABC is low when compared to the existing schemes

5.3. Energy Consumption

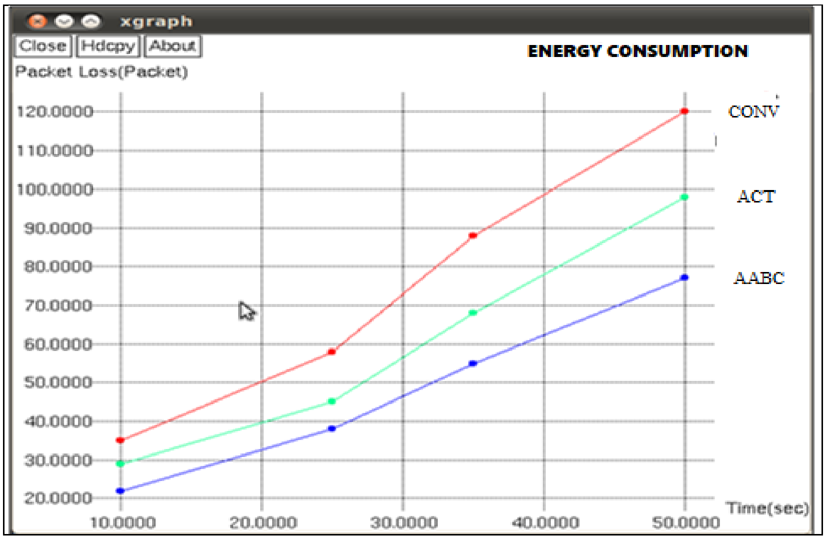

Figure 4. Energy Consumption

Figure 4 illustrates the Energy consumption generated by means of AABC Method and the overall performance made by existing CONV, ACT and proposed AABC. The energy consumption of AABC is low when compared to the existing schemes CONV and ACT.

6. CONCLUSION

The existing techniques use the concepts of the ant colony algorithm to find the best optimal route and also produce more improvement for all parameters taken into consideration, such as packet delivery ratio, throughput, delay, and energy consumption. The proposed AABC algorithm produces more improvement, especially the excepted parameter of energy consumption, than another ant bee colony algorithm. The vehicular ad-hoc network finds the best path-scheduling techniques through the Ant with Artificial Bee Colony Techniques. The parameters used in this technique are channel utilization, throughput, delay, and processing time. The simulation results show that the proposed techniques will assure the best quality of service when compared to the existing techniques. Future research work will be compared with other best techniques and experiments in a real-world environment.

REFERENCES

[1] X. Zhang and X. Zhang, "A binary artificial bee colony algorithm for constructing spanning trees in vehicular ad hoc networks," Ad Hoc Networks, vol. 58, pp. 198–204, Apr. 2017, doi: 10.1016/j.adhoc.2016.07.001.

[2] H. Hakli and M. S. Kiran, "An improved artificial bee colony algorithm for balancing local and global search behaviors in continuous optimization," Int. J. Mach. Learn. Cybern., vol. 11, no. 9, pp. 2051–2076, Sep. 2020, doi: 10.1007/s13042-020-01094-7.

[3] N. Karaboga, "A new design method based on artificial bee colony algorithm for digital IIR filters," J. Franklin Inst., vol. 346, no. 4, pp. 328–348, May 2009, doi: 10.1016/j.jfranklin.2008.11.003.

[4] A. K. Shukla and V. Suresh Kumar, "Cloud Computing with Artificial Intelligence Techniques for Effective Disease Detection," Int. J. Data Informatics Intell. Comput., vol. 2, no. 1, pp. 32–41, Mar. 2023, doi: 10.59461/ijdiic.v2i1.45.

[5] S. S. C. Bose, B. S. Alfurhood, G. H. L, F. Flammini, R. Natarajan, and S. S. Jaya, "Decision Fault Tree Learning and Differential Lyapunov Optimal Control for Path Tracking," Entropy, vol. 25, no. 3, p. 443, Mar. 2023, doi: 10.3390/e25030443.

[6] Manju Bargavi, M.Senbagavalli, Tejashwini.K.R, and Tejashvar.K.R, "Data Breach – Its Effects on Industry," Int. J. Data Informatics Intell. Comput., vol. 1, no. 2, pp. 51–57, Dec. 2022, doi: 10.59461/ijdiic.v1i2.31.

[7] D. Karaboga and B. Basturk, "Artificial Bee Colony (ABC) Optimization Algorithm for Solving Constrained Optimization Problems," in Foundations of Fuzzy Logic and Soft Computing, Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 789–798. doi: 10.1007/978-3-540-72950-1_77.

[8] C. Chidambaram and H. S. Lopes, "A new approach for template matching in digital images using an Artificial Bee Colony Algorithm," in 2009 World Congress on Nature & Biologically Inspired Computing (NaBIC), IEEE, Dec. 2009, pp. 146–151. doi: 10.1109/NABIC.2009.5393631.

[9] T. R. Benala, S. H. Villa, S. D. Jampala, and B. Konathala, "A novel approach to image edge enhancement using Artificial Bee Colony optimization algorithm for hybridized smoothening filters," in 2009 World Congress on Nature & Biologically Inspired Computing (NaBIC), IEEE, 2009, pp. 1071–1076. doi: 10.1109/NABIC.2009.5393866.

[10] H.-B. DUAN, C.-F. XU, and Z.-H. XING, "A HYBRID ARTIFICIAL BEE COLONY OPTIMIZATION AND QUANTUM EVOLUTIONARY ALGORITHM FOR CONTINUOUS OPTIMIZATION PROBLEMS," Int. J. Neural Syst., vol. 20, no. 01, pp. 39–50, Feb. 2010, doi: 10.1142/S012906571000222X.

[11] E. Kaya, B. Gorkemli, B. Akay, and D. Karaboga, "A review on the studies employing artificial bee colony algorithm to solve combinatorial optimization problems," Eng. Appl. Artif. Intell., vol. 115, p. 105311, Oct. 2022, doi: 10.1016/j.engappai.2022.105311.

[12] R. Qun and S. M. Arefzadeh, "A new energy-aware method for load balance managing in the fog-based vehicular ad hoc networks (VANET) using a hybrid optimization algorithm," IET Commun., vol. 15, no. 13, pp. 1665–1676, Aug. 2021, doi: 10.1049/cmu2.12179.

[13] C. Nandagopal, P. Siva Kumar, R. Rajalakshmi, and S. Anandamurugan, "Mobility Aware Zone-Based Routing in Vehicle Ad hoc Networks Using Hybrid Metaheuristic Algorithm," Intell. Autom. Soft Comput., vol. 36, no. 1, pp. 113–126, 2023, doi: 10.32604/iasc.2023.031103.

[14] R. Natarajan, S. R. P, S. C. Bose, H. L. Gururaj, F. Flammini, and S. Velmurugan, "Fault detection and state estimation in robotic automatic control using machine learning," Array, vol. 19, p. 100298, Sep. 2023, doi: 10.1016/j.array.2023.100298.

[15] M. Arif, G. Wang, T. Peng, V. E. Balas, O. Geman, and J. Chen, "Optimization of communication in VANETs using fuzzy logic and artificial Bee colony," J. Intell. Fuzzy Syst., vol. 38, no. 5, pp. 6145–6157, May 2020, doi: 10.3233/JIFS-179697.

BIOGRAPHIES OF AUTHORS

C.Kumuthini received her Bachelor's and Master's degrees in Computer Science from Periyar University, Tamil Nadu, India. She also received her PhD degree in Computer Science from Bharathiar University, India. She has 16 years of teaching experience. Her research interests are Vehicular Ad-hoc networks and Wireless Networks. Now, she works as a professor in the Department of Computer Applications at Dr. N. G. P. Arts and Science, Coimbatore, India. She is a member of the IAENG journal. She has published more than 20 articles in National and International Indexed journals, including SCI, WoS, and SCOPUS. She can be contacted at email: kumuthini@drngpasc.ac.in

N. Thangarasu is currently working as an assistant professor in the Department of Computer Science at Karpagam Academy of Higher Education, Coimbatore. I am greatly fascinated with the advanced computing technology and research programs in Cluster Computing, Cryptography and Network Security, Cloud Computing, Artificial Intelligent Systems, Information Security in large Databases and Data Mining, as well as the strong teaching experience. My doctoral dissertation also focuses on advanced security systems with cloud computing, and I have published more than 13 publications in reputed journals, which I find would be a great addition to the success of your teaching and research department. He can be contacted at email:drthangarasu.n@kahedu.edu.in

K. Kavitha received her Bachelor's degree in Computer Applications from Bharathidasan University and her Master's degree in Computer Applications from Bharathiar University, Tamil Nadu, India. She also received her PhD degree in Computer Science from Bharathiar University, Tamil Nadu, India. She has ten years of teaching experience and seven years of research experience. Her research area is Cloud Security. Now, she works as an Assistant Professor in the Department of Computer Applications at Dr. N. G. P. Arts and Science College, Coimbatore, India. She is a member of IAENG. She has published articles in various National and International Journals Indexed in Scopus & UGC Care. She is a reviewer in the Measurement Sensors journal. She can be contacted through email: kavitha.k@drngpasc.ac.in

Gomathy K received a B. Sc (Applied Science) from P.S.G College of Technology, a Master of Computer Applications, and an M. Phil degree from Bharathidasan University. She is currently working as an Assistant Professor at Dr. N.G.P Arts and Science College. Her area of Interest includes Programming language and networking. She is a member of IAENG. She has published articles in various National and International Journals Indexed. She can be contacted through email: gomathyk@drngpasc.ac.in