NOVEL ALGORITHM FOR THROUGHPUT ENHANCEMENT IN WIRELESS NETWORKS USING MULTICHANNEL

1Shabir Ahmad†, 2*Shafiq Hussain††, 3Mahboob Ahmad Butt†††, 4Zanab Safdar††, 5Junaid††, 6Quratulain††, 7Haroon Mahmood††, 8Zaid Bin Faheem††††, 9*Umar Draz††

† Department of Computer Science; Govt. College of Commerce; Multan, Pakistan
††Department of Computer Science; University of Sahiwal; Sahiwal, Pakistan
†††University of Veterinary and Animal Sciences; Lahore, Pakistan
†††† University of Engineering & Technology, Taxila; Punjab, Pakistan
***Corresponding Authors: Shafiq Hussain and Umar Draz**

Summary
In wireless networks when there are multiple paths from the source to destination, the network capacity should be enhanced in accordance with the growing demand of network resources. The throughput is a basic element in this situation. To achieve a maximum throughput, an efficient algorithm that can give high-performance, scalability and optimized routing using multi-channels is needed. To achieve these objectives, an Artificial Intelligence (AI)-based algorithm named Throughput Enhancement Algorithm for Multi-channels (TEAM) is designed. TEAM will contribute to the existing knowledge on how much network throughput can be enhanced using an AI routing mechanism. The proposed TEAM algorithm code was implemented in MATLAB to check the enhancement and learning in a network traffic throughput. In each experiment, the values of metrics were changed to determine the behavior of the network under different situations. Results show that an increase of a single iteration, there is 2% increase in throughput, and an increase of 50 iterations, the routing cost decreases by 100%, returning to its previous results. The results show that by using the TEAM algorithm, a wireless network can manage resources in a better way and increase the throughput of the network by selecting the best available path. The TEAM algorithm automatically manages routes in a network and optimizes the incoming traffic of a network. To validate our results, we compared our results with those of an existing ant colony optimization algorithm. The simulation results of the TEAM algorithm show that it is flexible and can equally fit in small and large-scale networks.

Keywords:

Wireless Networks, Artificial Intelligence, Topology, Throughput, TEAM, MATLAB.

1. Introduction

In the present age, wireless networks have become essential parts in communication. In the present wireless networks, the basic concepts about technology are still the same because they prove to be effectively used in previous decades [1, 2]. In recent years, the use of wireless services has significantly increased with the advent of devices, especially mobile and portable devices [3]. The requirements are the capacity of using advanced services and availability of resources for the increasing number of users. The network capacity should be enhanced to meet the growing demand of network resources.

To achieve these goals in a wireless environment, efficient protocols and algorithms are needed. Using these algorithms, the throughput of wireless networks can be increased. A wireless network includes a plurality of nodes that transmit data to and receive from the network [4]. Protocols are designed in such a way that data are sent to the network for transmission to the receiving node in an efficient manner [5, 6]. These protocols are the key elements of a wireless network. A constant research has been conducted to design and develop new methods and techniques to improve the efficiency of networks and support new generations of networks [7].

The development of effective networking techniques requires additional protocol stacks of network research, which is the heart of the network model. A protocol stack shows the modularization of network protocols [8]. Moreover, a backbone network has several techniques to optimize cross layers and increase the overall efficiency of the networks in various layers. A necessary interplay occurs between different networks, this effect has also detected new techniques. Nowadays, these new techniques are based on the perception of knowledge and geographical distribution. Perception is taken based on user behaviors using network resources.

In the past years, networks have rapidly grown and may contain millions of routers and computers being used by millions of users. To make connections in a network, different routing protocols are used for the routing of data among hosts. In these protocols, routers have the same routing table in a network [9, 10]. The data packets send using this routing table address. The commonly protocols used in traditional networks are RIP, RIPv2, OSPF, and EIGRP [11, 12]. In the OSI model, the third layer is used for routing protocols. In routing protocols, the collection of algorithms is used, where processes and procedures run on remote networks, and learns

Manuscript received August 5, 2020
Manuscript revised August 20, 2020

from their external environment and the changing topology. The routing tables are periodically updated [13].

2. Literature Review

The biological features of different living things can be studied, and analyses can be used for designing of machines [14]. The machine or robotics can be designed and generally accepted by a broader spectrum of artificial intelligence (AI), which ultimately understands the behavior of "intelligent agent" at all levels [15]. After the concept was intuitively created as swarm intelligence works, various technical applications have been designed. AI has been used and is well known for the optimized working of robotics. The same formalism was reused to solve the routing problems of wireless networks [16]. This is an interesting analogy in biology and may shed light on the most appropriate solutions to the network routing problem. Colonies of social insects have many features that represent a perfect network. The natural inspired ideas can be deployed in machines operations which are resistant to errors and flexible in nature [17, 18].

Based on the swarm intelligence concept, collective robotics was formulated. Useful tasks for human have been created based on the biological behavior of bees and ants, particularly performing efficient routing systems [19, 20]. This behavior is also called a biologically inspired system. Many researchers have set directions for exploring and searching robots. In the same context, the schooling behavior of fishes is based on the insect metamorphosis and is similar with the exploration of the flocking behavior of birds.

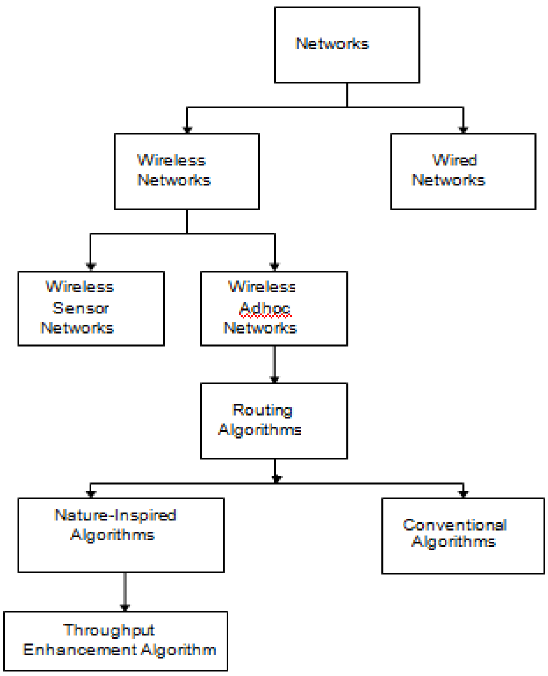

Fig. 1 Structure of the study

In recent research, the big challenge in networking is providing efficient intelligent routing services to users to maintain good reputation. The abovementioned challenge can be resolved in multi-dimensional ways. Another common challenge is to design, develop, and implement an efficient algorithm that can perform intelligent routing. The features of an intelligent routing algorithm that can suit any network are described below. A routing algorithm must bear characteristics, such as optimal routing, flexibility, efficiency, multiple route convergence, and scalability.

In addition, most of our previous work covers this domain in multiple aspects such that, we successfully experiment the network segmentation for large scale area in [4] and watchman based flood detection and recovery model using wireless sensors in [5]. Furthermore, to introduce the concept of wireless battery charging and its life prediction is also analyzed by Sana et. all. In this article the AA and AAA alkaline battery are examined, and their life estimation algorithm works according to support our words in a well-disciplined manner, see [11]. For this, we also introduce first time in literature, Energy aware distributed algorithm for smart wireless actuator networks. Most of the wireless links are down due to extra energy consumption in remote areas, where the unmanned efforts are required, for this, the role link stability and its threshold value have great impact overall the health of the network. we, therefore, simulates the link failure detection algorithm in [16, 17] to address this issue.

In modern era of technology where Wi-Fi need to convert Li-Fi [22] and some novel algorithms become necessity of wireless research and some artificial intelligence based approached are come into being in this field. In a nutt shell, same kind of approaches are introduced in [18, 19] to support our words to make the smooth flow of novel algorithm of throughput enhancement using multichannel.

3. Materials and Methodology

We developed a flexible algorithm for wireless routing, in which the throughput of the network is enhanced using AI ideas/basics. By developing the candidate algorithm, we have achieved the goals of our study and answered the research question.

3.1 Designing a Routing Framework Based on AI

A router working in a real engineering network with a dynamic approach is quite important for the better utilization of the network. This study critically analyzes the existing work performed on the selected domain of AI in the routing of complex networks and increasing the throughput. We also followed the software engineering approach of reusability of working parts and made a good technique. By adopting this approach, designers can develop a framework/protocol by keeping in view the top issues and implementation details of a network [21]. By using the nature-inspired approach, an intelligence-based framework was designed.

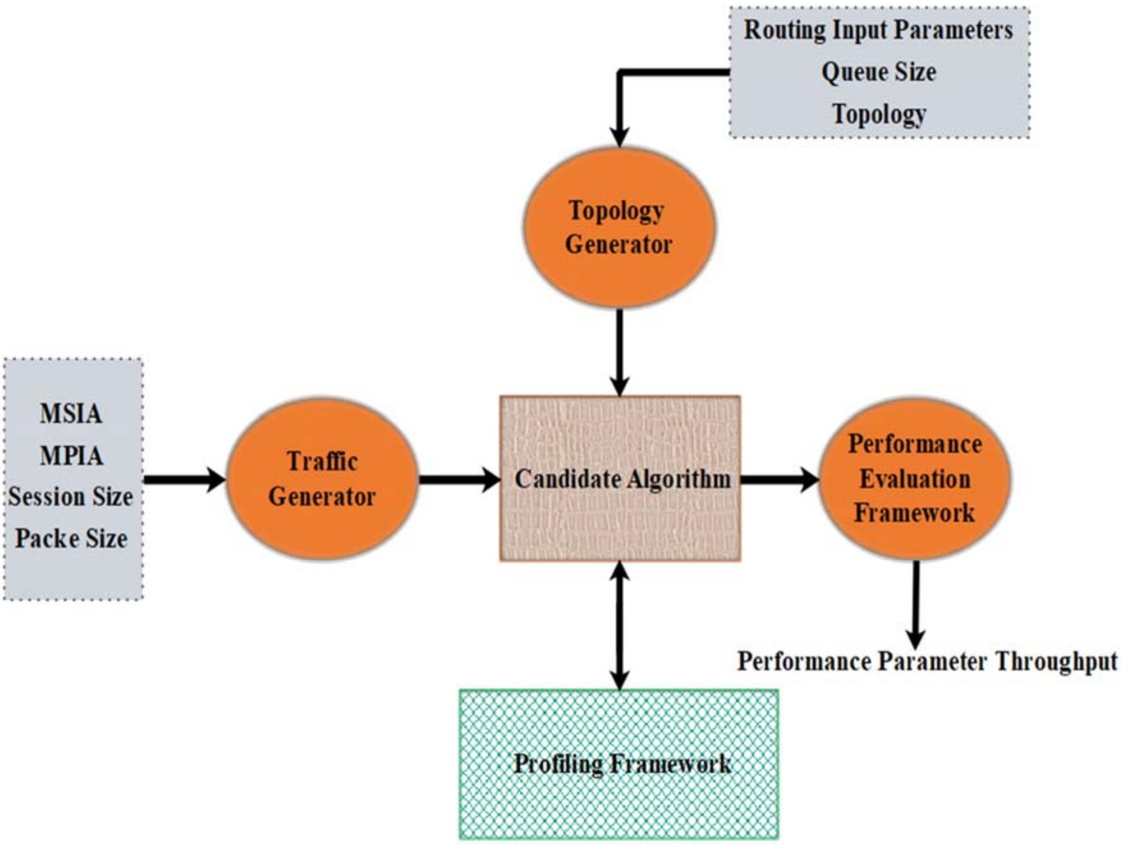

Fig. 2 Routing framework structural design [23]

3.2 Proposed TEAM Algorithm for Throughput Enhancement

The performance of the intelligence-based routing algorithm TEAM was analyzed in this section. The productivity of the routing algorithm was designed/modeled by the framework on the basis of values attained from the performance. In a real-world network, communication and processing are included for the arrangement of routing-based algorithms' resource cost. This framework is generally enough to investigate an agent-based system. Thus, the scalability of an agent-based routing algorithm behaves in two ways, namely, Ant Net and Beehive [24]. A valuable understanding was developed based on the ascending capacity of the algorithms, which are based on agent-based distributed systems.

3.3 Flowchart of the TEAM Algorithm

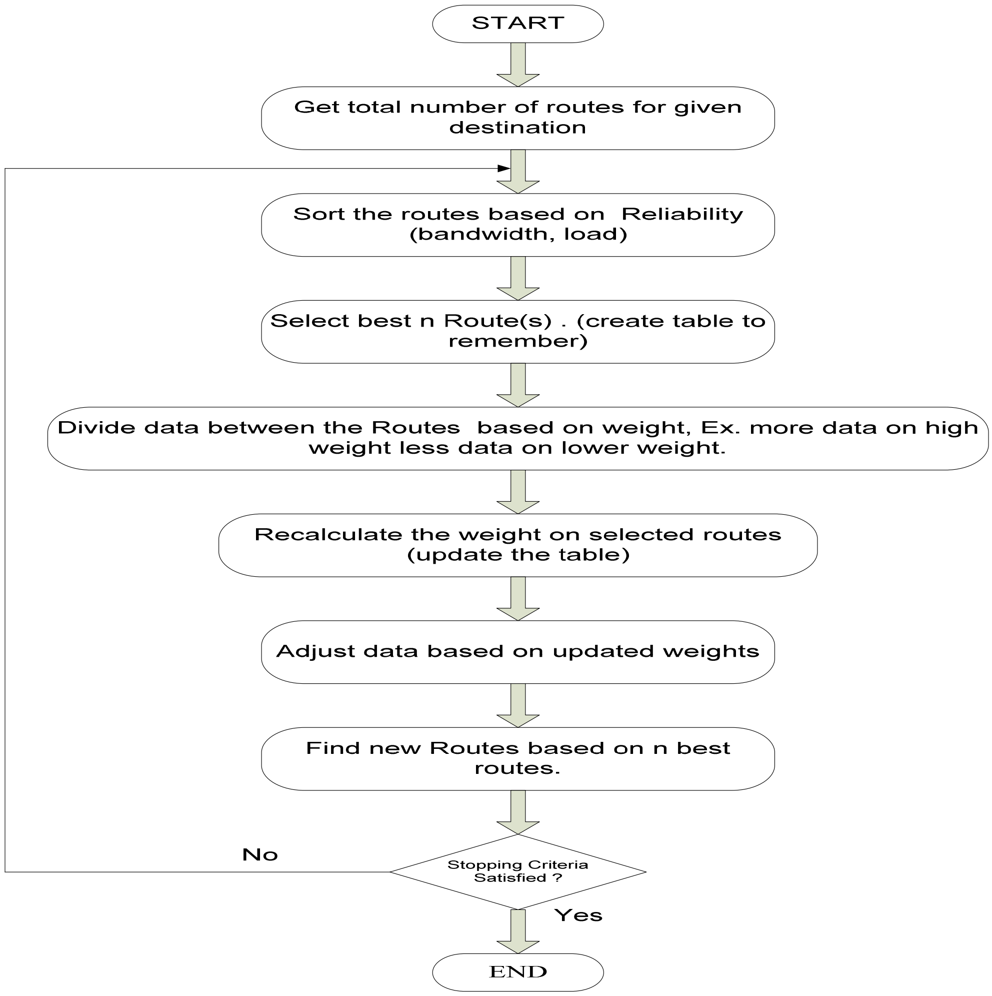

Fig. 3 Data flow diagram

3.4 TEAM Algorithm Features

The AI-based TEAM algorithm, which aims to enhance throughput has following features:

- The network can handle more nodes (bigger networks).
- The algorithm is flexible and can easily work in all directions.
- The routes of the network can be derived (The topology is automatically generated based on Waxtop algorithm).
- Hello packets are sent to different routes.
- Searching of good routes starts here.
- Hello packets move back to the sender and shares information about routes.
- Informative communication is performed here.
- The reliability of routes is checked examined here in accordance with the bandwidth and load of a route.
- Information about the reliability of routes is shared.
- More data packets are sent to more reliable routes, and less data packets are sent to less reliable routes (for better communication).
- The checking process of routes remains continuous.
- If the route remains good enough for communication, so more packets are sent to reliable routes to the destination.
- Most times, the sending route of data packets is more reliable, thus reducing cost.
- If the route is not so good enough and reliable to send more data packets, the communication moves to another route and the checking process continuous until communication ends.

$procedure\ launchTEAMAlgorithm, nodes(t, m_i, m)$

$if\ t\ (time)\%\ \Delta t(mean\ time) = 0\ or\ m_i\ \%\ packet_{Limit} = 0\ then$

$if\ t\ is\ considered\ a\ representative\ node\ for\ destination\ address, then$

$k_t \leftarrow For\ upper\_bond, \{h_t^w\ route\ with\ a\ long\ distance\}$

$else$

$k_t \leftarrow For\ lower\_bond, \{h_t^w\ route\ with\ a\ short\ distance\}$

$end\ if\ \ loop\ ended$ Now, for node representation

$if\ w = 0\ , then$

$gs_t \leftarrow t\ \{carrier\ node\}$

$end\ if\ \ loop\ ended$

$for\ z \leftarrow 1\ to\ N\ do\ \ for\ finding\ all\ possible\ routes$

$for\ replica\ creation\ \ h_t^{zw}\ of\ netwrok\ routes\ h_t^w$

$neighbor\ route\ address\ finding\ index\ z\ \ replica\ launching\ b_t^{zw}\ to\ neighbour\ at\ index\ z$

$z++\ \ for\ increments$

$end\ for\ \ \ for\ loop\ ended$

$end\ if\ \ if\ loop\ ended$

$end\ procedure$

Switching Data Packet

1: $Procedure\ for\ \frac{data}{packet} switching\left(P_{tp}, index\ i\right)$

2: $if\ p\ i\ withen\ the\ FZ\ routing, then$

3: $shareinfo\ \ IFZ\ of\ node\ i\ to\ the\ final\ node\ p$

4: $weight\ calculation\ h_{kw,}\ \forall k \in N(i)$ finding best rout

5: $else$

6: $shareinfo\ FRM\ of\ node\ i\ for\ new\ node\ searching$

7: $shareinfo\ IFR\ of\ node\ i\ for\ calcuating\ packet\ delays\ to\ node\ p$

8: $weight\ calculation\ h_{kw,} \forall k \in N(i)$

9: $end\ if\ (if\ loop\ ended)$

10: $neighbour\ selection\ on\ the\ base\ of\ probability\ n$*(for selection of alternate best routes)*

11: $routing\ data\ packet\ P_{tp}\ routing\ for\ n\ \ nodes$

12: $end\ of\ procedure$ */*for data packet switching*/*

```
procedure manageNeighbours(i) /* for neighbour node i */
    if t % Δt = 0  then   /* t is time here */
            for initializing transmission  send a hello packet to all neighbours
      if low response time then for time out then /*time out*/
            display message nighbour is down
            routing table is updatred at index i
            launch scouts (special agents nodes)to share info wiht other nodes

end if first ifloop ended
    end if second if loop ended
end procedure
```

4. Results and Discussions

The experiments were conducted in MATLAB, and the simulation results were also discussed. The TEAM algorithm was inspired from Beehive. Thus, the TEAM algorithm results are of significance, and its behavior in virtual and real networks is easily traceable due to similarity concepts. Different experiments were setup to utilize in real wireless networks. The results and findings of this study will help to improve the performance of the TEAM algorithm in small and large wireless networks.

Table 1: Performance Metrics of the TEAM Algorithm

Performance Metric	Description of the Metric
Cost	The cost during the delivery of the packet from the source to the destination was calculated in the TEAM algorithm using cost function. It also includes the time taken and bandwidth required for routing. In the proposed algorithm, if the overall cost for routing a packet in a network is low, then the throughput increases, showing the overall performance of the network. This metric also displays the mean value that represents the overall cost.
Fitness	Fitness is a performance parameter of a network to find the best route between nodes in a wireless network. The fitness level is dependent on the cost and mean value of the routing cost. In the TEAM algorithm, the fitness level of a route is kept constant until its mean cost is lower for a route between the source and destination nodes.
Nodes	In the TEAM algorithm, the number of nodes can be flexible and automatically adjusted with the possible routes among them. The large number of nodes in a network can increase the overall routing cost and lower the throughput, but the mean value will remain low. If the number of visits/iterations is large, then the mean cost value will decrease. However, a large number of nodes can provide more number of routes, and the algorithm becomes more efficient in finding the better routes for transmission.

Visits/Iterations	In the TEAM algorithm, the number of visits/iterations is mainly dependent on the network environment. As the TEAM algorithm is AI-based, it learns from its external environment and this process increases the number of visits/iterations. The routing cost also reduces with the increase of iterations and the overall throughput of the network.

4.1 Implementation of the TEAM Algorithm in MATLAB

The TEAM algorithm code was implemented in MATLAB to check the enhancement and learning in the network traffic throughput. In each experiment, the values of different metrics were changed. We determined the behavior of network under different situations. In the varying metrics, the number of repetitions or iterations was also changed to examine the behavior of the network traffic load.

The experiments were conducted in the MATLAB, and in the experiments, the metrics were given the same corresponding virtual values. The results or outputs that we received from the experiments were beneficial because when the number of visits/iteration was increased, the performance also increased. The routing cost automatically decreased as the TEAM algorithm learns from the environment. The best feature of an AI-based routing algorithm is learning from the external working structure and increasing its performance accordingly. The simulation results are shown in Figure4.

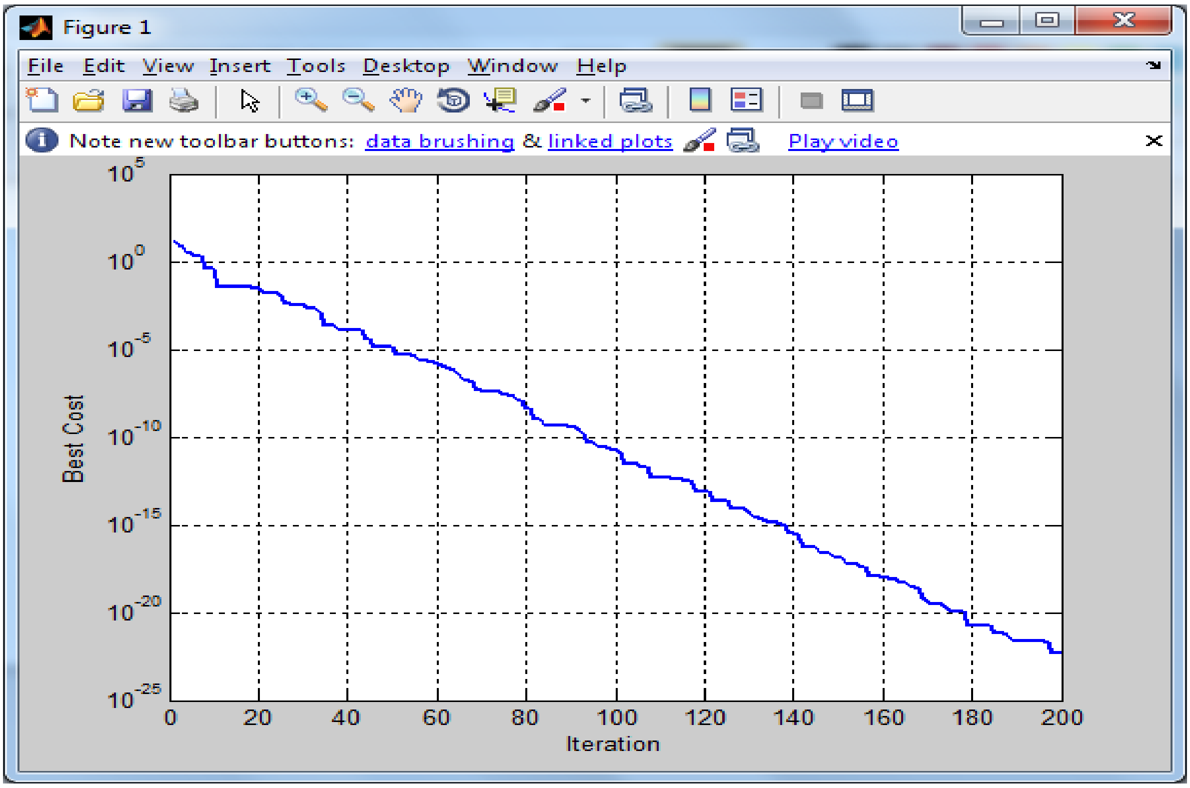

Fig. 4 Results with 200 iterations

Figure 4 shows the results after 200 iterations. The data show that when the routing cost decreases, the TEAM algorithm automatically learns from all its routes, which means that the performance of the network also increases. Thus, the algorithm becomes more efficient as the iterations increase.

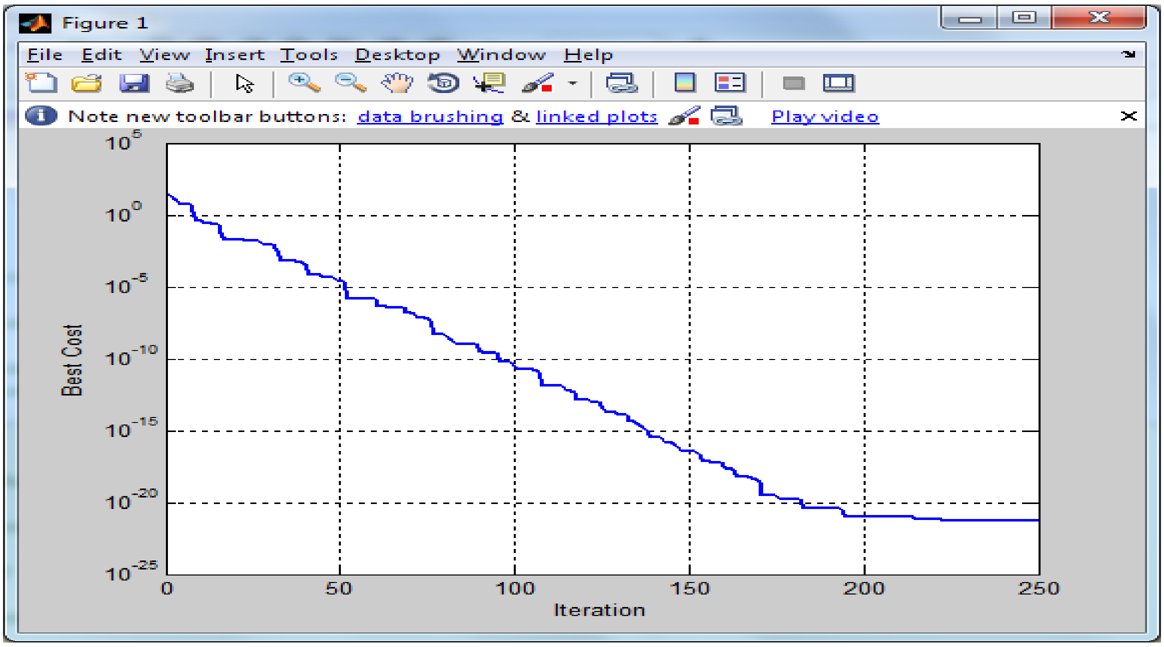

Fig. 5 Results with 250 iterations

Figure 5 shows the results after 250 iterations. The data show that when the number of iterations increases, the routing cost decreases. As a result, the performance improves and the throughput of the network increases accordingly. Moreover, the routing cost was the same after 190 to 250 iterations. In this way, the throughput increased up to 100%.

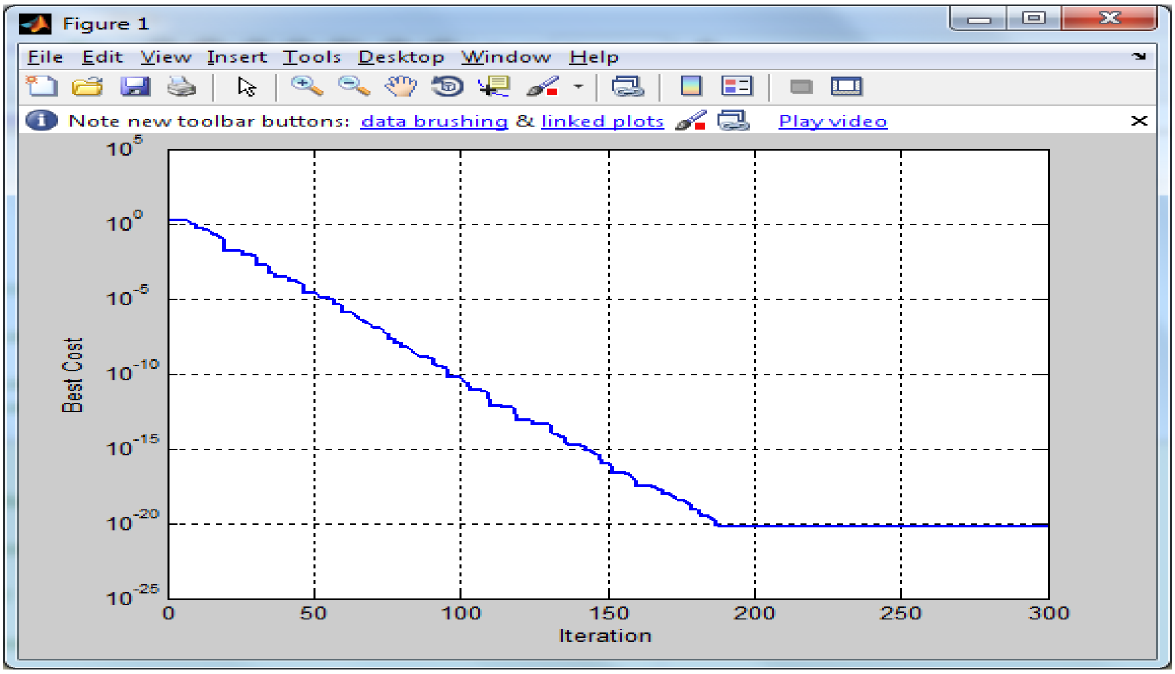

Fig. 6 Results with 300 iterations

Figure 6 shows the simulation results with300 iterations. The data show that cost is the same after180 to 300 iterations, and when the number of iterations was increased, the cost decreased. As a result, the performance and throughput of the network improve. In this way, the throughput increased up to 200% by only increasing 100 iterations, which allowed the TEAM algorithm to learn the network with a double rate.

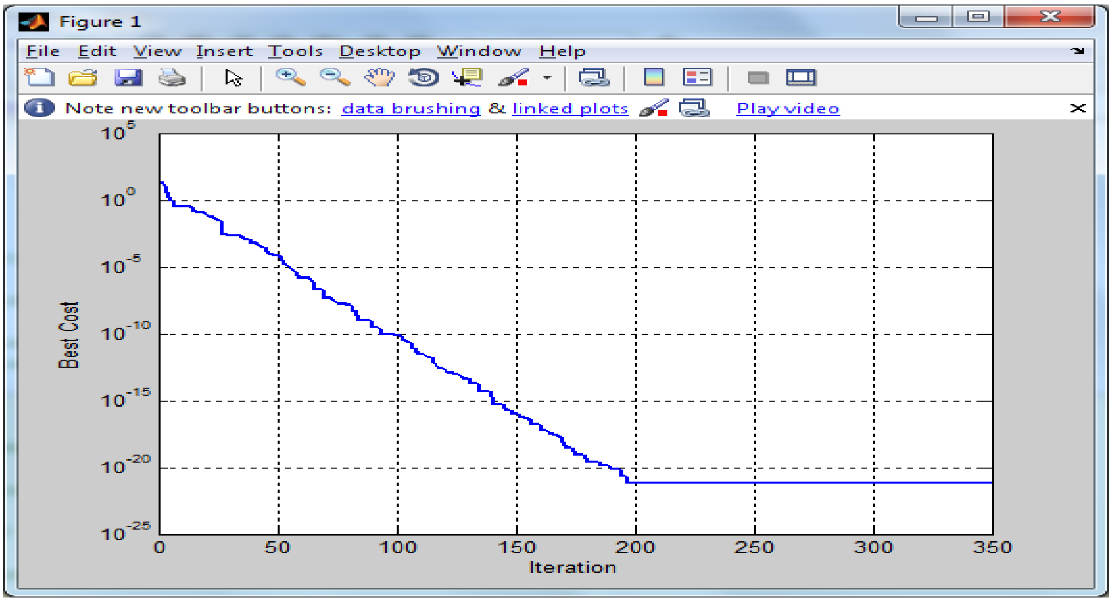

Fig. 7 Results with 350 iterations.

Figure 7 shows the simulation results using 350 iterations. The data show that the routing cost is the same after190 to 350 iterations, and when the number of iterations was increased, the cost decreased. In this way, the throughput increased up to 300% by only increasing 160 iterations, which allowed the TEAM algorithm to learn the network with a triple rate.

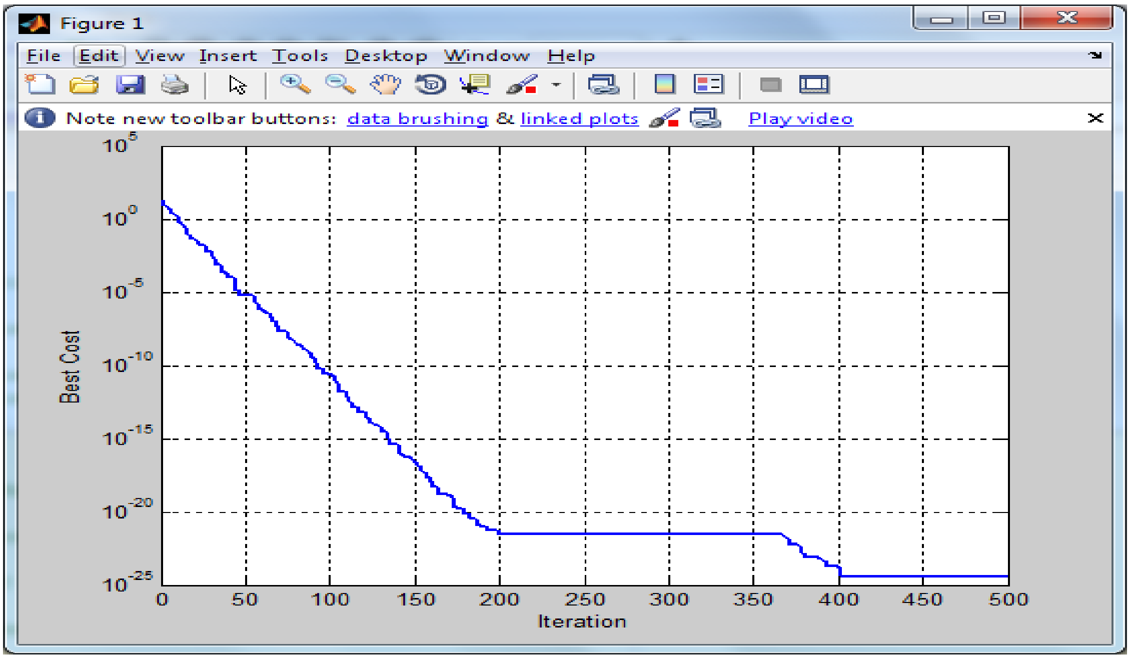

Fig. 8 Results with 500 iterations

Figure 8 shows the simulation results with500 iterations. The data illustrate that cost is the same after200 to 370 iterations, and when the number of iterations was increased, the cost further decreased. In this way, the throughput increased up to 560% by only increasing 300 iterations, which allowed the

TEAM algorithm to learn the network intelligently that shows a better performance and throughput of the network.

The simulation results of our proposed algorithm clearly show that when we increase the number of iterations or visits, the packets are delivered to the destination in the given network with a low routing cost, which will increase the overall throughput of a network by 100% in every increase of 50 iterations. Thus, the TEAM algorithm will learn more intelligently as time passes by in the wireless network. To validate our results, we compared our results with those of an existing ant colony optimization algorithm. The simulation results of the TEAM algorithm show that the algorithm is flexible and equally fit in small- and large-scale networks. The use of multi-channels also resulted in a better throughput of the network and increased the performance of the network.

5. Conclusion

An AI-based algorithm named “TEAM” was designed in this study. It is expected to contribute to the existing knowledge on how to enhance the throughput of a network using an AI routing mechanism. In this work, the special focus is on the intelligence-based routing that aims to overcome the congestion problem in any given network. This work will have a positive contribution in the area of nature-inspired engineering. The proposed TEAM algorithm code was implemented in MATLAB to check the enhancement and learning in a network traffic throughput.

In each experiment, the values of the metrics were changed to determine the behavior of the network under different situations. The findings show that an increase of a single iteration increases the throughput by 2% and that with50 iterations, the routing cost decreases to 100%. Thus, by using the TEAM algorithm, a wireless network can manage resources in a better way and the throughput of the network can be increased by selecting best available path. The TEAM algorithm automatically manages routes in a network and optimizes incoming traffic. The simulation results of the TEAM algorithm prove that it is flexible and can equally fit in small- and large-scale networks. The use of multi-channels also resulted in a better throughput of the network and increased the performance of the network.

5.1 Future Work

In the future, the big challenge is knowledge-based routing, which is the ability of learning and reasoning. The future goals include adapting the same algorithm with minor parameter variations for the routing scheme. Hence, it can, by itself, constitute to the backbone of a complete wireless sensor network and other protocol suites. The analysis can also be performed in NS2 simulators or even in MATLAB.

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Shabir Ahmad: received the master's degree in computer science in 2000, Master's in Telecommunication from Bahauddin Zakariya University, Multan, Pakistan in 2006 and MS computer science degree from ISP, Multan in 2015. His main research is on Wireless Networking, AI and Software Engineering. His many research papers has been published in several ISI indexed journals.

Dr. Shafiq Hussain: received his M.Sc degree in Computer Science from Bahauddin Zakariya University, Multan, Pakistan and PhD degree in Computer Science from University of Sunderland, UK in 2015. He is currently working as Associate Professor of Computer Science in Department of Computer Science, University of Sahiwal, Pakistan. He is also founder and Chairman, Department of Computer Science in University of Sahiwal. He has successfully completed HEC funded project as Project Director. He is also working Director IT and Project Director of Higher Education Commission (HEC) of University of Sahiwal. He has supervised more than 30 postgraduate research students and published many research papers in academic journals.

Brigadier Dr. Mahboob Ahmad Butt: Got his DVM degree during 1988 and joined Pak Army in 1989. During his service, he got M.phil degree from Quaid-i-Azam university Islamabad in 1993 and PhD degree during 2019 from UVAS Lahore. He worked in different scenarios within Pakistan and internationally with UNO and worked for the low-income communities. He worked as senior scientific research officer in bovine genetic improvement center, having vast working experience in educational system. Remained head of the Army professional training institutes. He, now start his collaboration with Umar Draz on his platform of NetCom on different projects of bioinformatics and Polio Free Pakistan (PFP).

Zanab Safdar: is serving as Lecturer in the Department of Computer Science, University of Sahiwal, Sahiwal, Pakistan since 2020. She received her Master of Science degree in Information Technology with distinction from Bahauddin Zakariya University, Multan, Pakistan, in 2018 and the Bachelor of Science degree in Information Technology from The Women University, Multan, Pakistan, in 2016. She, now has great contribution in different well reputed journals like Future Generation of Computer System and Elsevier. In addition, she had successfully attended the international conference in Malaysia as a Principle Author. Most of the organization and research body acknowledge her research efforts in term of her research productivity as distinguish. She leads her cumulative impact factor and select invited reviewer in different international journals and IEEE/ACM Conferences. Her research interests include Big Data, E-Health, IoT, Blockchain and future intelligent networks. Recently, she is starting her collaboration with Umar Draz on his platform of NetCom.

Junaid Ahmed: Currently working as a lecturer in Computer Science in University of Sahiwal. Has been teaching at public institutions since 2018. His research interest includes System Security, Network Security and Operating Systems. He has served as a research assistant at Sysnet (research lab at Lums) during his master's studies. His industry experience include working as a Software Engineer at TRG from 2014 to 2016. He has completed his bachelor's in computer science from Fast-nu in 2014 and he has a master's in computer science degree from Lums completed in 2018.

Quratulain: Lecturer Department of Computer Science, University of Sahiwal, Pakistan. MS in Computer Science from NED University of Engineering and Technology Karachi.

M. Haroon Mehmood: received a bachelor's degree from GCU Lahore in 2016 and a master's degree from NCBA & E Lahore in 2018. He is now a lecturer in the University of Sahiwal since 2020. He has also worked in different software houses in Lahore from 2017 to 2019 as a software developer. He is also working as a freelancer with the different software houses in Lahore.

Zaid Bin Faheem: received his BSc and MS degree in computer engineering from the University of Engineering and Technology, Taxila, Pakistan in 2014 and 2018, respectively. He is currently working as a lecturer in Computer Science Department, Government College University, Faisalabad, Sahiwal Campus, Pakistan. His main research interests are Machine Learning, Chaos-Based Cryptography, Watermarking and Information Security. He is active partner of NetCom platform with Umar Draz since 2018.

UMAR DRAZ: He earned his master's degree with distinction as MSCS at COMSTS University Islamabad, Sahiwal Campus in 2018. He, now, lecturer in University of Sahiwal since 2020. He has been Active Participant of Imagine Cup International and Best Information Technology Award BITA_2017 and 2018 with novel idea of CPEC projects (Runner Up). He has distinguished number of publications in reputed journals and conferences with good cumulative impact factor, including world best paper award from University of LaTaroob, Australia and European Alliance International (EAI) in recognition of his quality research and productivity. He as invited reviewer of different IEEE, Elsevier, ACM, SCI and EAI Journals and permanent reviewer board member of Journal of Intelligent networks and different IEEE/Scopus National and International Conferences. He has been co-research partner in several projects of wireless communication of Li-Fi and IoT with Joint Venture of Najran and Tabuk University, Kingdom of Sudia Arabia and Inha University South Korea. Currently his research interest includes Wireless Communication, Deep Learning, Underwater Sensor Networks, Block-chain, and Intelligent Future Networks with 6 G.