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END TO END DELAY IMPROVEMENT IN HETEROGENEOUS MULTICAST NETWORK USING FUZZY GENETIC APPROACH

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ABSTRACT

Routing plays an important part in delivering data from senders to receivers efficiently, in multicast communication. In QoS multicast, receivers receive data within specified QoS constraints. This is a challenge if the heterogeneous network consists of wired and wireless devices. This paper investigates the performance of Protocol Independent Multicast – Sparse Mode (PIM-SM) protocol performance within a heterogeneous network operating a video conferencing application and suggests an improved routing protocol with Fuzzy based Genetic Optimizing techniques to enhance QOS parameters such as delay, speed and packet dropped in bits/sec in the multicasting. The video conference transmission speed in bits/sec was increased in Fuzzy logic genetic approach and it was much better when compared to PIM-SM and Genetic algorithm based approach in a Heterogeneous multicast network simulation. Extensive simulations using the proposed technique and existing PIM-SM were tried out and it was revealed that the proposed Fuzzy based optimization technique both improved network throughput and lowered end to end delay.

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KEY WORDS

Protocol Independent Multicast – Sparse Mode (PIM-SM), Wireless Network, Heterogeneous Network, Genetic Algorithm, Fuzzy Logic

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INTRODUCTION

Multimedia communication applications need a source to forward information to many destinations through communication networks. Application examples include:

- In multiparty multimedia teleconference, video and voice from every conference site are sent to other conference sites to ensure that conferees see and communicate in real time [1].
- In remote video lectures for distance education, the instructor's video and voice are sent to students via a communication network.
- In video-on-demand systems, a problem is video retrieval from disks [2]. To overcome this, many customer requests for the same video object are batched and then one I/O stream serves multiple customers [2]. Multimedia information is forwarded from the video server to many customers through this method.

A multicast session is created with a multicast tree through which data is shifted to a multicast group. Multicast routing algorithms construct multicast trees. Quality of service (QoS) requirements like end-to-end delay, delay variation, loss, cost, throughput should be met in group applications for effective network functioning. When a multicast tress goes through wired and wireless devices in heterogeneous networks, resources alongside the path could fail to provide required QoS leading to multi cast tree failure. For efficient multicast communication, the tree should meet all resource requirements. The aim of QoS is provision of specific level of predictability and service control. Delay, Jitter, Bandwidth and Reliability are parameters which measure QoS.

It is important to determine a multicast tree of minimal cost [3], [4] to support such applications for every communication session. The source node sends multimedia information to destination nodes through this tree. As multimedia information should not be delayed too much [5], total delay from a source node to a destination node must be lower than a specific requirement. The issue of selecting multicast trees is called multimedia multicast routing and is NP-complete [3]. Hence heuristic algorithms are of great practical interest here.

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Protocol Independent Multicast (PIM) is generally used in multicasting [6] which is a multicast routing architecture to create trees in various sparsely represented groups. PIM's robustness, flexibility, and scaling properties ensure that it is suited to large heterogeneous networks [7]. PIM is a protocol collection optimized for various scenarios. PIM Sparse mode (PIM-SM) and PIM Dense mode (PIM-DM) are common multicast protocols. PIM-SM uses source-based and core-based trees while PIM-DM uses only source-based trees. PIM-SM is mainly used in all networks and PIM-DM is mainly in small domains. In PIM routing protocols, join and prune messages join and leave a multicast distribution tree.

The Protocol Independent Multicast - Sparse Mode (PIM-SM) architecture:

- Maintains conventional IP multicast service model of receiver-generated membership;
- Uses specific joins which propagate hop-by-hop from members' linked directly to routers toward distribution trees.
- Constructs a shared multicast distribution tree in the middle of centered at a Rendezvous Point, building source-specific trees for sources whose data traffic requires it.
- Independent of specific unicast routing protocol; and
- Uses soft-state mechanisms to adapt to network conditions/group dynamics.

Evolutionary algorithms are good to solve optimization and search problems [8, 9]. Two genetic algorithms were suggested for solving multicast routing problem without delay [10]. A step is computing shortest paths between all network node pairs. When algorithm include delay constraints, the resulting algorithms solve delay-constrained shortest path problem (i.e., solve an NP-complete problem). So a genetic algorithm is not required to solve any hard sub-problem should be so designed which can also give nearly optimal solutions for multimedia multicast routing.

This work proposed implementation of Fuzzy Logic in Genetic Optimization techniques to improve QOS for heterogeneous environments including wired/wireless nodes. The rest of the paper is organized as follows: Section 2 reviews related works, Section 3 details the methodology, Section 4 gives the results and Section 5 concludes the paper.

RELATED WORKS

Biswas and Izmailov[11] suggested a PIM-SM based IP-multicast routing framework to deliver heterogeneous QoS. Two tree construction algorithms: TIQM and NUQM were suggested. TIQM depended on total availability of tree-specific information on a multicast group while NUQM did not need tree specific information. Pseudo-optimal QoS-constrained trees are computed using TIQM but face control-scalability problems. NUQM overcomes this issue by restricting information used in tree computation. A QoS-extended intra-domain PIM-SM framework was proposed.

For multimedia multicast routing, Qingfu Zhang et al., [12] proposed an orthogonal genetic algorithm. The incorporation of an experimental design approach known as orthogonal design into the crossover operation is its salient feature. The solution space can be searched in a statistically sound manner and it is the suitable one for parallel implementation and execution. To solve two sets of benchmark test problems, the orthogonal genetic algorithm is implemented. For practical problem sizes, the results reveal that near-optimal solutions within moderate numbers of generations are capably found by the orthogonal genetic algorithm.
Ren-Hung Hwang et al., [13] proposed a novel multicast routing algorithm based on Genetic Algorithms (GA). To evaluate the performance of the proposed algorithm, computer simulations were performed on a random graph. The numerical results that are demonstrated by the proposed algorithm provide a better solution to the Steiner tree problem. As the multiple QOS constraints, like delay, jitter, and loss probability are required by many multimedia applications, the proposal extends to address the application of the proposed algorithm to get multiple constrained multicast trees. Along with the increase in the number of nodes of the network or the number of destinations of a multicast request, the time complexity of the proposed algorithm also increases linearly. Hence the novel multicast routing algorithm proposed emphasis to reduce multicast cost while maintaining a reasonable
path delay and provides an effective solution to the issue of multicast routing.

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Shangchao Pi, et al., [14] proposed a fuzzy controller based multipath routing algorithm in MANET (FMRM). The aim of developing the FMRM algorithm is to construct the fuzzy controllers by assisting to decrease reconstructions in the ad hoc network. The results obtained by simulation of the proposed algorithm shows that it effectively outperforms in applications to the MANETs. For multipath routing decision, the FMRM algorithm is an efficient routing protocol. Sukhvinder singh [18] proposed the genetic algorithm may be employed for heuristically approximating an optimal solution to a problem, in case of quality of service routing finding the optimal route based on QoS constraints.

To find routes which gratify the multiple independent QoS constraints simultaneously are addressed with multi-constrained QoS routing. Santhi et al., [15] proposed a Fuzzy cost based Multi constrained Quality of service Routing (FCMQR) protocol in order to choose an optimal path with regarding to multiple independent QoS metrics like number of intermediate hops, bandwidth and end-to-end delay. This is on the basis of multi criterion objective fuzzy measure. Every available resources of the path are changed into a single metric fuzzy cost in this proposed technique. To find the lifetime of the path, mobility prediction is performed. The optimal one concerned is the path with the maximum lifetime and minimum fuzzy cost which is implemented in transmission. The performance of the proposed FCMQR is obtained by simulation. The results illustrated improved packet delivery ratio, increased path success ratio and incurred less end-to-end delay. Hence an exact and effective technique to evaluate and estimate the QoS routing stability and cost in dynamic mobile networks is provided. And also, the proposed method outperforms than the existing FLWMR and FLWLAMR protocol. Sara Aliabadi et al., [19] proposed the Quality of Service in routing needs to ensure the chosen path has less traffic, less packet loss, optimum length and the most possible bandwidth together.

METHOD

GENETIC ALGORITHM

Gradient search techniques are meant for local search, getting solutions around its starting point [16]. Global search techniques get more optimal solutions, though dependent on ideal setting of starting values. The Genetic Algorithm (GA) is a population-based optimization algorithm, based on biological evolution. Gene sets are replicated, varied and mutated in natural evolution. So, mechanisms like selection, reproduction, mutation are used in GA to get better solutions. Solutions to optimization problem as seen in bit-strings is the population used in GA. Fitness functions evaluate every solution. An initial population is evolved to the next generation on application of operators such as selection, reproduction, crossover and mutation. Better solutions are produced in every generation. The evolution process continues forming new generations until a correct solution is reached or specific number of generations obtained. The pseudo-algorithm of GA is shown in [Figure -1].

For each $n_i \in N_r$ requires a new routing table. Consisting of the R shortest, R cheapest and R least used paths. R is an algorithm parameter. A chromosome is represented by a lengthy string. |Nr| where each element (gene) g_i represents a path between source s and destination n_i . Route selection s dependent on the following parameters.

Discard individuals: Set P might have duplicate chromosomes. Hence, randomly generated individuals replace duplicated chromosomes.

Evaluate individuals: The P individuals are evaluated using objective functions. Then, non-dominated P individuals are compared with individuals in P_{nd} to update the non-dominated set, removing P_{nd} dominated individuals.

Compute fitness: Fitness is computed for every individual, through use of a SPEA procedure.

Selection: A roulette selection operator is applied over the set $P_{nd} \cup P$ to generate a subsequent evolutionary population P.

Crossover and Mutation: This work includes a two-point crossover operator over selected pair of individuals with some genes in each chromosome of the new population being randomly changed (mutated), to get a new solution and this process continues until a stop criterion/ specific maximum number of generations, is satisfied.

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BEGIN
1.        Generation t=0;
2.        Initialize the population
P(t);
3.        While not Termination
criterion do
      A Evaluate the population
P(t);
      b.Next P'(t) (by
Crossover/mutation)
         over P(t);
      c. Evaluate P'(t);
```

Fig: 1. The Genetic Algorithm process

FUZZY LOGIC

Fuzzy Logic (FL) is a multi valued logic which handles imprecision and approximate reasoning with precise logic [17]. FL allows defining of intermediate values between conventional evaluations like true/false, yes/no, etc. Concepts/ideas like very slow or rather fat can be formulated mathematically. FL helps formulating problems in order to apply a more human-like way of thinking in the programming of computers. Fuzzy Logic methodology is a problem-solving control system. It can be implemented into small, simple systems to large networked systems. It can also be incorporated into hardware or software or in both. FL computes definite conclusion when presented with ambiguous, imprecise, noisy input information.
FL forms simple rules based on "IF X AND Y THEN Z" to solve control problem rather than modeling a system mathematically. The FL model is empirically-based, formulated more on operator's experience rather than its technical understanding of the system.
The simplest fuzzy model consists of a set of rules with an "if – then" structure:

$$If < \text{condition } 1 > and \ldots and < \text{condition } n > then < \text{conclusion} >$$

Nodes in an actual dynamic network find it hard to maintain globally accurate network state information. Hence it is unreasonable/inefficient to express QoS constraints with deterministic values. This paper proposes a QoS multicast routing problem through use of generalized fuzzy-constrained fuzzy-optimization model. Network state information imprecision and QoS fuzziness constraints account for the need to invoke fuzzy set theory. A new fuzzy genetic algorithm for QoSmulticast routing is presented and simulation experiments prove its efficiency.

RESULTS

[Figure -2] shows the experimental test bed used for simulation of the proposed system, which is implemented as a layer over PIM-SM. The network is a heterogeneous environment. The throughput for video traffic using the proposed system and compared with PIM-SM is shown in **[Figure -3]**. **Figure 4** and **5** show the end to end delay and the overall data dropped in the network respectively.

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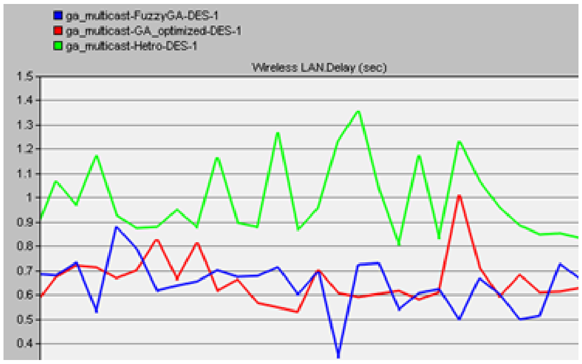

Fig: 2. The experimental test bed used in this work

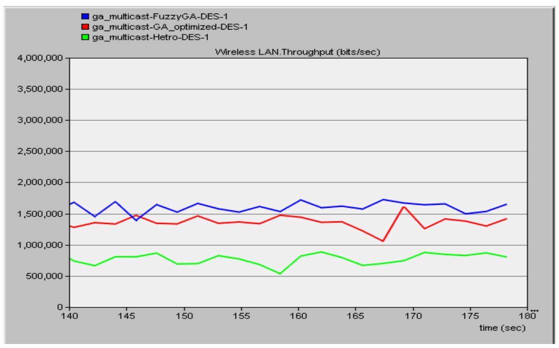

Fig: 3. shows the throughput in WLAN.

Figure- 3.The throughput obtained in bits/sec in the WLAN section. (____the proposed fuzzy based optimization multicast, ____ genetic algorithm optimized multicast and ____PIM-SIM)

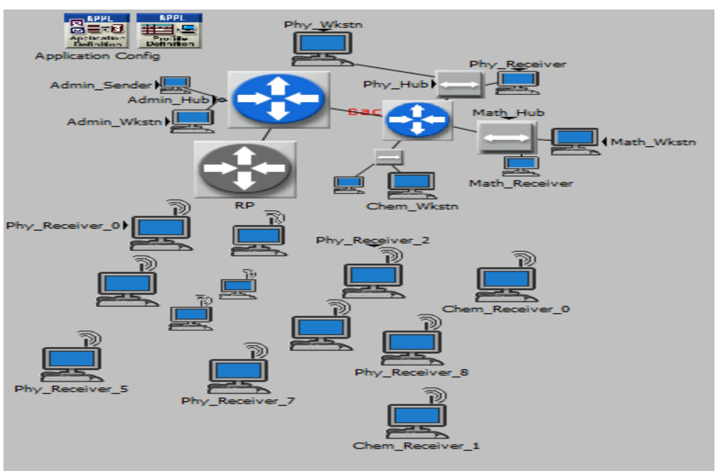

Fig:4. shows the overall end to end delay in the network.

Figure- 4: The overall end to end delay in the heterogeneous network (____the proposed fuzzy based optimization multicast, ____ genetic algorithm optimized multicast and ____PIM-SIM)

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Figure 3 shows the throughput in the wireless section of the proposed optimization technique. It can be seen the proposed fuzzy based optimization technique (blue graph) increases the throughput for video transmission.

It can be seen that the end to end delay for the video conferencing decreases. The packet dropped in the wireless LAN section drops considerably due to the fuzzy based genetic optimization as shown in **Figure-5.**

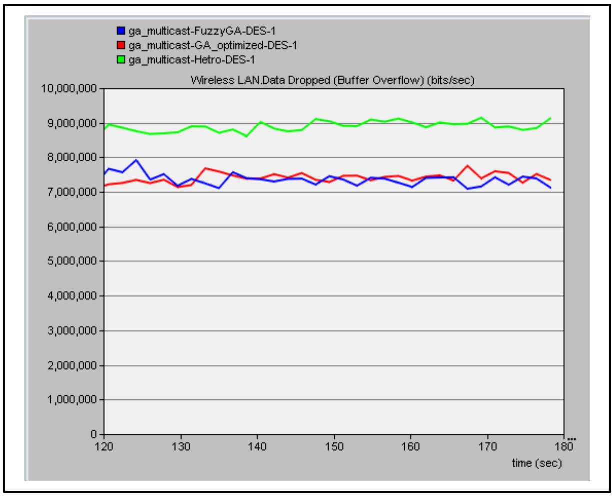

Fig: 5. The data dropped in bits/second

Figure- 5: The data dropped in bits/sec in the heterogeneous network (____the proposed fuzzy based optimization multicast, ____ genetic algorithm optimized multicast and ____PIM-SIM)

DISCUSSION

This paper proposes a QoS multicast routing problem through use of generalized fuzzy-constrained fuzzy-optimization model. Network state information imprecision and QoS fuzziness constraints account for the need to invoke fuzzy set theory. A new fuzzy genetic algorithm for QoS multicast routing is presented and simulation experiments prove its efficiency. In this work, the effectiveness of PIM-SM in heterogeneous environment using a Fuzzy based Genetic optimization is studied. Video conferencing traffic was used in this study. Critical QOS parameters for PIM-SM and the proposed routing is investigated. A novel fuzzy based optimization technique over the PIM-SM stack was proposed using fuzzy logic and genetic optimization. The proposed method reduced the overall end to end delay in the network and increased the throughput of the network.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

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FINANCIAL DISCLOSURE

The authors report no financial interests or potential conflicts of interest.

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