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ACCESSING THE NEIGHBORHOOD DETAILS IN EMERGENCY OF LOCATION DEPENDENT SERVICES BY USING THE GENETIC BAT ALGORITHM

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Abstract

With the escalating accessibility of mobile devices, there is a growing need for location-based applications. As a result, various location based services have been implemented in recent times. The main objective of the present work is to incorporate Location-Based Service (LDS) with Emergency Medical Service for eminence enhancement.

In the present paper, a Genetic Bat Algorithm (GBA) is proposed for the nearest emergency departments in location dependent services (LDSs) by employing LDSs the patients can get the neighborhood hospital locations in medical application. For the purpose of improving the LDSs, a two-stage K Nearest Neighbor (KNN) and GBA algorithm are designed. The two stage KNN algorithm is employed for filtering out the list of all the hospitals built in the located city. Depending on the Euclidean distance, the neighborhood hospitals in the city are found and the time taken for travel to these locations is calculated. GBA algorithm combines the Genetic Algorithm (GA) and BAT algorithm to choose an optimal path. The randomized parameters such as loudness and pulse emission rate are optimized by applying the Genetic algorithm. Thereafter, on the basis of the echolocation behavior of bats, the optimal direction or tracks are deputed with the best QoS constraints. In this paper, QoS limitations like Packet Delivery Ratio (PDR), End to End (E2E) Delay, Jitter, Throughput and Energy are treated as objective functions. The results obtained from experiments indicate that the newly introduced system outperforms the already available system in terms of packet delivery ratio, end to end delay, consumption of power and throughput.

Keywords- *Quality of services, Mobile devices, location. services.*

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1. INTRODUCTION

Through the location dependent service (LDS) models, information delivery to mobile consumers has advanced significantly in this period of the mobile revolution [Bangui *et al.* (2016); Chitrangada et al. (2020)]. The LDSs is a category of information service that can be accessed by portable devices like smart phones and other hand-held gadgets, and it offers location-dependent services for both persons and objects [Ruben *et al.* (2022)]. When approaching, entering, or departing from one site to another, it directs mobile users. There is some propagation delay involved in the information transmission from the service provider to the end user in this case, so it is necessary to periodically determine the locations of mobile users [Anisetti *et al.* (2006)]. When the number of users rises, the server that processes location service requests occasionally becomes overworked [Shivhare *et al.* (2015)]. As a result, it becomes difficult and crucial to accurately locate the object and offer the necessary service without delay or data loss in a timely manner [De and Mondal (2011); De and Mukherjee (2011)]. Corresponding to such requirement, diverse location dependent services materialize in recent times (Smith et al. (2004); Wealands et al. 2007). The proposed algorithm incorporates location-based service (LDS) with crisis medical service for eminence enhancement. In this anticipated study, two-stage K Nearest Neighbor (KNN) method and Genetic bat algorithm (GBA) algorithm is utilized for progress the LDSs [Belay *et al.* (2018); Bok *et al.* (2019)]. By means of two phases KNN algorithms, patients acquire the adjacent hospital data. And then optimal paths are preferred with GBA grounded on the QoS limitations. The investigational outcomes illustrate that the anticipated scheme accomplished high recital contrast to prevailing scheme with respect to packet delivery ratio, end to end delay, power utilization and throughput. Specifically, Section 1describes the genetic algorithm in detail. Section 2 explained the methodology used in the study. Section 3 presents the results, and finally, section 4 ends with conclusions and future research.

1.1 Overview of Genetic algorithm (GA)

Genetic algorithms (GAs) are stochastic, population grounded search and optimization procedures stimulated by the practice of natural selection and genetics. They are grounded on the genetic processes of biological organisms [Zhao *et al.* (2020)]. Over many generations, natural populations proceed according to the basic assumptions of selection and "endurance of the fittest". By mimicking this plan, genetic algorithms are able to "evolve" the outcome of a real-world crisis if done correctly encoded. Genetic algorithm (GA) is an optimization method which follows the process of natural selection [Ilyas *et al.* (2012)]. Natural selection in nature is capable of eradicating weak and unhealthy organisms that are surrounded by their environment. The chances of passing on their genes to subsequent generations are better for those who are physically fit. In the long term, organisms with the right gene combination in their DNA end up dominating their population. At times, during the sluggish progression of evolution, haphazard transformations may takes place in genes. New species can evolve from the old ones if these alterations provide extra compensation in the struggle for survival. Natural selection eliminates useless alterations [Chen *et al.* (2019)].

Chromosome structure

The inherent resolution to a crisis can be modeled in GA expressions as a collection of choice factors to be optimized. These individual actors recognized as genes are connected mutually to outline a string of values entitled as chromosome. Every gene in the string controls one or more characteristics of the chromosome [Katoch *et al.* (2021)].

Selection

Throughout the reproduction stage of the Genetic algorithm, individuals are chosen from the population and recombined to create novel offspring's which will encompass the subsequent generation. The selection process helps to find potential regions of viable solutions in the search space. Tournament selection is efficient due to its efficiency and performance among various selection methods. When choosing participants for a tournament, n people are randomly selected from a bigger population, and the selected ones compete next to one another. The one with the highest fitness is successful and will be included in the subsequent generation of the population[Katoch *et al.* (2021)].

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Crossover

Crossover operator is a significant operator of GA as it amplifies the assortment of the population and progress novel solution which may significantly optimize the crisis. In crossover two chromosomes identified as parents are chosen amongst the population with inclination towards the fitness value and outlines novel chromosomes termed offspring. In the midst of the diverse crossover approaches, Arithmetic crossover is implemented. For the crossover functionality one finest chromosome supported by the fitness value and a haphazard chromosome from the population is chosen as parents and offspring are produced according to:

$child_1 = r*parent_1 + (1-r) * parent_2$ ….(1)

$child_2 = r*parent_2 + (1-r) * parent_1$ …..(2)

Mutation

The result of GA is the operator to check the mutation solution space. By reintroducing genetic variation into the population, the mutation operator initiates arbitrary change into the chromosome's feature. This allows it to overcome local pitfalls by subtly upsetting existing solutions. Among diverse mutational processes, identical mutations are favored.

Algorithm:

Step1: Verify an Initial Population.

a) Random or

b) by certain Heuristic

Step 2: Repeat

a) <u>Determination of the each member's fitness within the population</u>. : =

In this situation, fitness scalability is useful. Fitness Scaling encourages competition in the middle of the strings by regulating the fitness values of the super-performers down and up. The very awful strings will fade out as the population ages. One example is linear scaling.

b) <u>Reproduction (Selection)</u> : =

Check which strings are "copied" or "selected" for the mating pool, and count how many times each string is picked. More often than inferior performers, superior performers will be derivative. As an illustration, the likelihood of selecting a string with a fitness value of f is equal to f/ft, where ft is the total of the population's fitness values.

<u>Crossover</u> : =

(i) Mate every single string haphazardly by means of some crossover method.

(ii) For every mating, haphazardly choose the crossover location(s).

c) <u>Mutation</u>

On a chromosomal gene, mutation

occurs randomly. Despite being rare, mutation has a huge impact. Mutation makes sure to reach Every area of the crisis space. When a gene mutates, it is randomly chosen and roughly restored with another letter of the alphabet, up until the completion of the highest number of generations.

2. PROPOSED METHODOLOGY

The emergency medical services provided by LDS are effective. Patients in need are typically transported to the nearby hospital by ambulance. Emergency medical technicians (EMTs) are in charge of managing situations including medical emergencies, injuries, and accident-related conditions. EMTs may need to determine which hospital is nearby and accessible when performing calculations. For non-emergent patients, a novel method is advised to run LDS in order to:

(a) investigate whether hospitals are nearby based on the provided geographic location; and

(b) circumnavigate to the chosen target hospitals supported by the path selection algorithm.

2.1 Two-Stage K Nearest Neighbor (KNN)

One of the simplest non parametric lazy procedures termed as "Closest Point Search" is a method. In retrospect, the recital of the K-Nearest Neighborhoods (K-NN) classifier is extremely reliant on the distance metric cast-off to recognize the K Nearest Neighbors of the query point [Chen *et al.* (2015); Osborn (2019)]. The nearest neighbor search has been originating numerous applications in searching the adjacent hospitals. The most admired class of such services is KNN queries where users investigate for geographical points of interests (e.g., hospitals) and the subsequent position and travel-times to these locations are calculated [Chen *et al.* (2020); Sun *et al.* (2021)]. Therefore, a two-stage K Nearest Neighbor (KNN) method is advised to improve search efficiency and lessen the transfer of redundant information. Sort the records of all hospitals built in the location city during the initial phase. In the first phase, only information regarding hospitals in Pune, for instance, would be given if the patient was located in Pune City. As a result, the city's location can be identified.

When a mobile user asks a provider of location-based services (LDS) about K-Nearest Points of Interest (POIs) based on his present location, the K Nearest Neighbor (KNN) uncertainty arises.The distance among neighbors is usually calculated by means of Euclidean distance [X *et al. (*2022); Xie *et al.* (2019)]

The distances among the chosen price and the adjacent neighbour are intended by means of the Euclidean distance. The Euclidean distance is designed by:

$$d(x,y) = ||x-y|| = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \quad (3)$$

Where,

n - Number of coordinates of the two points and,

x and y - the coordinates of the two points(users and POIs)

The second stage takes into account the response time of the usual emergency call after calculating the adjacent hospital's distance from the city due to Euclidean geometry. The typical emrgency response time in India is 8 minutes. That is, in the next stage, the map should only show the hospitals that are within an 8-minute drive.

2.2 Objective Function

In this work QoS constraints such as Packet Delivery Ratio (PDR), End to End (E2E) Delay, Jitter, Throughput and Energy are measured as an objective function. The parameters are estimated based on the weight basis and P indicates the path delay, T is the throughput, E_t is the transmission energy, PDR is the packet delivery ratio and J is the jitter [Y *et al.* (2021)].

$F_i = W_1 * P + W_2 * E_t + W_3 * E + W_4 * PDR + W_5 * J$ ……. (4)

Minimize Delay, $De_P = \sum_{(i,j) \in E} de_{ij} x_{ij}$ ……………… (5)

Maximize throughput, $T = \sum_{(i,j) \in E} T_{ij} x_{ij}$ ……………..… (6)

Minimize transmission energy, $E_{tx} = \sum_{(i,j) \in E} E_{txij} x_{ij}$ …. (7)

Maximize packet delivery ratio $PDR = \sum_{(i,j) \in E} PDR_{ij} x_{ij}$ … (8)

Where,

$X_{ij} \in \{0,1\}$, $(i,j) \in E$,

T_{ij} *is throughput between the node (i,j)*

de_{ij} *is delay between node (i,j)*

E_{tx} *is transmission energy between node (i,j)*

PDR_{ij} is packet delivery ratio between node (i,j)

2.3 Genetic Bat Algorithm (GBA)

In Circumnavigate to the chosen target hospitals grounded on the pathway selection modus operandi. In this effort suggest advocating a novel meta-heuristic technique, clearly, the Bat Algorithm (BA) grounded on the echolocation recital of bats, optimal route or tracks are preferred with finest QoS limitations [Nazmiye *et al.* (2022)]. The echolocation abilities of microbats is impressive since these bats can judge their meals and distinguish different types of flies even in absolute darkness. For simplicity make use of the succeeding predictable or idealized rules:

1. Using echolocation, all bats sense distance (hop to hop count distance), and they also ‘know’ the modification in the midst of quarry and indirect obstacles in several methods;

2. Bats fly by chance with velocity vi at path location xi with an immovable frequency fmin, variable wavelength λ and loudness A0 to inspect for prey. They can automatically adjust the wavelength of their discharged pulses and normalize the rate of pulse radiation , conditional on the immediacy of their target.

3. Although there are many ways in which loudness can differ, in this instance let's assume that it varies from a positive A_0 to the lowest degree constant value A_{min}.

In overhead affirmed three romanticized system local optima problematic takes place which is deciphered by disbursing the genetic trials. Then optimal directions are chosen between sources to terminus for LDSs in Mobile Computing.

In the above stated three idealized system local optima crisis occurs which are resolve by means of the genetic operations. Bat fly haphazardly allocate Loudness and pulse emission rate to hunt for prey. The arbitrarily assigned factors are optimized by utilizing genetic algorithm which is portraying in algorithm 2. Then optimal directions are chosen among sources to destination for LDSs in Mobile Computing [NCBI, (2020)].

Every bat will move in the direction of the current best position (or solution) in the GBA, for the i^{th} bats in the swarm having velocity v, position x (solution), and frequency f_i, and its velocity, position, and frequency are updated over the period of iteration as trails:

$$fi = f_{min} + (f_{max} - f_{min}) \beta$$
$$v_i^t = v_i^{t-1} + (x_i^{t-1} - x_g^{t-1}) f_i$$
$$x_i^t = x_i^{t-1} + v_i^t \quad \ldots\ldots\ldots\ldots (9)$$

Where β is random number of a uniform distribution in [0, 1] and symbolizes the present global best solution (position) after contrasting all the solutions (positions) amongst all the bats. These equations can promise the examination capability of BA. For the local search, when a solution is chosen amongst the present best solutions, a novel candidate solution can be produced as :

$$x_{new} = x_{old} + \varepsilon A^t \quad (10)$$

Where the random integer ε is in the range [-1, 1] and the unique answer is either near the current best solution or separate from it. Here is the average volume of all bats. When deciding on target, a bat will gradually turn down the volume and quicken the pace at which it emits pulses in order to follow and capture the target (prey). As the iterations advance, the loudness and pulse emission rate change, as shown in:

$$A_i^t = \alpha A_i^{t-1} \quad \ldots\ldots\ldots \quad (11)$$

$$r_i^t = r_i^0 (1 - exp(\gamma t)) \quad \ldots\ldots\ldots \quad (12)$$

Where γ *and* α are constants. Indeed, the factor gearshifts the convergence of bat algorithm [Xiaofeng and Hongbo (2020)]. The fundamental steps of BA can be abridged as the pseudo code revealed in Algorithm 1.

Algorithm 1:

Target function f(x), x = (x_1……x_d)^T

Step 1: Initialize the bat population x(i = 1, 2, . . . , n) and v_i .

Step 2: Describe pulse frequency f_i, pulse rate r_i , and the loudness A_i .

Step 3: While (t < max iteration)

Step 4: for =1 to n

Step 5: Generate novel solutions by regulating frequency, update velocities and locations [equations (9)]

Step 6: if (rand > r_i)

Step 7: Choose a solution amongst the best solutions randomly

Step 8: produce a local solution around the chosen best solution

Step 9: end if

Step 10: Produce a novel solution by flying haphazardly

Step 11: if (rand < A_i && (x_i) < (x_g))

Step 12: Recognize the novel solutions

Step 13: Amplify r_i and diminish A_i

Step 14: end if

Step 15: end for

Step 16: Rank the bats and locate the present best x_g .

Step 17: end while

step 18: Output consequences and visualization

Design of GA algorithm:

GA is a randomized global search modus operandi that solves troubles by imitating procedures experiential from natural evolution. GA develops a population of candidate solutions. Every solution is typically coded as a binary string described as a chromosome. The fitness of every single chromosome is then assessed by means of a recital function after them chromosome has been decoded. Ahead of achievement of the assessment, a biased roulette wheel is cast off to haphazardly choose pairs of enhanced chromosomes to endure those genetic operations as crossover and mutation that imitate nature. The recently fashioned chromosomes turn out to be stronger than the weaker ones from the preceding generation; they will restore these weaker chromosomes. This progression practice continues in anticipation of the stopping criterion are accomplished.

Algorithm 2:

Step 1: initialize population (nodes in the path)

Step 2: Describe Genetic algorithm parameters pc, pm

Step 3: Calculate the fitness value (pulse emission rate and loudness) of every individual (nodes) in that population (path).

Step 4: While itr <= Maxgen

Step 5: Pertain evolutionary Genetic algorithm operators

Step 6: Selection: Choose the individuals; identify parents that contribute to the population at the subsequent generation. In the anticipated GA tournament selection is utilized.

Step 7: Crossover: Create an offspring population Child,

Step 8: if pc >rand,

Step 9: Select one best solutions x from the population grounded on the light intensity/fitness value and haphazard solution y from the population for crossover operation. By means of a crossover operator, produce offspring and affix them back into the population. Step 10: $Child_1$= r $parent_1$ + (1 − r) $parent_2$;

Step 11: $Child_2$= r $parent_2$ + (1 − r) $parent_1$;

Step 12: end if

Step 13: Mutation: Mutation modifies an individual, Parent, to create a single novel individual, child.

Step 14: if pm >rand,

Step 15: Mutate the chosen solution with a predefined mutation rate.

Step 16: end if

Step 17: end

In this proposed work, the randomly assigned factors such as pulse emission rate and loudness are optimized by using genetic algorithm. The route information, nodes in the path, information about of neighboring nodes are given to genetic algorithm as an input. The pulse emission rate and loudness are increased while the minimum number of nodes in the path. For that purpose these two factors are considered as a fitness function. After the completion of selection, cross over and mutation the randomly assigned factors are optimized. These optimized factors are initialized in the bat algorithm. Based on the QoS metrics the proposed algorithm select an optimal path.

In this work an uncertainty that was propel to server by mobile users is routed by server and then server transmits the services over optimal path which is preferred by means of GBA algorithm grounded on QoS metrics like PDR, E2E Delay, Jitter, Throughput and Energy.

3. RESULTS AND DISCUSSION

The imitation software OMNET++ is used for the experimentations on a Pentium 2.8 GHz and 2 GB RAM with variable K no of nodes. Evaluate to other prevailing techniques, anticipated procedures scheme has exposed higher recital for all K. Anticipated procedures effects are deliberated using QoS metrics as a replacement for calculating query initiator. The anticipated association encompasses of 30 mobile users and 100 number locations at patients. Grounded on End-To-End (E2E) Delay, throughput, Packet Delivery Ratio (PDR) and energy utilization, the recitals of anticipated GBA and obtainable HSLA, GQPSO, and Enhanced LDS Reference replica (ELRM) are evaluated.

1. End to End Delay

The typical amount of time a packet takes to travel through the network from its origin to its destination is known as the end-to-end delay. The end-to-end delay for the number of nodes is shown in Table 1.

Number of nodes	End to End Delay (ms)			
	ELRM	HSLA	GQPSO	GBA
100	24	21	18	15
200	26	24	22	19
300	30	28	24	22
400	33	30	28	25
500	35	32	30	28

Table. 1. End to End Delay vs Number of nodes for existing ELRM with the proposed HSLA, GQPSO and GBA algorithms

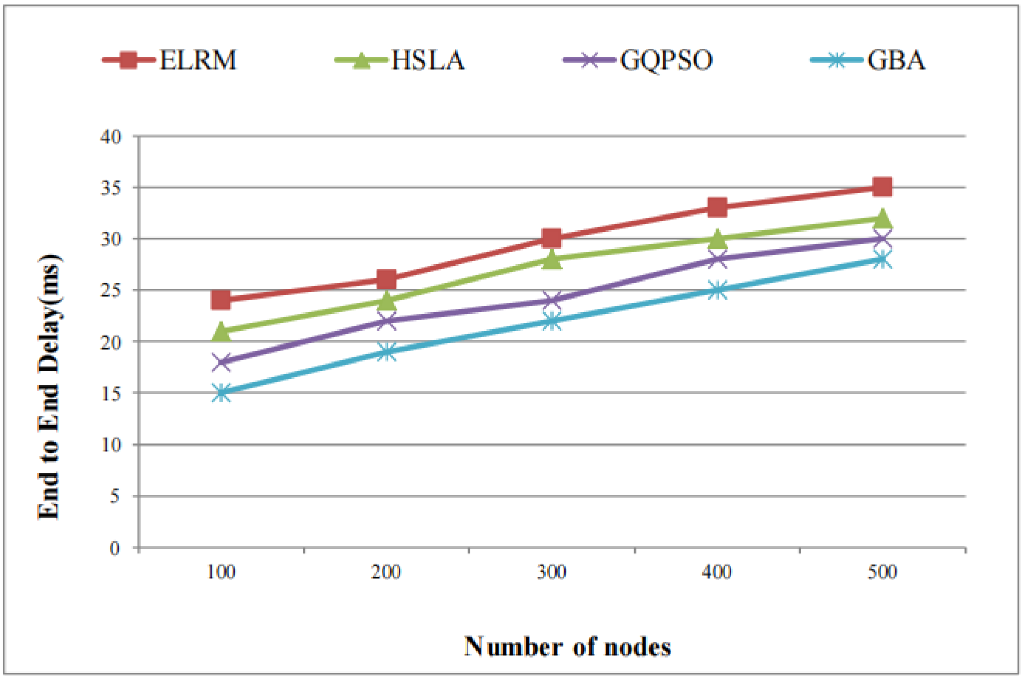

Fig. 1. End to End Delay comparison for existing ELRM with the proposed HSLA, GQPSO and GBA algorithms

By the surveillance, it is observed that the delays among numerous techniques are amplified from sources 100 to 500 nodes (Figure 1). From the outcomes it terminates that the anticipated GBA generates lesser E2E delay of 21.8 ms for 500 numeral of nodes which is 2.6 ms, 5.2 ms and 7.8 ms lesser when contrast to GQPSO, HSLA and ELRM. In view of the fact that the anticipated effort is cast off for corresponding LDS and QoS in the network.

2. **Throughput**

Throughput is a term used to describe the speed at which information packets are effectively broadcast via a system or communication network. It's typically expressed in bits per second (bit/s or bps). Additionally, it is specific to practiced data units during a given period of time. Table 2 represented the Throughput for number of nodes.

$$Throughput = \frac{Number\ of\ delivered\ packet * Packet\ Size}{Total\ duration\ of\ simulation} \quad (13)$$

Number of nodes	Throughput (kbps)			
	ELRM	HSLA	GQPSO	GBA
100	230	250	270	280
200	250	267	290	300
300	270	279	300	310
400	279	290	330	350
500	284	310	350	360

Table 2. Throughput vs Number of nodes for existing ELRM with the proposed HSLA, GQPSO and GBA algorithms

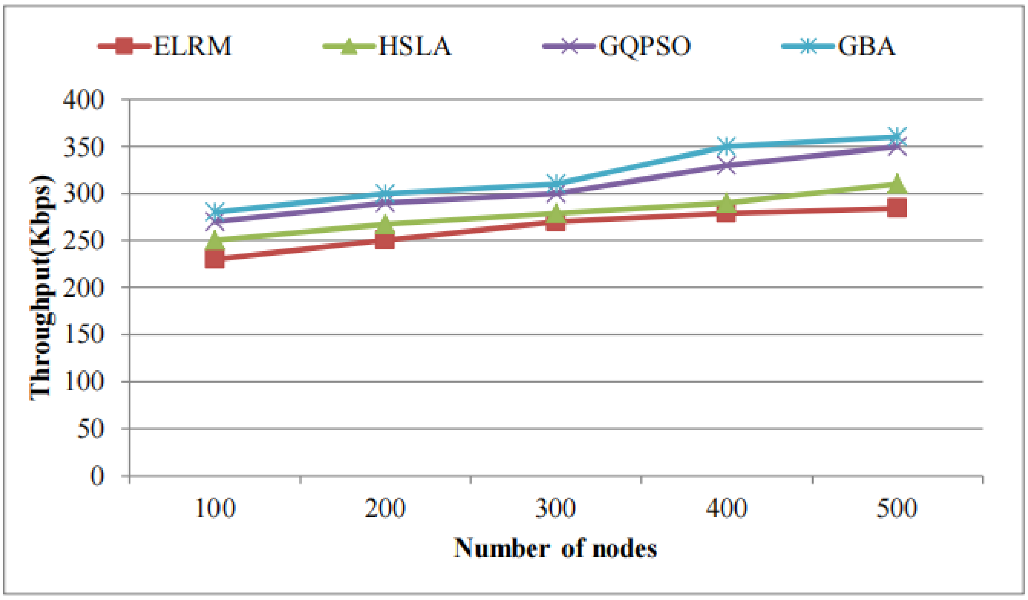

Fig.2. Throughput comparison for existing ELRM with the proposed HSLA, GQPSO and GBA algorithms

Figure 5.2 illustrates the throughput recital comparison outcome of diverse algorithms. By the surveillance, it is observed that the throughputs among numerous techniques are amplified from sources 100 to 500 nodes. As of the outcome it terminates that the anticipated GBA generates superior throughput of 320 Kbps for 500 numbers of nodes which is 12 Kbps, 40.8 Kbps and 57.4 Kbps higher when contrast to GQPSO, HSLA and ELRM.

3. **Packet Delivery Ratio**

This measure represents the ratio of the number of information packets that were successfully disseminated to the total number of packets generated by all sources. The network consistency is amplified by a high packet delivery ratio, which supports the QoS.

Table 3 represented the Packet Delivery Ratio for sum total of nodes.

Number of nodes	Packet Delivery Ratio (%)			
	ELRM	HSLA	GQPSO	GBA
100	77.21	79.36	80.63	82.59
200	78.51	80.51	81.48	83.82
300	79.28	81.41	82.47	84.71
400	80.15	82.49	83.78	85.36
500	81.25	83.56	84.93	86.41

Table 3. Packet Delivery Ratio vs Number of nodes with the proposed HSLA, GQPSO and GBA algorithms

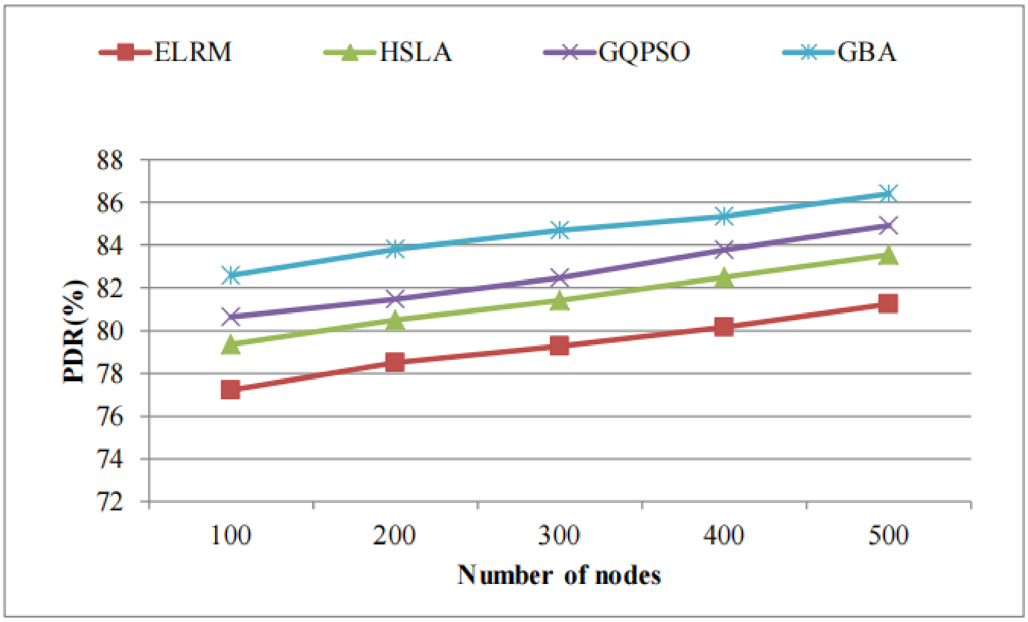

Fig.3. PDR comparison with the proposed HSLA, GQPSO and GBA algorithms

Figure 3 illustrates the size of the Packet Delivery Ratio (PDR) that works with diverse procedures in real time from the starting place to every destination node. From the consequences it terminates that the anticipated GBA generates higher PDR outcomes of 84.57% for 500 numbers of nodes which is 1.92%, 3.112% and 5.29 % higher when evaluated to GQPSO, HSLA and ELRM respectively.

4. Energy consumption

The amount of energy used on average over a given length of time to send, receive, or forward a packet to a node in the network is known as energy consumption. The energy usage for the specified count of nodes is shown in Table 4.

Number of nodes	Energy Consumption (J)			
	ELRM	HSLA	GQPSO	GBA
100	1154	1032	956	836
200	2345	2276	2085	1946
300	3258	3147	2986	2743
400	4056	3879	3718	3549
500	4989	4816	4683	4518

Table 4. Energy consumption vs Number of nodes with the proposed HSLA, GQPSO and GBA algorithms

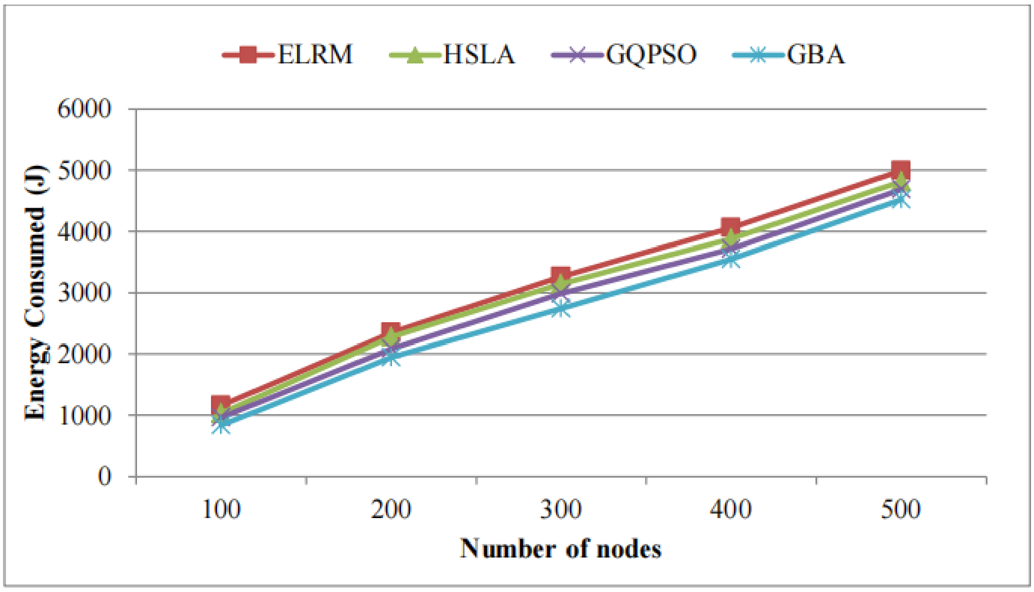

Fig.4. Energy Consumption comparison with the proposed HSLA, GQPSO and GBA algorithms

Figure 4 illustrates the energy devoted that run with diverse algorithms in imitation environment from the source to every target node. From the consequences it finishes that the anticipated GBA creates lesser energy utilization of 4518J for 500 numbers of nodes which is 165J, 298J, 471J and 945 J smaller when contrast to GQPSO, HSLA and ELRM.

5. SUMMARY

In this paper, an advanced algorithm is proposed for yielding the service in time in addition to the user precise quality demands. The user want to access the LDS service, initially decides over the size of the sphere called the Global Spherical Area in terms of its radius. When the Optimal GRA has been calculated, the query maker gets a query requestor from the set of available nodes in random within the GRA. The nodes are referred to with their pseudonyms, which are sent back from nodes, during the process of calculating the Spherical Rotated Area (SRAs) added with the QoS parameters. Then, the query is forwarded to the query requestor, and then it is provided to the LDS server with GRA. As the GRA is an indeterminate area, the challenger might find locating the query maker difficult. The LDS server then returns a list of results suitable for this GRA. Hence the query maker filter out the values, he is concerned about, from the set of results obtained. But it does not take the QoS constraints into consideration for achieving resourceful LDSs. In order to surpass the above challenge, the present work proposed, a GeneticBat Algorithm (GBA) for the nearest emergency departments in Location Dependent Services (LDSs). For the purpose of improving the LDSs, a two-stage K Nearest Neighbor (KNN) and Genetic Bat Algorithm (GBA) algorithm are designed. The two stage KNN algorithm is employed for filtering out the list of all the hospitals built in the located city. Depending on the Euclidean distance, the neighborhood hospitals in the city are found and the time taken for travel to these locations is calculated. GBA algorithm combines the Genetic Algorithm (GA) and BAT algorithm to choose an optimal path. The randomized parameters such as loudness and pulse emission rate are optimized by applying the Genetic algorithm. Thereafter, on the basis of the echolocation behavior of bats, the optimal direction or tracks are deputed with the best QoS constraints. In this technical work, QoS limitations like Packet Delivery Ratio (PDR), End to End (E2E) Delay, Jitter, Throughput and Energy are treated to be objective functions. The results obtained from experiments indicate that the newly introduced system outperforms the already available system in terms of packet delivery ratio, end to end delay, consumption of power and throughput.

LDS are well-suited to the medical service crisis in aggregate. Emergency medical technicians (EMTs) are in charge of handling urgent situations involving medical issues, complaints, and accident-related ailments. It is advised to use a novel algorithm when running LDS for patients in order to determine which health centers are located close together based on current geographic coordinates using the K-Nearest Neighbor (KNN) algorithm, and circle around the selected target hospitals using the Genetic Bat Algorithm (GBA).

Declaration

Author Contribution-

Chitraganda Chaubey - Conception and design, data acquisition, analysis, interpretation, and manuscript writing.

Rupali Khare- Interpretation of data, Drafting and revisiting the article.

All authors read and approved the final manuscript.

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