Elitism based genetic algorithm for cache node placement in wireless sensor network

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Abstract— **The system lifetime can be amplified if the correspondence between sensor hubs in the WSN is diminished. Reserving the information close to the asking for hub will be useful to decrease the information access idleness and correspondence overhead; in this manner system lifetime will be expanded. Store hub is especially difficult when every hub of system has a constrained memory to reserve. Select the hubs that can go about as reserves and settle on solicitation sending choices and afterward we perform ideal arrangement of these store hubs in remote sensor arrange .The current methodology utilization of a multi objective hereditary calculation for reserve hub situation in remote sensor system (WSN). In this methodology GA effectively helps in selecting sensor hubs to actualize reserving and appeal sending choice .Our proposed plan is Elitism based Genetic Algorithm (EBGA), which will be select just best arrangement and dispense with the most exceedingly terrible arrangement. By utilizing EBGA the execution would be enhanced than existing approach and system life time increment. Time utilization in system for the information transforming is likewise lessened. The average latency or end to end delay d by 7.33% and packet delivery ratio in the network by 5.55%.**

IndexTerms— **Elitism; Cache Node Placement; Remote Sensor Network (WSN); Genetic Algorithm, EBGA.**

I. Introduction (Heading 1)

Remote sensor systems are systems of little, lightweight remote hubs, Deployed in substantial numbers, Monitors nature or framework by measuring physical parameters, for example, temperature, weight, stickiness. A remote sensor system (WSN) of spatially disseminated self-governing sensors to screen physical or ecological conditions, for example, temperature, sound, weight, and so on and to helpfully go their information through the system to a fundamental area. The more present day systems are bi-directional. The advancement of remote sensor systems was propelled by military applications, for example, front line reconnaissance; today such systems are utilized as a part of numerous mechanical and purchaser applications, for example, modern procedure checking and control, machine wellbeing observing, etc.

Wireless Sensor Network

Remote sensor system comprises of number of sensor hubs which are conveyed in the district of investment. A sensor system is a gathering of imparting sensing gadgets or hubs. The majority of the hubs is not so much imparting at any specific time, and can just speak with a couple of close-by hubs .The base station is an expert hub. Information sensed by the system is steered back to a base station. The base station is a bigger PC where information from the sensor system will be aggregated and prepared. Sink is utilized to infuse inquiries into the sensor field and sensor hubs are utilization to sense the occasion which is happened in the field and offer react to that question. Sensor hub comprises of sensing unit, preparing unit, trans-collector unit and force administration unit .The system has directing convention to control the steering of information messages between hubs.

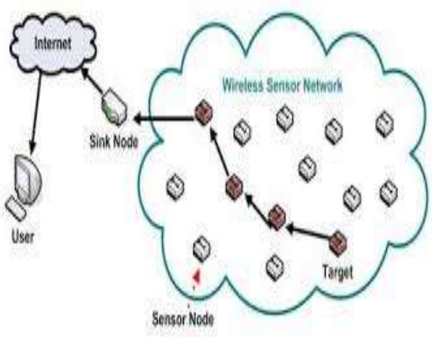

Figure 1: Wireless Sensor Network

Wireless Sensor Networks mainly consists of sensors. Sensors are –

- Low power, limited memory, energy constrained due to their small size.
- Wireless networks can also be deployed in extreme environmental conditions and may be prone to enemy attacks.
- Although deployed in an ad hoc manner they need to be self organized and self healing and can face constant reconfiguration.

Architecture of Sensor Network

It can be categorized in two category layered and clustered –

Layered Architecture

A single powerful base station (BS), Layers of sensor nodes around BS, Layer i: All nodes i-hop away from BS

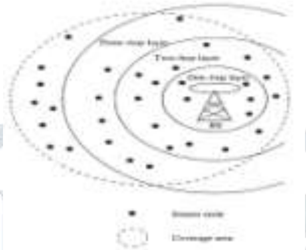

Figure 2: Layered Architecture of WSN

Clustered Architecture

Grouped the sensor nodes into clusters, each cluster is governed by a cluster-head, BS receives the messages only by cluster heads, suitable for data fusion, self-organizing.

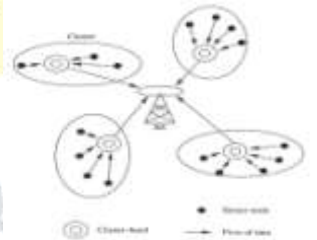

Figure 3: Clustered Architecture of WSN

II. Related Work

Alnuem M. investigates the state-of-the-art node placement schemes and analyzes their performance for LWSN. He proposed non – uniform sensor placement schemes such as LDD and strategic deployment of GW can significantly improve network performance [1].

Bhondekar AP et al. uses multi-objective algorithm to design WSN topologies and optimizes application parameters, connectivity parameters and energy parameters by using a single fitness function. It is preferable to operate a relatively high number of sensors and achieve lower energy consumption for communication purposes [2].

Chauhan N et al. are proposed Global Cooperative Caching Scheme Uses cache discovery algorithm to find the node who has cached the queried data item, employs Cache admission control, Cache consistency, Cache replacement mechanism to improve the performance of the n/w. Achieved significant byte hit ratio & average query latency as compare to other cache strategies[4].

Cheng P et al. formulate a constrained multivariable non linear programming problem to determine the data transmission pattern and location of sensor nodes. Optimal node placement and data transmission pattern in terms of network lifetime and total power consumption and leads to a significant benefit over the uniform placement [5].

Dimokas N & Katsaros D cooperative data caching has been proposed as an effective and efficient technique called new energy efficient

Cooperative caching protocol (EBCCoCa) to achieve to serve data in short latency and with minimal energy consumption concurrently, which proved superior to the state-of-th-art, competes protocol [6].

Dimokas N,et al. suggest mediators are used for communication and protocol include components for locating cached data as well as for implementing data purging out of sensor caches in advanced simulator environment. Proposed protocol is able to reduce the global hits & increase the remote hits at an average percentage of 50% & 40% respectively [7].

Grewal AS, Pandhe MS, Kaur SP Proposed work is based on dynamic clustering using neural network by rebuilding grid algorithm which re clusters the sensors after every round of communication. In this paper to avoid the probability of pits, and increase the packet delivery time and decrease the packet loss rate by rebuilding grid algorithm for wireless sensor networks using NN approach and dynamic clustering [8].

Hussain S et al, Used a genetic algorithm to create energy efficient clusters for data dissemination in wireless sensor networks. Percentage of alive nodes and energy graph indicate that using GA-based hierarchical clusters increase the network lifetime. No of transmission are increased by 20% [10].

Jameii SM, propose a NSGA-II based multi-objective algorithm for optimizing area coverage, number of active sensors and energy consumed by nodes, all of these objectives simultaneously. The proposed algorithm both of the coverage rate and number of working sensor are considered simultaneously as objective and found better solution than SGA algorithm [11].

Jena RK et al. proposed a multi-objective practical swam optimization (PSO) algorithm based framework and this optimizes the operational modes of the sensor nodes along with clustering scheme and transmission signal strengths. It is preferable to operate a relatively high number of sensors and achieve lower energy consumption for communication purposes than having less active sensors with consequently larger energy consumption [12].

Mahmud S et al. work on multiple base stations to the energy consumption of sensor nodes and proposed quadratic-time algorithm for optimally deploying base station. Heuristic performs well and took less time [15].

Jena RK, works on evolutionary algorithm to design parameters such as network density, connectivity and energy consumption have been taken into account for developing framework. NESA algorithm decide which sensors should be active, which one should operate as cluster-in-charge and whether each of remaining active normal nodes should have medium or low transmission range [13].

Luu HV & Tang X work on Distributed method for constructing multipath routing structure and enhanced data collection scheme for WSNs and the Proposed method significantly achieved better trade –offs among the robustness, latency & energy efficiency of data collection [14].

Pant S et al, present a survey paper that proposed various caching techniques that helps to reduce network traffic and improves utilization of bandwidth of wireless sensor network. This survey paper contains various caching scheme to improve the performance of wireless sensor network [16].

Rana M et al. work on Cooperative circular scheme for wireless sensor network are used to improve network battery life and energy consumption. They achieved 10% improvements in network battery lifetime & 60% improvement in energy consumption [17].

Rahman MD A et al. Emulated Caching scheme is used where latest sensed data are always known without requiring the sensors to sense & report continuously Wireless sensor network's life time increases from emulate caching.

Shrivastav JR & Sudarshan TBS, consider grid based static sensor nodes and use genetic algorithm for cache node placement which increases sensors per cache in charge & field coverage. Average latency and total no of message in network was improved 6.99% and 4.55% respectively by genetic algorithm. Greater no of active sensors make WSN less energy consumer for communication as compare to a dense n/w [19]

Thakkar A & Kotecha K, Routing algorithm is proposed by introducing Energy Delay Index for Trade-off (EDIT) is used to select cluster heads and optimize both energy and delay. By using EDIT protocol successfully demonstrated the effect of two types of distances to be used to elect the cluster heads and analyses energy delay trade-off [20].

III. Problem Statement

Today the broad advancement made in the two divergent ranges of exploration that are low power installed frameworks and conveyed apply autonomy because of which portable sensor systems came into creation . The free versatility of hubs has presented to its own particular difficulties as well as the issues which are connected with static sensor systems are assuaged. The arrangement of expansive scale systems of both static and portable hubs for diverse uses of observing of wellbeing, environment to military are normal in not so distant future. The issue of observing of basic conditions more than a substantial territory with the assistance of wireless sensor systems.

Due to the limitations in Wireless sensor systems, for example, data transmission, lifetime of battery, rate of processor (CPU) and measure of memory there is a vital requirement for successful correspondence methods for development of nature of gathered information.

In existing approach we major the following problems-

IV. Discrete genetic algorithm was used which consider discrete values in search space for the solution.

V. Accuracy is most important factor in cache node placement. Existing approach contains less accuracy.

VI. It required more computational time.

VII. Consider best solution as well as worst solution.

VIII. Only one factor i.e. energy efficiency was considered. I want to be including other factor like network performance, traffic control.

IV. METHODOLOGY

Network Model

Our plan expect Sensor field includes extensive number of sensor hubs equipped for imparting one another through remote medium.Each sensor nodes is responsive of their geographical coordinates (x, y), which are also the node identities. We are accepting sensor field to be a two dimensional plane. As we have expected that SNs are static, appointing directions to them .Entire sensor field is built into a framework of square-sized cells as shown in figure 4. A typical cluster consists of number of sensor nodes and a sensor only belongs to one cluster. The location information is represented by a coordinate (x,y) and assign one of the node as cache node from each cluster .

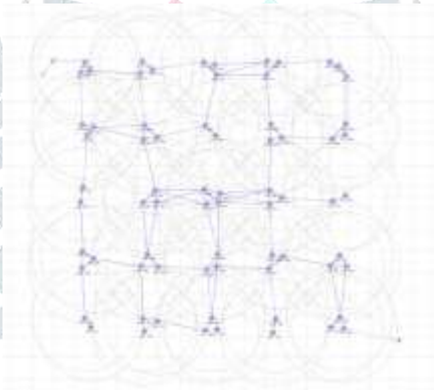

Figure 4: Setup of Wireless Sensor Network

Let S be the network size (in terms of hops). Assume nodes n1, n2, ……..nn be the number of nodes between source and sink.

Cache node placement

Hereditary calculation takes a shot at the standard of survival of the fittest to create off springs that prompt wanted arrangements. The era and inquiry methodology utilized as a part of hereditary calculation lead to plan arrangements that are custom-made to their particular outline goals inside the characterized requirements. Therefore, more than various era or emphases, alluring configuration qualities get advanced. GA is connected to tackle complex outline issue including both discrete and ceaseless variables.

EBGA Algorithm

1. **[Start]** Generate random population of *n* chromosomes (suitable solutions for the problem)
2. **[Fitness]** Evaluate the fitness *f(x)* of each chromosome *x* in the population
3. **[New population]** Create a new population by repeating following steps until the new population is complete
    1. **[Selection]** Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to be selected)
    2. **[Crossover]** With a crossover probability cross over the parents to form a new offspring (children). If no crossover was performed, offspring is an exact copy of parents.
    3. **[Mutation]** With a mutation probability mutate new offspring at each locus (position in chromosome).
    4. **[Accepting]** Place new offspring in a new population

5. **[Selection]** Select the best Solution and drop the worst solution
4. **[Replace]** Use new generated population for a further run of algorithm
5. **[Test]** If the end condition is satisfied, stop, and return the best solution in current population
6. **[Loop]** Go to step 2

Design of Algorithm

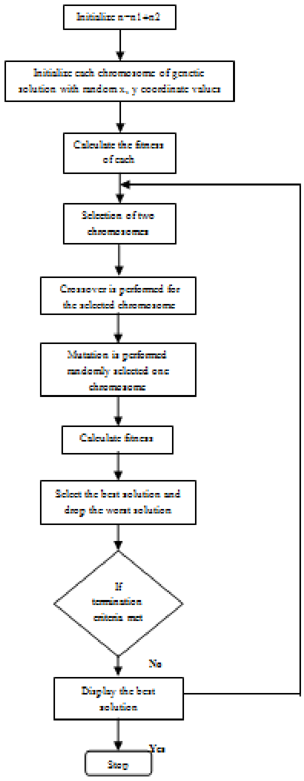

Figure 5: Flow of EBGA

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V. Results

The optimized GA position shows tha the position where placement of cache node gives better performance than the randomly placed position. The figure 6 shows packet delivery ratio vs nodes

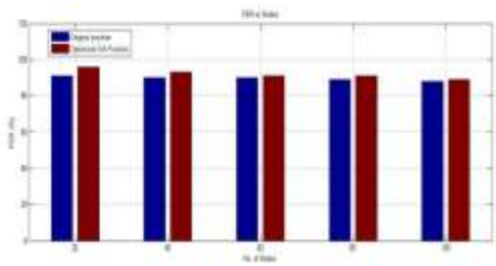

Figure 6: PDR vs nodes

The average latency increased because the better placement of cache node.
The figure 7 shows End to End Delay vs nodes

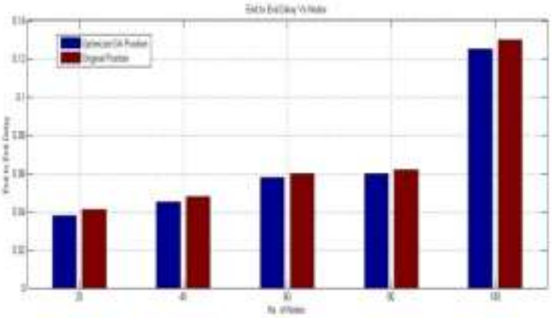

Figure 7: End to End Delay vs nodes

VI. CONCLUSION

I conclude that the genetic algorithm improved the network performance than the other optimization technique like MA, PSO and ACO. Wireless sensor network with a greater number of active sensors consumes less energy communication instead of dense network with a smaller number of active sensors. The average latency and number of packet transmission reduced via genetic algorithm. The network performance increased by EBGA (Elitism Based Genetic Algorithm) because of only best solution would be considered and drop the worst cases. The average latency or end to end delay improves by 7.33% and packet delivery ratio in the network by 5.55%.

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