

# Successive Convex Approximation with Adaptive Beam Scanning Antenna to Fore Fend Data Collision in WSN

P. Bagyalakshmi, and A. Muruganandam

**Abstract**—Recent development in low powered and less sized sensor devices make implementation of wireless sensor network in health care a reality. Moreover, Routing protocols in network determine network lifetime and efficiency of a network. Conventional AODV routing protocol consumes more energy and increased end-to-end delay. In this paper, we propose a successive convex approximation routing scheme (SCAR). The routing scheme increases network lifetime and end-to-end delay compared to AODV scheme. In successive convex approximation, routing (SCAR) nodes elect a convex head. The convex approximation approach minimizes data collision and prolongs network lifetime. The routing scheme simulate in network platform and the same implement in hardware to validate proposed scheme effectualness.

**Index Terms**—successive convex approximation, network lifetime, end to end delay

## I. INTRODUCTION

The number of standalone wireless devices expected to increase five times in the next decade. Wireless sensor network comprises of numerous nodes depending on the application. The number of nodes ranges from few hundreds to thousands. Furthermore, data reliability and network lifetime are metrics that define effectuality of Wireless Sensor Network (WSN). The effectuality of a wireless sensor network improves with routing schemes. Conventional routing algorithms at times do not utilise the energy in the network entirely. Moreover, depending on the routing scheme data collision occur in network. Hence, there is a need of a routing scheme to utilize energy in the network uniformly and minimize data collision.

In directed diffusion routing the data in network, name with attribute value pairs. The attribute pair help combine data from different sensor nodes. The data accumulation reduces number of transmission and minimizes redundancy in base station. The base station sends a request signal for particular data from sensor nodes. The request signal typically consists of data frame. The network executes the task described in the data frame. The data frame broadcast by base station to all nodes. The broadcast scheme causes data collision with other nodes in the network. The directed diffusion routing broadcast scheme implement in localised area and not in geographical area [1]. Moreover, the request signal for data should reach only to nodes of interest. Rumor

routing employs agent to acquire data only from specific nodes. In rumor routing the sensor nodes updates change in data on a local look up table and generates a agent packet. When a node requests for data the nodes that posse's knowledge of route information provides route information from the event table. Furthermore, the agent packet transmits data to distant nodes in the network. The approach minimizes data collision in network [2]. The Route Information Table (RIT) approach increases processing time and energy in network. A minimum cost forwarding algorithm adopts route of nodes for data transmission, which consume minimum energy and time. Every node in network has knowledge of least cost for data transmission to destination. Upon reception of data from other nodes, the receiver node calculates least cost route and transfers the data to its neighbouring node [3]. Gradient based routing minimizes least cost calculation by saving the number of hops count for data to reach base station. The routing schemes lowers data traffic in the network by uniformly spreading the traffic over network with data aggregation. The uniform data distribution in the network consumes energy of all nodes uniformly and prolongs network lifetime [4]. Furthermore, sufficient knowledge of network about nodes and route data minimises energy and end-to-end delay. Constrained Anisotropic Diffusion Routing (CADR) protocol queries nodes in the network to gain knowledge. The nodes in the network evaluate with CADR protocol and determine the sensor nodes capable of receiving the data. The sensor nodes determine by routing data only to nodes surrounding a particular event. In addition, Information Driven Sensor Querying (IDSQ) protocol determines the nodes with most knowledge of network. However, the IDSQ fails to provide information about how the information and query done between nodes and base station [5]. Cougar scheme gains knowledge of data flow in the network by adding a query layer in between application and network layer. The WSN network resembles a distributed database system in which the cougar use data aggression to save energy, however, the use of query layer increases overhead and memory of nodes [6]. ACQUIRE routing protocol splits query into many sub queries. The sub queries flow from base station to other nodes in the network. The query flows form one node to the other nodes in the network. The nodes reply partially to query and the query forward to the next node gathering information [7].

## II. RELATED WORKS

The Energy Aware Routing Protocol (EARP) improves network lifetime. The protocol determines energy consumption of each path in the network. Instead of relying on one single path the protocol, have multiple paths for data transmission. The use of multiple paths at varying time

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intervals prolongs network lifetime. The protocol eliminates path with more energy consumption and a look up table form with routes and their corresponding energy consumption. The EARP protocol improves network lifetime for stationary nodes [8]. However, for network with mobile nodes the routing protocol and route information determine by random walks and Bellman-Ford algorithm. The algorithm further determines distance between nodes and location of nodes in network. The inaccuracy in node location determination makes it impractical to apply the scheme in real time [9]. For practical applications geographic adaptive fidelity routing algorithm implement which increase network lifetime. The algorithm splits entire network into zones. Each zone comprises of nodes, which communicate with other nodes to perform roles. In each zone, one node stays active while the rest goes to sleep mode. The active node gathers data for other nodes and transfers data to base station. The nodes in zones switch modes after specific time interval. The approach increases overall network lifetime [10]. Moreover, the lifetime further increase by Geographic and energy aware routing approach (GEAR). Instead of relaying data from sensor packets at time intervals, In GEAR the data transmit from sensor node upon reception of a query. The query routes only to destination region instead of sending the query to entire network [11]. Furthermore, a localized routing approach minimizes network traffic in the network. The Greedy other adaptive face routing protocol always forwards data to immediate neighbour node. The approach increases risk of data reaching a node whose neighbour can only be a transmitter node [12]. The Face Routing algorithm (FRA) approach transfers data to best nodes that falls in its boundary area. However, the routing scheme exploits energy of nodes to transfer data [13]. QOS based routing such as Sequential Assignment Routing analyzes energy constraints and balances data quality. The routing protocol transfer data based on constraints such as packet priority, energy and Qos of path. The routing scheme increases overhead since the sensor nodes keep track of constraints on a table [14]. Furthermore, to improve end-to-end delay performance a SPEED protocol assigns speed values for each packet in the network. The delay estimation help avoid accumulation of data in a network when dealing with data packets of more size. Therefore, the proposed work aims to improve network lifetime and packet delivery ratio with minimal tradeoffs.

### III. METHODOLOGIES

Routing algorithm decides efficiency and network lifetime of wireless sensor network. Conventional AODV routing algorithm transfers data as a whole from one node to other until the data reaches destination node. Moreover, data collision in a network further affects throughput of the network. In wireless sensor network, nodes experience incommodiousness, which affects successful data transfer to destination. In time critical applications the AODV, routing scheme offers major drawbacks. A successive convex approximation approach accomplishes successful data transfer in time critical applications.

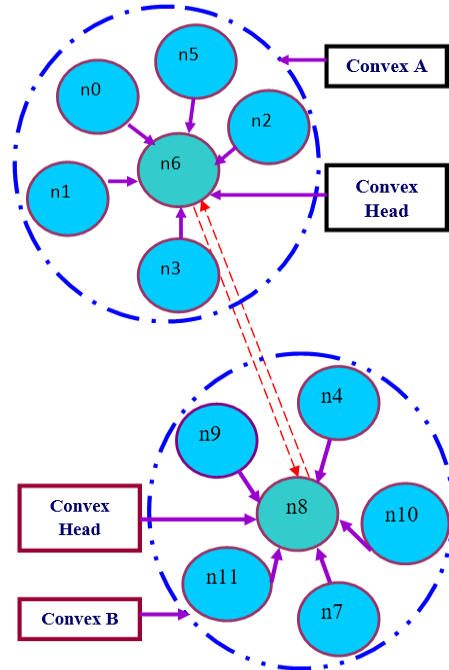


Fig. 1. Convex head and associated nodes

The nodes in the network form a convex as shown in Fig. 1. Each convex has a convex head (node n6 for convex A, n8 for convex B) elected by the nodes in the convex. Unlike conventional routing algorithm all nodes in a convex transfers data to the convex head. In addition, to avoid data collision the nodes in the convex equip with directional antenna. During initial communication, the convex head sends a beacon signal to one of the nodes in the convex. The node replies to the convex head with the sensed data. The on demand data retrieval from nodes provides advantages in time critical applications. The energy source utilisation minimize with on demand access policy. In addition, the process repeats itself for all nodes in the convex. The convex head comprises of data from all nodes. The convex head now transfers the data to destination node via other convex heads if necessary. Furthermore, simulation and hardware implementation validate routing scheme effectiveness. The successive convex approximation (SCA) simulate in Ns2 environment. The SCA routing scheme evaluate in terms of network lifetime, throughput, packet delivery ratio, packet loss ratio and end to end delay.

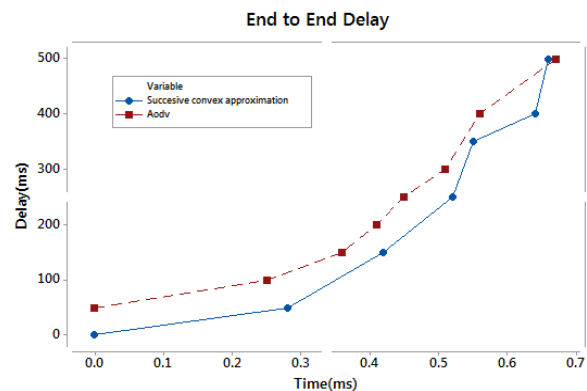


Fig. 2. End – to – End delay

The above Fig. 2 shows end-to-end delay between nodes for AODV and SCA algorithm. Compared to AODV the delay is less for SCA algorithm. The delay varies at the end

since the data from nodes report to the convex head. The convex head scans for other convex heads status and then transfers the data.

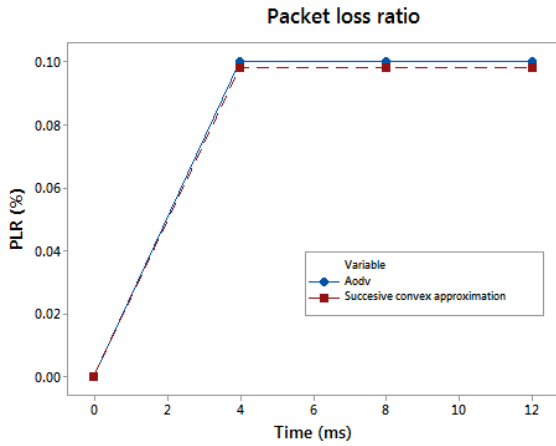


Fig. 3. Packet loss ratio

The packet loss of both AODV and SCA algorithm show minimal losses. The packet loss ratio of network graphically plot with simulation time and data packets as shown in Fig. 3.

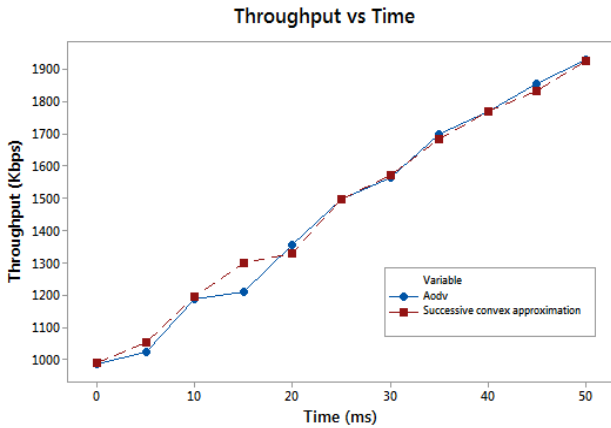


Fig. 4. Throughput

The throughput of network depends on successful packet delivery.

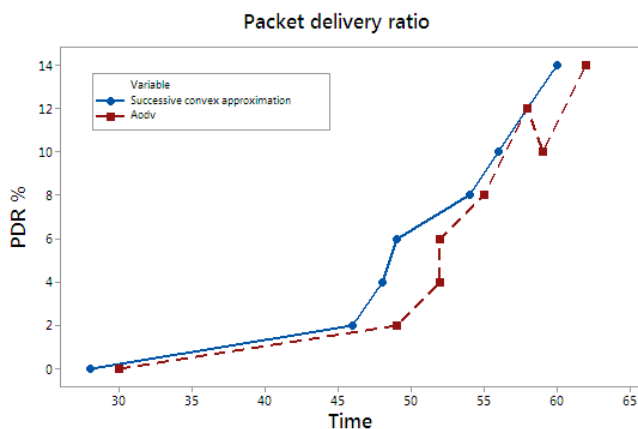


Fig. 5. Packet delivery ratio

Comparing Fig. 4 and Fig. 5 projections the throughput of SCA routing algorithm performs better compared to AODV routing scheme. The delivery ratio dips and increases at the end due to delay in data transfer by the convex head.

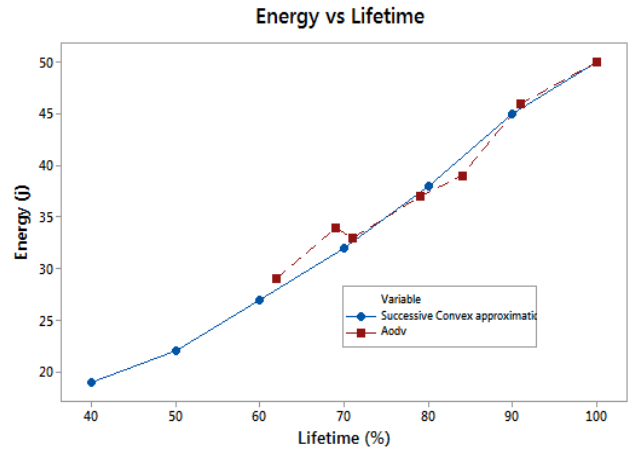


Fig. 6. Lifetime of network

All the nodes in the network power with limited battery source. The lifetime of AODV network, reduce quickly due to bulk data transfer of data between nodes as shown in Fig. 6. However, the data transfer only occurs at limited time intervals from nodes in SCA nodes. The scheduled data transfer increases lifetime. The energy source of all nodes utilise uniformly in SCA network.

#### A. Hardware Implementation

The successive convex approximation implement in hardware to analyse the routing scheme. The nodes in the network form with a PIC microcontroller and a transceiver.

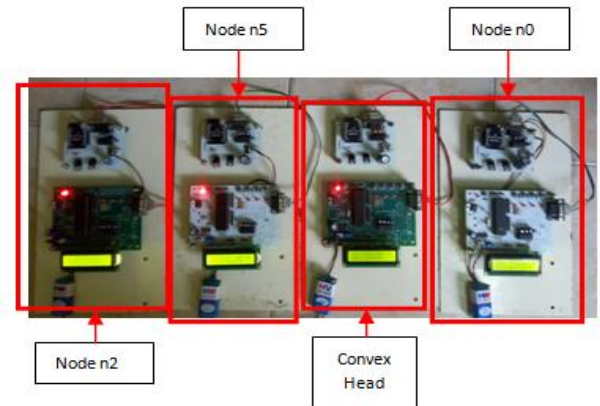


Fig. 7 Hardware description of Convex in network.

Fig. 7 shows the successive convex approximation scheme. The convex comprises of sensor nodes and a convex head. Each node in the convex incorporates a microcontroller and a wireless transceiver. The nodes powered by a 9v battery source. The sensor data from controller sent to transceiver through serial communication protocol. All the nodes transfer the data to convex head. Moreover, the on-demand data access policy improves network lifetime of nodes in the convex. The network life of nodes in convex given by

$$E = \sum_{i=1}^T |E_i| \quad (1)$$

The number of nodes in a convex express as

$$N_i = ((2i - 1)N) / T^2 \quad (2)$$

The total data transfer in the convex, the data from sensor nodes to the convex head and on to other convex head expressed as

$$F_i = N - \sum_{j=1}^i N_j = (N(T^2 - i^2)) / T^2 \quad (3)$$

The nodes in a convex transfer data to Convex head in that particular convex. The data transfer in the convex and the energy consumption express as

$$E_i = E_{\text{relay}} + E_{\text{gen}} \quad (4)$$

$$E_{\text{relay}} = (t / p) F_i b_s e_b$$

$$E_{\text{gen}} = (t / p) N_i b_s (e_s + e_{\text{tx}})$$

Thus,

$$E_t = \frac{t N b_s (e_b (T^2 - i^2) + (e_s + e_{\text{tx}}) (2i - 1))}{T^2 p} \quad (5)$$

The node lifetime of each node in the convex is given by,

$$L_i = \frac{E_i p T^2}{N b_s (e_b (T^2 - i^2) e_b + (2i - 1) (e_s + e_{\text{tx}}))} \quad (6)$$

With the above considerations the minimum lifetime of nodes in convex express as

$$L = \min_{i=1 \dots T} L_i \quad (7)$$

With the assumption as all nodes in a convex have equal energy level the energy in each convex is given by,

$$E_i = \frac{N_i E}{N} = \frac{(2i - 1) E}{T^2} \quad (8)$$

So, the energy level of nodes in a convex express as,

$$L_i = \frac{EP}{N \frac{T^2 - i^2}{2i - 1} b_s e_b + N b_s (e_s + e_{\text{tx}})} \quad (9)$$

Moreover the residual energy of nodes in other convex obtain by,

$$E_{\text{resi}} = \frac{E}{T^2} \left[ (2i - 1) - \frac{(T^2 - i^2) e_b + (2i - 1) (e_s + e_{\text{tx}})}{(T^2 - 1) e_b + e_s + e_{\text{tx}}} \right] \quad (10)$$

The life time of the network increase with 1 and 6

$$E_t = E_1 \frac{(T^2 - i^2) e_b + (2i - 1) (e_s + e_{\text{tx}})}{(T^2 - 1) e_b + e_s + e_{\text{tx}}} \quad (11)$$

## B. Hardware Results

The Successive convex approximation routing scheme implement in hardware and the routing scheme

effectiveness assess in terms of throughput, end-to-end delay, packet delivery ratio and network lifetime.

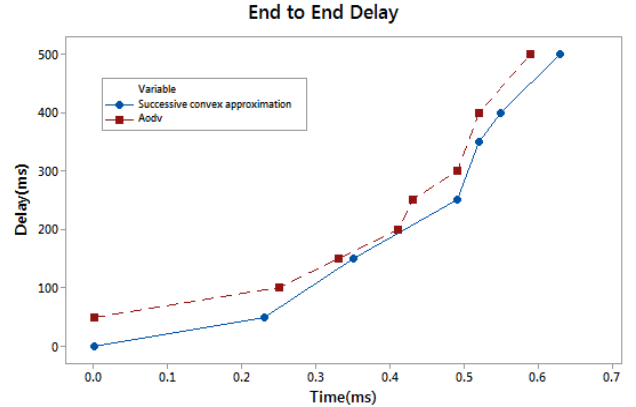


Fig. 8. End to end delay

The end-to-end delay for SCA routing scheme is less compared to AODV scheme and more than simulation results as shown in Fig. 8. The delay increases due to longer processing time of data by controllers in nodes. The results are tangible and observable when the transmission packets are more.

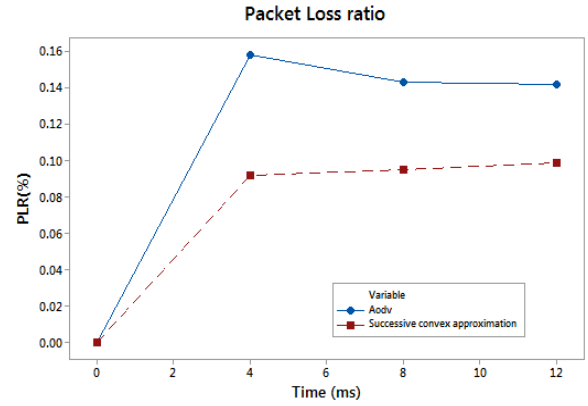


Fig. 9. Packet loss ratio

The Fig. 9 shows Packet loss ratio of AODV and SCA routing scheme. The packet loss occur more in AODV since the nodes burden with entire data. However, SCA algorithm handles only changes in values from sensor nodes. The minimal data handling results in reduced data losses in network.

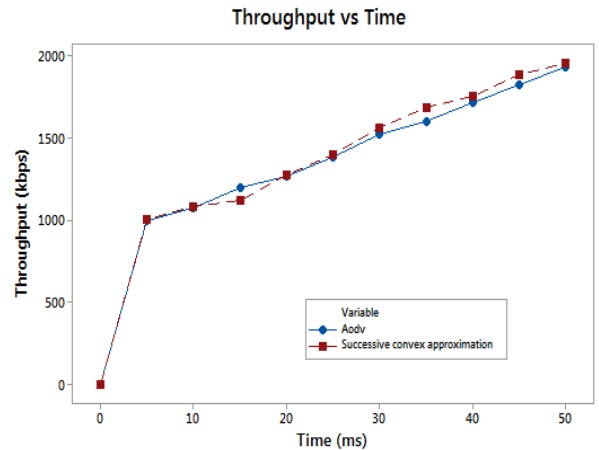


Fig. 10. Throughput

The results in Fig. 10 show throughput analysis of SCA routing scheme. The SCA routing scheme has better

throughput delivery compared to AODV routing scheme.

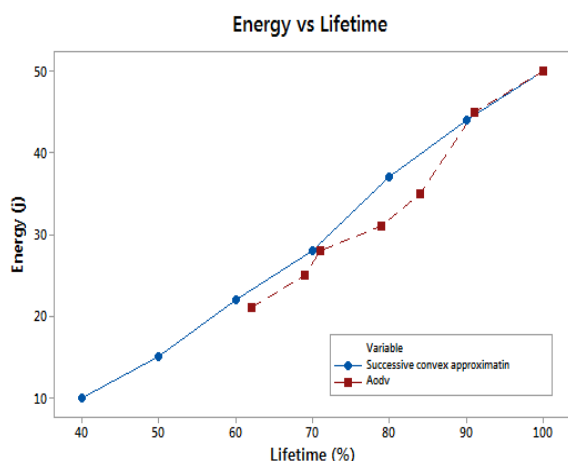


Fig. 11 Network lifetime

The Fig. 11 shows network lifetime analysis of AODV and SCA routing scheme. The SCA routing scheme has more standby time. For network lifetime analysis the earliest dead node taken to estimate network lifetime.

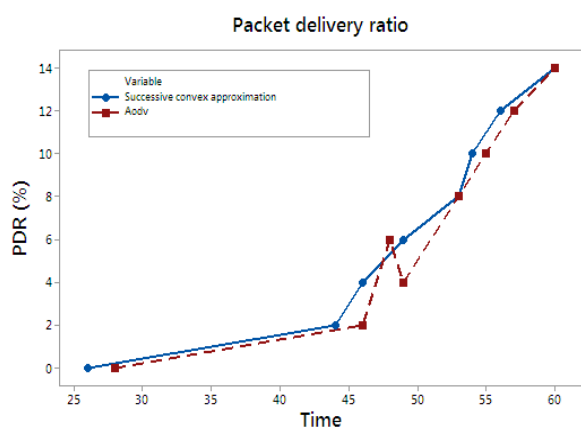


Fig. 12 Packet delivery ratio

The Packet Delivery Ratio (PDR) analysis of SCA routing scheme and Aodv routing scheme is shown in Fig. 12. The delivery ratio increase linearly with respect to data packets in the network. However, the delivery ratio dips at an instant due to more data transfer and holdup due to data processing by the nodes.

#### IV. CONCLUSION

The work describes about the routing scheme to improve network life time. The proposed successive convex approximation routing scheme simulate in NS2 environment to check routing scheme feasibility and the same implement in hardware to validate the proposed routing scheme effectiveness. Moreover, the routing scheme utilizes energy resource of all nodes in the network uniformly. The routing scheme simulate in software and the same implement in hardware to validate the proposed routing scheme effectiveness and feasibility. The simulation and hardware results show improved network lifetime and minimal packet loss ratio.

#### CONFLICT OF INTEREST

We declared that there is no such issue. We have no problem to publish our journal in your esteemed

publications. You proceed your process for publication of journal. We are grateful to thank your publications. You gave an excellent opportunity for us. There is no conflict of interest in this journal. The above information is true to the best of our knowledge.

#### AUTHORS CONTRIBUTION

In this research contribution, all the authors were discussed, performed the analysis, study conception and design, collected the data, analysis tools, performed the analysis, performed the computer simulations result and interpretation or results, and have full focus on this journal with strong concentration, handle with proper grammatical corrections, wrote the paper and approved the final version of writing the manuscript preparation. We have no other issues in this journal.

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