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Mobility Control Based Dual Data Transmission for Load Balancing in WSN

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Abstract: The three-layer model is suggested for collecting mobile data in WSNs, which include sensor, cluster head as well as mobile collector (known as SenCar) layers. The frameworks employ distributed load balanced cluster as well as dual data uploading that is known as LBC-DDU. The aim is the achievement of excellent scalability, longer network lifetime as well as low data collection latency. At the sensor layer, a LBC protocol is suggested for sensors to organize themselves as clusters. As opposed to current clustering techniques, our strategy creates several cluster heads in every cluster to sense of balance the work load and help dual data uploading. At the cluster head layer, the inter-cluster transmission range is carefully chosen to security the connectivity among clusters. Several cluster heads in a cluster cooperate with one another to achieve energy-saving inter-cluster communications. Through inter-cluster transmissions, cluster head information is forwarded to SenCar for its moving path planning. At the senCar layer, SenCar is set with two antennae that enable two cluster heads to concurrently upload data to SenCars in every time by using multi-user multiple-input/multiple-output (MU-MIMO) method. The path planning for SenCar has been optimized for fully utilizing dual data uploading capacity through proper selection of polling points in all clusters. Through visiting of all chosen polling points, SenCars may effectively father information from cluster heads and forward the information to static data sinks. In existing system sencard layer poling point selection is manual in this paper I proposed systematic sencard poling point selection algorithm for artificially select the polling point by random, extract the cluster area of network and collusion less poling path finding. Poling point selection algorithm is used to find the polling point which directly collects the data from its neighbors.

Key words: Wireless sensor networks (WSNs) · Data collection · Load balanced clustering · Dual data uploading · Multi-user multiple-input and multiple-output (MU-MIMO) · Mobility control · Polling point

INTRODUCTION

The production of the implementation for low-cost, low-power, multifunctional sensors have made wireless sensor networks (WSNs) a prominent data collection model for extracting local measures of interests. In such applications, sensors [1] are generally densely deployed and randomly spread over a sensing field and left unattended after being deploy, which make it difficult to recharge or replace their batteries. After sensors form into independent organizations, those sensors near the data sink typically reduce their batteries faster than others because of more relaying traffic. When sensors near the data sink exhaust their energy, network connections and exposure may not be assured. Due to these constraints, it is fundamental to formulate an energy-effective data collection strategy which utilizes energy in an uniform manner across the sensing field for achieving longer network lifetimes. Moreover, because sensing data in certain application are sensitive to time, data collection might be needed to be performed in a single timeframe. Hence, effective large-scale data collection strategy ought to focus on excellent scalability, longer network lifetime as well as lower data latency. On the basis of the focus of these works, they can be roughly divided into three category [2].

The first category is the improved relay routing in which data are relayed among sensors. Further relaying, some other factor, such as load balance, schedule patterns as well as data redundancy, are considered.

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The second organizes sensors as clusters and permits cluster heads to take accountability for transmitting data to data sinks. Clustering is certainly helpful for applications with definitive need of scalability and is very efficient in local data accumulation because it can decrease the collisions and balance load amongst sensors. The third is to exploit mobile collectors for taking the trouble of data routing from sensors. Though these works offer effective solutions to data collection in WSNs, their inefficiencies have been noticed. Specifically, in relay routing schemes, minimizing energy expenditure on the forwarding path does not essentially extend network lifetime, because some crucial sensors on the route might run out of power faster than some others. In cluster-based models, cluster heads will certainly utilize more power than other sensors because of handling intra-cluster aggregations as well as inter-cluster data forwarding. Although utilizing mobile collectors might reduce non-uniform power utilization, it might result in inadequate data collection latency. On the basis of the observations, in the current paper, three-layer mobile data collection model is suggested which is Load Balanced Clustering as well as Dual Data Uploading (LBC-DDU).

The primary motivation is the utilization of distributed clustering for scalability, for employing mobility for conserving energy as well as uniform power utilization as well as for exploiting Multi-User Multiple-Input and Multiple-Output (MU-MIMO) [3] method for simultaneous data uploading for shortening latency. As opposed to clustering methods suggested in earlier works, the current protocol balances load of intra-cluster aggregation as well as allows dual data uploading between several cluster heads as well as mobile collectors. Secondly, several cluster heads in a cluster may collaborate with one another for performing energy efficient [4] inter-cluster transmission. As opposed to other hierarchical strategies, cluster heads here do not transmit packets from other cluster, which efficiently reduces burden of all cluster heads. Rather, forwarding routes amongst clusters are utilized solely for routing small-sized ID data of cluster heads to mobile collectors to optimize data collection tours [5]. Thirdly, mobile collectors with two antennae (SenCar) are deployed for allowing simultaneous uploading from two cluster heads through usage of MU-MIMO communication.

SenCars collect information from cluster heads through visiting all clusters. They choose stop locations in all clusters and determine sequences for visiting them, so that data collection may be carried out in least time.

The current work primarily differs from other mobile collection strategies in the usage of MU-MINO method that allows dual data uploading for shortening data transmission latencies.

Sensor Layer

Load Balanced Clustering: Here, distributed load balanced clustering algorithm at the sensor layer is presented. The essential operation of clustering is the selection of cluster heads. To delay network lifetime, it is naturally expected that the chosen cluster heads are those with greater residual energy. So, percentage of the residual power of every sensor is utilized as initial clustering priority.

Cluster Head Layer

Connectivity among Chgs: Cluster head layers are not considered. As mentioned previously, several cluster heads in CHG coordinate amongst cluster members and cooperate for communicating with other CHGs. So, inter-cluster communications in LBCDDU is fundamentally the communication amongst CHGs.

Through employment of mobile collectors, cluster heads in CHGs are not required to forward cluster heads in CHGs are not required to forward data of every sCHG to SenCars. CHG data is utilized for optimizing the moving trajectories of SenCars. For CHG information forwarding, the main issue at the cluster head layer is the inter-cluster organization to ensure the connectivity among CHGs.

Sencar Layer

Trajectory Planning: In the current section, optimization of trajectories of SenCars for data collection tour with CHG data known as mobility control at SenCar layers is discussed. SenCars stop at certain polling points in all clusters for collecting data from several cluster heads through single-hop transmissions. Hence, discovering the optimum trajectory for SenCars may be decreased to identifying chosen polling points for all clusters and determination of sequence for visiting them.

Proposed System: The three-layer model is suggested for collecting mobile data in WSNs, which include sensor, cluster head as well as mobile collector (known as SenCar) layers. The frameworks employ distributed load balanced cluster as well as dual data uploading that is known as LBC-DDU. The aim is the achievement of excellent scalability, longer network lifetime as well as low data collection latency.

At the sensor layer, a LBC protocol is suggested for sensors to organize themselves as clusters. Several cluster heads in a cluster cooperate with one another to achieve energy-saving inter-cluster communications. Through inter-cluster transmissions, cluster head information is forwarded to SenCar for its moving path planning.

At the SenCar layer, SenCar is set with two antennae that enable two cluster heads to concurrently upload data to SenCars in every time by using multi-user multiple-input/multiple-output (MU-MIMO) method.

The path planning for SenCar has been optimized for fully utilizing dual data uploading capacity through proper selection of polling points in all clusters. Through visiting of all chosen polling points, SenCars may effectively father information from cluster heads and forward the information to static data sinks. Extensive simulations are conducted to evaluate the effectiveness of the proposed LBC-DDU scheme.

The outcomes reveal that when every cluster has maximum of two cluster heads, LBC-DDU attains greater than 50 percent energy savings per node as well as 60 percent energy savings on cluster heads when compared with data collection using multi-hop relays to static data sinks and 20 percent lesser data collection time in comparison with conventional mobile data gathering [6].

Advantage:

- Can efficiently gather data from cluster.
- Dual data uploading for fast data collection.

System Architecture: An overview of LBC-DDU model is depicted in Fig, which comprises three layers: sensor, cluster head and SenCar layers.

Sensor layer is the bottom as well as basic one. For generality, no assumptions are made regarding sensor distribution or node capacity, like location-awareness. All sensors are assumed to be capable of communicating only with their neighbors, that is, the nodes within their transmission range. At the time of initialization, sensors organize themselves into clusters. All sensors decide to be either cluster heads or cluster members in a distributed fashion.

The protocol constructs clusters so that all sensors in a cluster are one hop away from a minimum of one cluster head. The advantage of such organization is that intra-cluster aggregation is restricted to one hop. If a sensor is covered by several cluster heads in a CHG, it may optionally affiliate with a single cluster head for load balancing. For avoiding collisions at the time of data aggregation, CHG uses time-division-multiple-access (TDMA) based method to coordinate transmissions between sensor nodes. After the cluster heads are chosen, the nodes synchronize local clocks through beacon messages.

Once local synchronization is completed, an existing scheduling strategy can be adopted to collect data from cluster members. It is to be noted that only intra-cluster synchronization is required here as data is collected through SenCar. If there is imperfect synchronization, certain hybrid techniques for combining TDMA with contention-based access protocols (Carrier Sense Multiple Access (CSMA)) which listen to medium before communicating are needed. When SenCar arrives, every CHG uploads buffered data through MU-MIMO transmissions and synchronizes local clocks through the global clock on SenCar by acknowledgement message. Finally, periodical re-clustering is carried out to rotate cluster heads amongst sensors with greater residual energy to obviate draining energy from cluster heads.

Cluster head layer comprises of all cluster heads. As mentioned previously, inter-cluster forwarding is solely utilized to transmit the CHG data of each cluster to SenCar that contains identification list of several cluster heads in a CHG. This information must be transmitted before SenCar leaves for its data collection tour. On receiving this data, SenCar utilizes it to figure out where to stop in each cluster to gather data from the CHG. For guaranteeing the connectivity for inter-cluster transmissions, the cluster heads in CHG may cooperatively transmit duplicated data to achieve spatial [7] diversity that leads to reliable transmissions as well as energy saving. Furthermore, cluster heads may adjust their output power for a suitable transmission range for ensuring a certain degree of connectivity amongst clusters.

Top layer is the SenCar one which primarily manages mobility of SenCars. There are two problems to be addressed in this layer. Firstly, we need to define the positions wherein SenCar stops to transmit with cluster heads when it reaches a cluster. In LBC-DDU, SenCars communicate with cluster heads through single-hop communication. It is set with two antennae and each sensor has one antenna and is maintained as simple as possible.

Traffic pattern of data uploading in clusters is many-to-one, wherein data from several cluster heads converge to SenCar. Fitted with two receiving antennas, SenCar permits dual data uploading when possible, wherein two cluster heads may upload data concurrently. Through processing the received signals by filters on the basis of channel state data, SenCar may successfully split and decode the data from various cluster heads.

To gather data rapidly, SenCar should stop at locations inside a cluster which can achieve maximal capacity. Theoretically, since SenCar is mobile, it can choose any position. But, this is not feasible in practice, as it is difficult to predict channel conditions for all potential positions. Hence, we only look into a finite set of positions.

For mitigating the impact from dynamic channel conditions, SenCars measure channel state data prior to every data collection tour for selecting candidate positions for data collection.

These locations that SenCar can stop to perform concurrent data collections are known as polling points. SenCar does not need to visit all polling points. Rather, it identifies some polling points that are accessible and these are known as chosen polling points.

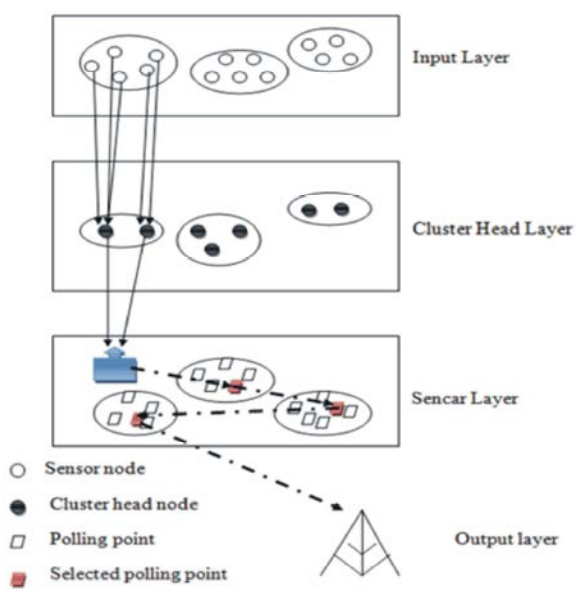

Fig. 2.1: System Architecture

Through usage of MU-MIMO data collection time may be sped up and overall latency may be reduced. Another application setting emerges in disaster management and rescues. For instance, to combat forest fires, sensor nodes are typically deployed densely for monitoring the situation.

Data Flow Diagram

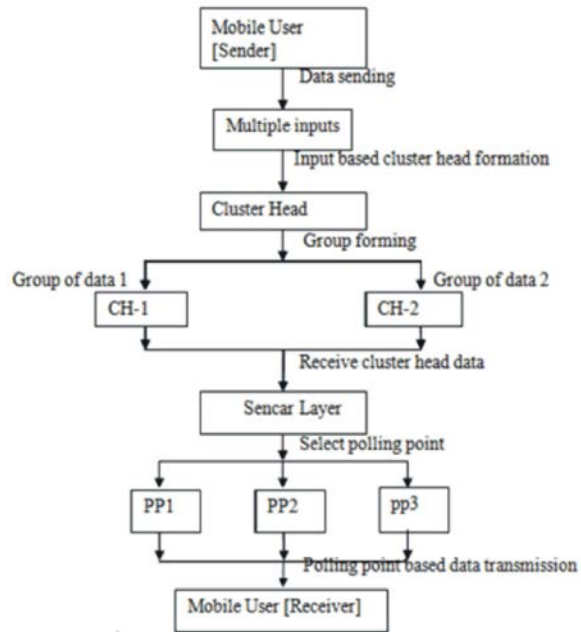

Fig. 2.2: Data Flow Diagram

Base Cluster Forming: Similar type storage networks are forming as a group each cluster have cluster head who is representing whole cluster. The third stage is cluster forming which determines which cluster head a sensor ought to be associated with. The criterion can be defined thus: for sensors with tentative status or being cluster members, they will arbitrarily affiliate themselves with a cluster head amongst its candidate peers for load balancing. If there are no cluster heads among candidate peers of the sensor with tentative status, sensor claims itself as well as its current candidate peers as cluster heads. The details given show the final result of clusters, wherein every cluster has two cluster heads while sensors are associated with separate cluster heads in the two clusters.

Cluster Head Group Forming: The Collection schemes consume energy uniformly across sensing fields for achieving long network lifetimes. Moreover, as sensing data in certain applications are time- sensitive, data collection may be required to be performed within a specified time frame. Therefore, an efficient large scale data collection Scheme should aim at good scalability, long network lifetime and low data latency. Cluster head and mobile collector (known as SenCar) layers. The model utilizes distributed load balanced clustering as well as dual data uploading, known as LBC-DDU.

The aim is to achieve excellent scalability, long network lifetimes and less data collection latency. At sensor layer, distributed load balanced clustering (LBC) protocol is suggested for sensors to organize themselves into clusters. Cluster heads or cluster members in a distributed fashion. Finally, sensors with greater residual energy become cluster heads and every cluster has maximum of M cluster heads, wherein M is a system variable. For convenience, the several cluster heads in a cluster are known as a cluster head group (CHG), with every cluster head being a peer of others.

MIMO Uploading: The feasibility of employing MIMO techniques in wireless sensor networks is envisioned in. Because of difficulties to mount several antennas on one sensor node, MIMO is adopted in wireless sensor networks to seek co operations from multiple nodes to achieve diversity and reduce bit error rate. An overview of MIMO-based scheduling algorithms to coordinate transmissions was discussed in. Another challenge in MIMO is that the energy consumption in circuits could be higher than a traditional Single-Input-Single-Output (SISO) approach. In, it was demonstrated that MIMO can outperform SISO when the transmission distance is larger than certain thresholds.

Sencar Layer Forming: Top layer is the SenCar one which primarily manages mobility of SenCars. There are two problems to be addressed in this layer. Firstly, we need to define the positions wherein SenCar stops to transmit with cluster heads when it reaches a cluster. In LBC-DDU, SenCars communicate with cluster heads through single-hop communication. It is set with two antennae and each sensor has one antenna and is maintained as simple as possible.

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Efficient Sencard Polling Extending: In existing system sencard layer poling point selection is manual in this paper I proposed systematic sencard poling point selection algorithm for artificially select the polling point by random, extract the cluster area of network and collusion less poling path detection.

Poling point selection algorithm is used to find the polling point which directly collects the data from its neighbors. A senCar visits every polling point and gathers the data from them then transmits it to the sink nodes thus decreasing the data gathering [8,9] latency as well as energy utilization on data gathering and thereby lifetime of networks get increased.

The technique can be used to extract the cluster area and add to the additional polling point to the specific cluster in the networks.

Cluster Formation Algorithm

Let us consider a WSN with ‘n’ stationary nodes deterministically deployed in a [X, Y] area.

// Topology setup phase

1) Specify Location;

//Location of node in the WSN

2) Find Neighbours;

//Check neighbouring nodes and create table

3) Find neighbour node distance;

// Get the distance of each neighbor and store it in the table.

// CH selection

4) For each node

If the node is alive

// Energy> threshold nodes(k) having energy >= average energy threshold.

If k >1 then

Case 1: //Deterministic deployment

Find out the nodes (n) with average minimum distance from BS.

Case 2: //Random deployment

Find out the nodes(n) with maximum number of neighbors.

If n > 1 // break the tie in CH election

Determine the node(x) with least id.

5) Assign node x as CH

6) Send CH announcement to all members, BS

// Rotate the role of CH

7) if timeout after m seconds

if energy level of CH < threshold then

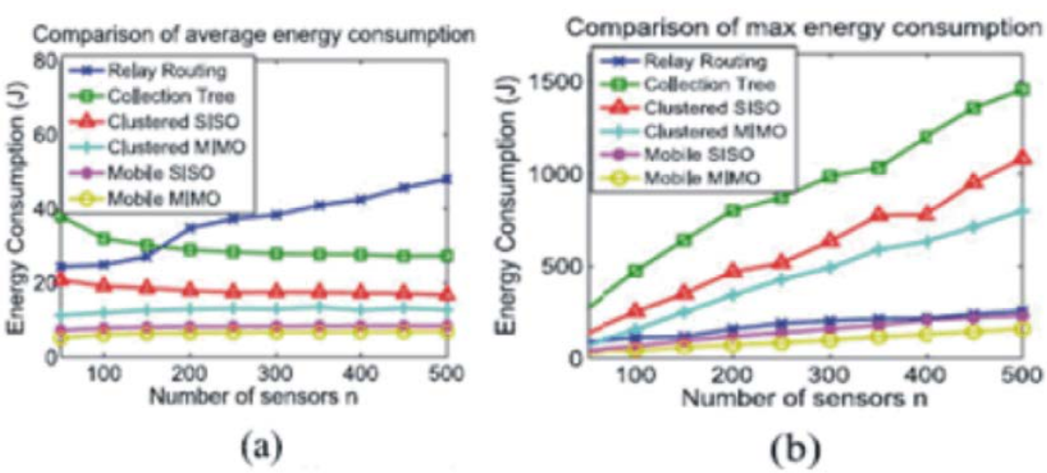
Goto step 4;

Evaluation: Average energy consumption for all sensors as well as maximal energy consumption in network are compared. We set l ¼ 250m, np ¼ 400, as well as M ¼ 2 while varying n from 50 to 500.

It is to be noted that when n ¼ 50, network connectivity is not capable of being ensured always for multi-hop transmission with static sinks. The outcomes here are solely the average of the connected networks in the experiment. But, the mobile strategies can work excellently not merely in connected networks but in disconnected networks as well, because the mobile collector functions as virtual links for connecting the separated sub-networks. We can observe that mobile MIMO strategy leads to the minimum energy utilization on sensor nodes, while the methods which transmit messages via multi-hop relay to static data sinks lead to at least twice more energy on every node. Fig. 7b presents maximal power consumption in the network. Network lifetime typically lasts till the first node exhausts its energy. Strategies with lesser maximum energy consumption will have longer network lifetimes.

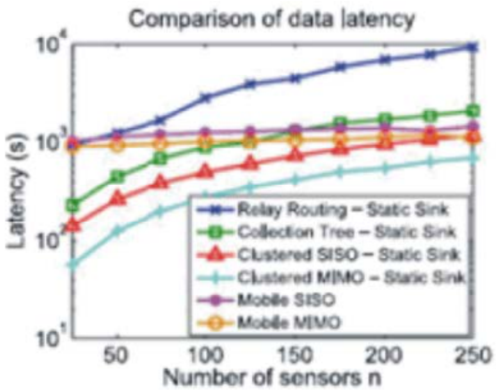
Mobile MIMO has the minimal maximum energy consumptions and curves for strategies that use multi-hop [10] relaying to static data sinks (Relay Routing, Collection Trees as well as Clustered SISO/MIMO) climb more rapidly and higher than mobile MIMO strategy. When network size is increased, network lifetime of the strategies will deteriorate as more relayed traffic is required to traverse the congested regions near data sinks.

Secondly, data latency is illustrated by Fig. 7c. Here, data latency is defined as time duration for the data sinks to collect all sensing data available. For mobile strategies, data latency is the same as the time duration of a data collection tour that consists of the moving time as well as data transmission times. Lower latency is got with clustered SISO/MIMO as opposed to Relay Routing or Collection Tree techniques. This is due to the fact that nodes are arranged in clusters and so routing burden is split into smaller tasks by various clusters. Relay routing has the greatest latency because selecting node with the greatest energy as the subsequent hop might not result in the shortest route. Whereas, mobile SISO/MIMO has a little greater latency than clustered SISO/MIMO as well as Collection Tree methods because of SenCar's moving time. But, it is to be noted that when n > 300, latency of Collection Tree techniuque exceeds mobile SISO/MIMO and the slope for multi-hop relaying to static sinks are steeper than mobile SISO/MIMO. This is due to the fact that although mobility implies extra moving time, one-hop communication for both data aggregation as well as uploading conserve time in routing considerably, while multihop traffic relay [11] to the static sinks might not scale well when quantity of nodes rises. Finally, the benefit of mobile MIMO compared to mobile SISO is seen by conserving 20 percent time totally. This is because of concurrent data uploading to SenCars at polling points in mobile MIMO method.

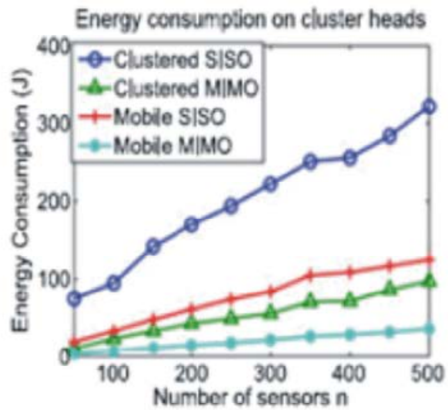


(a) Average energy consumptions per node.

(b) Maximum energy consumption.



(c)



(d)

(c) Data latency.
(d) Average energy consumption for each cluster head.

CONCLUSIONS

In this future proposed system, the concept solves the problems about communication level of polling point with each cluster. The MIMO process applied with the n no of cluster groups with the polling points with scheduling process.

In this paper, LBC-DDU model is suggested for mobile data collection in wireless sensor networks. It comprises sensor, cluster head as well as SenCar layers. It utilizes distributed load balanced clustering for self-organizing sensors, adopts collaborative inter-cluster transmission for energy-effective communication amongst CHGs, utilizes dual data uploading for rapid data collection and optimizes SenCar mobility for enjoying the benefits of MU-MIMO. The performance study reveals the efficacy of the proposed model.

The outcomes reveal that LBC-DDU can considerably reduce power consumptions by reducing routing burdens on nodes as well as balancing workload amongst cluster heads that achieves 20 percent less data collection [12,13] time compared to SISO mobile data gathering and over 60 percent energy savings on cluster heads.

Energy overheads are also justified. Outcomes with varying number of cluster heads are also studied. In the end, it is to be noted that there are several issues which should be further studied. Firstly, the issue is the discovery of polling points as well as compatible pairs for every cluster.

A discretization strategy should be formulated to partition the continuous space [14] for locating the optimum polling point for every cluster. Then discovering the compatible pairs is a matching problem for achieving optimum overall spatial diversity. Second issue is the scheduling of MIMO uploading from several clusters.

An algorithm that adapts to the current MIMO-based transmission scheduling algorithms should be studied in future.

The polling point selection algorithm can be increase the transmission range and polling point of the cluster in wireless sensor networks.

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