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AN EMPIRICAL CLUSTER BASED APPROACH FOR ENERGY EFFICIENT ROUTING WIRELESS SENSOR NETWORKS

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ABSTRACT

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. In this paper, we have proposed an empirical technique for the cluster based optimization of energy and routing

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INTRODUCTION

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

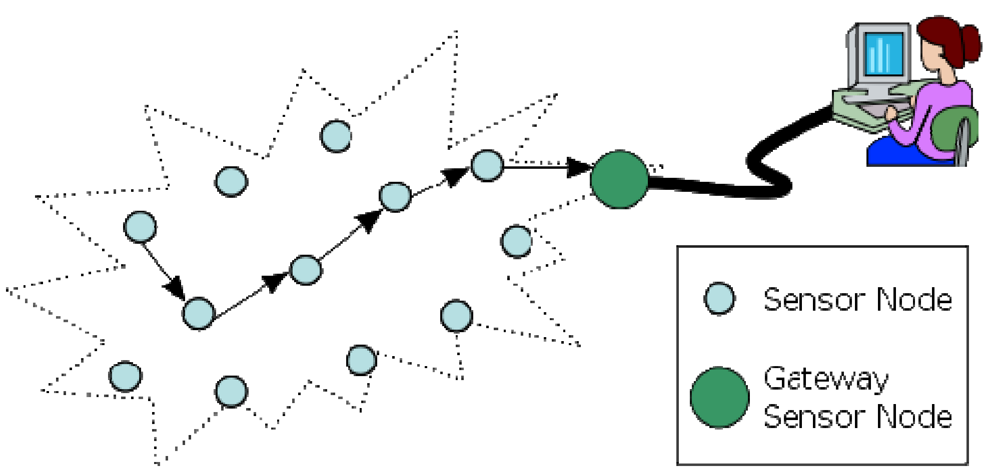

Fig.1

1.2 Applications

1.2.1 Area monitoring

Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors detect enemy intrusion; a civilian example is the geo-fencing of gas or oil pipelines.

1.2.2 Environmental/Earth monitoring

The term Environmental Sensor Networks has evolved to cover many applications of WSNs to earth science research This includes sensing volcanoes, oceans, glaciers, forests etc.

1.2.3 Air quality monitoring

The degree of pollution in the air has to be measured frequently in order to safeguard people and the environment from any kind of damages due to air pollution. In dangerous surroundings, real time monitoring of harmful gases is a concerning process because the weather can change with severe consequences in an immediate manner. Fortunately, wireless sensor networks have been launched to produce specific solutions for people.

1.2.4 Air pollution monitoring

Wireless sensor networks have been deployed in several cities (Stockholm, London and Brisbane) to monitor the concentration of dangerous gases for citizens. These can take advantage of the ad-hoc wireless links rather than wired installations, which also make them more mobile for testing readings in different areas. There are various architectures that can be used for such applications as well as different kinds of data analysis and data mining that can be conducted.

1.2.5 Forest fire detection

A network of Sensor Nodes can be installed in a forest to detect when a fire has started. The nodes can be equipped with sensors to measure temperature, humidity and gases which are produced by fire in the trees or vegetation. The early detection is crucial for a successful action of the firefighters; thanks to Wireless Sensor Networks, the fire brigade will be able to know when a fire is started and how it is spreading.

1.2.6 Landslide detection

A landslide detection system makes use of a wireless sensor network to detect the slight movements of soil and changes in various parameters that may occur before or during a landslide. Through the data gathered it may be possible to know the occurrence of landslides long before it actually happens.

1.2.7 Water quality monitoring

Water quality monitoring involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves.The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

1.2.8 Natural disaster prevention

Wireless sensor networks can effectively act to prevent the consequences of natural disasters, like floods. Wireless nodes have successfully been deployed in rivers where changes of the water levels have to be monitored in real time.

1.3 Characteristics

The main characteristics of a WSN include:

- Power consumption constrains for nodes using batteries or energy harvesting
- Ability to cope with node failures
- Mobility of nodes
- Communication failures
- Heterogeneity of nodes

- Scalability to large scale of deployment
- Ability to withstand harsh environmental conditions
- Ease of use

Sensor nodes can be imagined as small computers, extremely basic in terms of their interfaces and their components. They usually consist of a processing unit with limited computational power and limited memory, sensors or MEMS (including specific conditioning circuitry), a communication device (usually radio transceivers or alternatively optical), and a power source usually in the form of a battery. Other possible inclusions are energy harvesting modules, secondary ASICs, and possibly secondary communication interface (e.g. RS-232 or USB).

The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as they typically forward data from the WSN on to a server. Other special components in routing based networks are routers, designed to compute, calculate and distribute the routing tables.

Literature Survey

[1] They have proposed a novel Cluster Based Routing Protocol (CBRP) for prolong the sensor network lifetime. CBRP achieves a good performance in terms of lifetime by balancing the energy load among all the nodes. In this protocol first we Cluster the network by using new factors and then construct a spanning tree for sending aggregated data to the base station which can better handle the heterogeneous energy capacities.

[2] Clustering provides an effective method for prolonging the lifetime of a wireless sensor network. Current clustering algorithms usually utilize two techniques; selecting cluster heads with more residual energy, and rotating cluster heads periodically to distribute the energy consumption among nodes in each cluster and extend the network lifetime. However, they rarely consider the hot spot problem in multihop sensor networks. When cluster heads

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cooperate with each other to forward their data to the base station, the cluster heads closer to the base station are burdened with heavier relay traffic and tend to die much faster, leaving areas of the network uncovered and causing network partitions. To mitigate the hot spot problem, they've proposes an Unequal Cluster-based Routing (UCR) protocol. It groups the nodes into clusters of unequal sizes. Cluster heads closer to the base station have smaller cluster sizes than those farther from the base station, thus they can preserve some energy for the inter-cluster data forwarding. A greedy geographic and energy-aware routing protocol is designed for the inter-cluster communication, which considers the tradeoff between the energy cost of relay paths and the residual energy of relay nodes.

[3] Hierarchical cluster-based routing (HCR) technique is an extension of the LEACH [1] protocol that is a selforganized cluster-based approach for continuous monitoring. In LEACH, the network is randomly divided into several clusters, where each cluster is managed by a cluster head (CH). The sensor nodes transmit data to their cluster heads, which transmit the aggregated data to the base station. In HCR, each cluster is managed by a set of associates and the energy efficient clusters are retained for a longer period of time; the energy-efficient clusters are identified using heuristics-based approach. Moreover, in a variation of HCR, the base station determines the cluster formation. A Genetic Algorithm (GA) is used to generate energy-efficient hierarchical clusters. The base station broadcasts the GA-based clusters configuration, which is received by the sensor nodes and the network is con- figured accordingly**.**

[4] The efficient node-energy utilization is one of important performance factors in wireless sensor networks because sensor nodes operate with limited battery power. They've proposed a cluster based routing algorithm to extend the lifetime of the networks and to maintain a balanced energy consumption of nodes. To obtain it, we add a tiny slot in a round frame, which enables to exchange the residual energy messages between the base station (BS), cluster heads, and nodes. The slot is used in the Pre-setup phase. The performance of the proposed protocol has been examined and evaluated with the NS-2 simulator. As a result of simulation, they have confirmed that our proposed algorithm shows the better performance in terms of lifetime than LEACH.

[5] The energy consumption among nodes is more imbalanced in cluster-based wireless sensor networks. Based on this problem, in that paper, a cluster-based routing protocol for wireless sensor networks with non uniform node distribution is proposed, which includes an energy-aware clustering algorithm EADC and a cluster-based routing algorithm. EADC uses competition range to construct clusters of even sizes. At the same time, the routing algorithm increases forwarding tasks of the nodes in scarcely covered areas by forcing cluster heads to choose nodes with higher energy and fewer member nodes as their next hops, and finally, achieves load balance among cluster heads.

[6] They have presented two new routing protocols for mobile sensor networks, viz. power-controlled routing (PCR) and its enhanced version, i.e. Enhanced Power-Controlled Routing (EPCR). In both the protocols, fixed transmission power is employed in the clustering phase but when ordinary nodes are about to send their data to their respective cluster-heads, they change their transmission power according to their distance from their cluster-head. While in PCR, the nodes are associated with the cluster-head on the basis of weight, in EPCR it is done on the basis of distance. In addition to the protocols, we are suggesting a packet loss recovery mechanism for the PCR and EPCR. Both protocols work well for both mobile and static networks and are designed to achieve high network lifetime, high packet delivery ratio, and high network throughput. These protocols are extensively simulated using mass mobility model, with different speeds and different number of nodes to evaluate their performance.

CSMA-Based Medium Access [7]:

The MAC protocol must be able to support variable but highly correlated and dominantly periodic traf_c. This does not _t traditional CSMA-based schemes which assume stochastically distributed traf_c mainly for point-to-point _ows. This scheme uses constant listening periods for energy ef_- ciency and introduces random delays for robustness. In order to achieve fairness, an adaptive rate control scheme is used.

Hybrid TDMA/FDMA CSMA-Based Medium Access [8]:

In this scheme hybrid TDMA-FDMA is shown to be more energy ef_cient than TDMA or FDMA. This work emphasizes that energy ef_cient protocols for sensor networks cannot be designed unless physical layer and hardware issues are taken into account. Protocols throughout the protocol stack should be aware of the physical layer and hardware and not treat them as .black boxes..

SMACS and EAR [9]

In this model sensor nodes are mostly stationary and there exists a number of higher energy mobile nodes. SMACS achieves network startup and link-layer organization for the sensor nodes by combining neighborhood discovery and channel assignment phases so that by the time nodes hear all their neighbors the have formed a connected network. This is achieved without the presence of global or local master nodes. Uses _xed allocation of duplex time slots at _xed frequency. Exploits large available bandwidth compared to sensor data rate. Conserver power by random wake up during setup and after time slot allocation by turning radio off while idle. EAR enables seamless connection of the mobile nodes and is transparent to SMACS.

Existing technique

In the Existing cluster based protocol all the sensor nodes that has to communicate each other or transfer packets is possible only with the help of cluster head.

The existing protocol doesn't follow any routing technique's so many sensor nodes are participating in network than needed, so there is loss power of those nodes.

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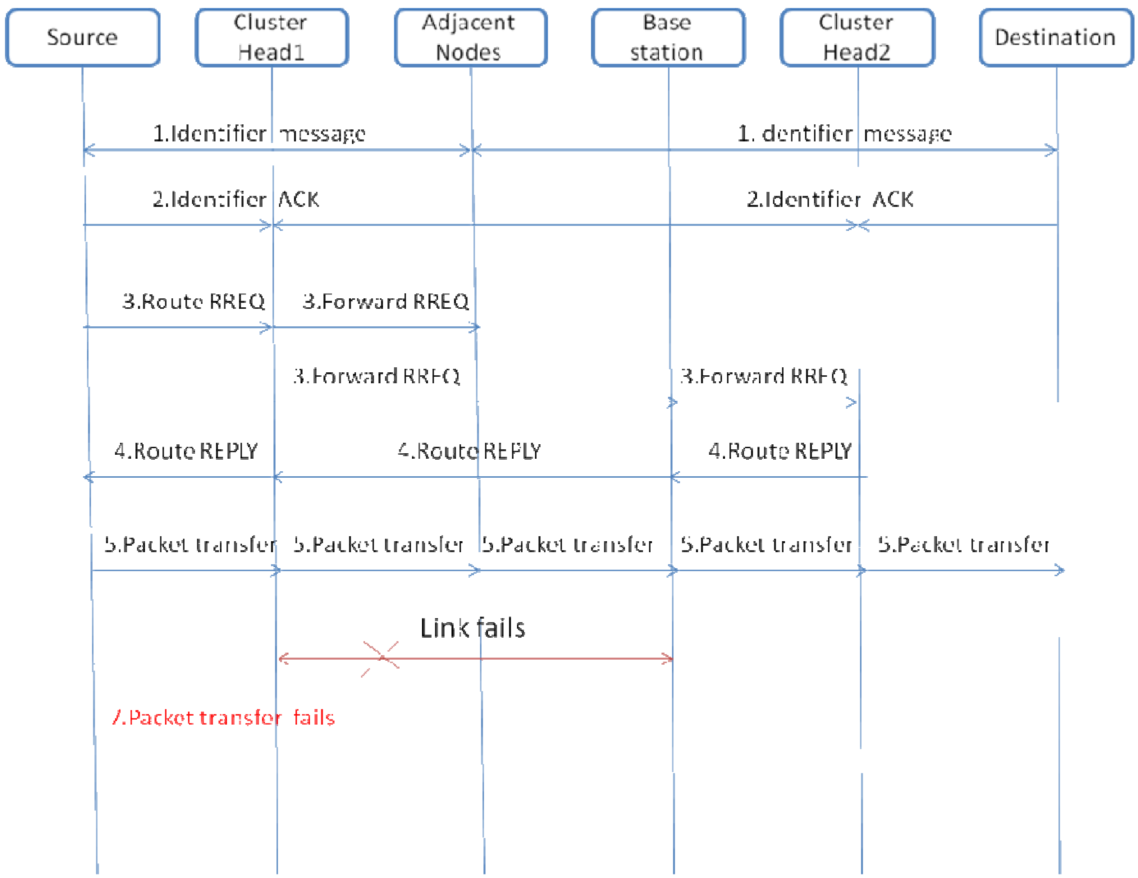
Sequence diagram



Proposed technique

Step 1:

Cluster Heads broadcasts identifier message to all other wireless sensor nodes (Adjacent Nodes). The adjacent nodes replies with identifier acknowledgement to the cluster head.

Step 2:

The Cluster Head manages the routing table and also the details of all the nodes in its group. The Cluster Head also maintains details about other groups Cluster Head and its address with the help of Base station.

Step 3:

The normal sensor node in a group maintains a table that contains information of its Cluster Head address and the common identifier generated by the Cluster Head.

Step 4:

The address of the Cluster Head that has already involved in routing has stored in every packet, it is used for verification by other Cluster Head.

Step 5:

When a source node in a need of route to deliver packets to the destination node, it sends Route Request message to the Cluster Head, the Cluster Head uses its common identifier to verify the packets.

Step 6:

The Cluster Head checks whether the destination node is in house, if the destination node is present under its group, then it sends the packet directly. If the destination node is not in house then it sends Route Request message to Base Station, The Base Station intent passes it to the Cluster Head which manages the Destination node. The Cluster Head passes then passes packets to the Destination node.

Step 7:

The sensor node under motion makes new route request to the Cluster Head, then Cluster Head passes the information to the base station. Source node and destination node under range directly communicates with each other with the help of adjacent nodes.

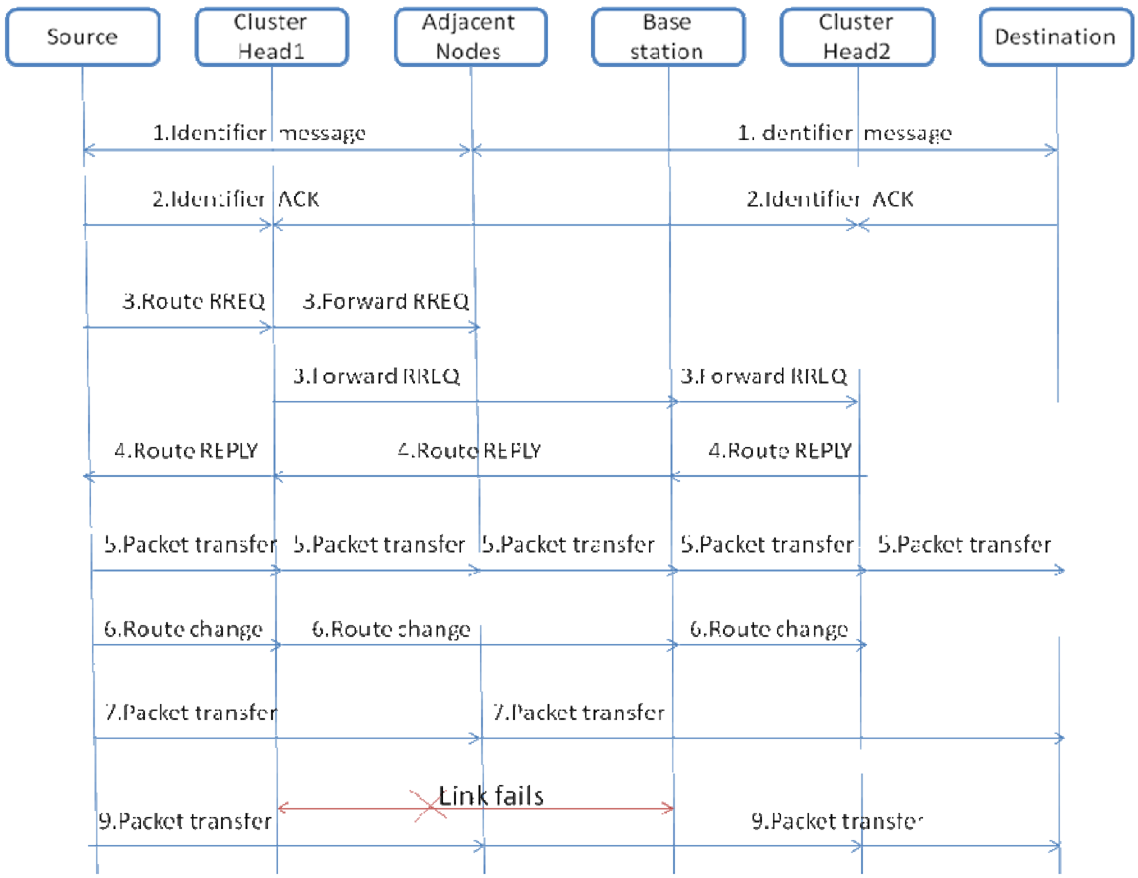
Step 8:

If the source node detects destination node is under its range it sends route change request to cluster head and it starts sending packets directly to the destination node(shortest path) through nearby adjacent nodes.

Step 9:

Suppose link with cluster head 1 fails, then packet transfer continues with other adjacent node under another cluster head.

Sequence Diagram



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