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Current State of Art of Energy Efficient PEGASIS Routing Protocols in WSNs

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Abstract: Wireless sensor network is an ad-hoc network that consists of small nodes with sensing, computing and communicating wireless abilities and these sensor nodes communicate with each other via various Routing Protocols. The essential challenging factors in the design of routing protocols in WSNs must be overcome in order to have an efficient transmission in a wireless sensor network. Researchers have designed and improvised different routing protocols to overcome factors such as, to maximize the network lifetime, balance energy consumption without losing accuracy, increase throughput of the network, power management, multi-hop transmission etc. Amongst these, energy conservation is a critical design issue. Hence, this article reviews and compares the improved versions of Power-Efficient Gathering in Sensor Information Systems (PEGASIS) protocol to achieve prolong communication in a wireless sensor network with minimal energy consumption.

Keywords: WSN, PEGASIS, Energy-Efficiency, Routing Protocols, LEACH, PDCH, EEPB, IEEPB, PEGASIS-ANT, ACO, PEG-BBO.

I. INTRODUCTION

The area of Wireless Sensor Networks (WSNs) is one of the fast growing fields in the engineering and scientific world. The main objective of WSN is to sense the crucial information from the environment depending on the type of application for which it is deployed. A WSN consists of hundreds and thousands of Sensor nodesand these nodes send this information to its Base Station (BS) to establish communication.Basically, each sensor node contains sensing, processing, transmission, mobilizer, position finding system, and power units and they coordinate with each other for the production of high-quality information about the physical environment [1]. WSNs are being used in many applications such as military and civil operations, weather monitoring, security and tactical surveillance, detecting environmental conditions such as temperature, movement, sound, light).

The rest of the paper is organized as follows: Section 2 provides a brief overview of the routing challenges. Section 3 explains the working of PEGASIS protocol. In section 4 we review and provide a comparative study of improved versions of PEGASIS protocol. Finally, we draw the conclusion in section 5.

II. ROUTING CHALLENGES

Routing is an important functionality in any network. Routing algorithms in WSNs are responsible for selecting and maintaining the routes in the network. Routing in WSNs differs from conventional routing due to its inherent characteristics. First, traditional IP-based protocols may not be applied to WSNs due to the large number of sensor nodes. Second, sensor nodes require careful resource management due to limited energy, storage and processing capacities. Additionally, all the application of WSN, unlike traditional communication network requires the flow of sensed data from multiple sources to the BS. That's why the topologies of Communication Networks (bus, ring, peer to peer, and multi-cast) cannot be implemented [2]. Third, sensor networks are application-specific. Fourth, it is not feasible to use GPS hardware. It is found in [3] that algorithms based on triangulation can work quite well under the certain conditions. Even then, it is favourable to have GPS-free solutions [1]. Due to such distinctive characteristics, a constant need has been felt to propose new solutions to enable routing in WSNs.



Fig: 1 Classification of Routing protocols in WSNs

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The existing routing protocolsdesigned for WSNs can be categorized into different classes (refer fig. 1), according to the network structure as flat, hierarchical, or location-based. Furthermore, these protocols can be classified into multipathbased, query-based, negotiation-based, quality of service (QoS) - based, and coherent-based depending on the protocol operation [1].

Various routing protocols have been developed and designed by researchers for WSNs. However, we have chosen PEGASIS routing algorithm for our study.

III. PEGASIS PROTOCOL

PEGASIS [4] is an optimal chain-based protocol that is an improvementon LEACH [5] [6]. The main goal of this protocol is for every node to only communicate with their nearest neighbours nodes only and in each round of communication, the nodes are selected randomly in the chain and takes turns to transmit the aggregated information to the base station. The nodes are randomly placed, organize them in the form of chain using greedy algorithm. This mechanism of chain construction using Greedy Algorithm is shown in Fig. 2.



Fig2: Chain formation

In a given round, control token passing approach started by the leader is applied to begin data passing from the ends of the chain. The cost is very small since the token size is very small [4]. Token passing approach is shown in Fig. 3 [7].



PEGASIS improves on LEACH for distinctive network sizes and topologies. It diminishes the overhead of dynamic cluster formation, limiting the number of data transmission volume through the chain of data collection and the energy load is spread out consistently in the network.

IV. ENERGY-EFFICIENT VERSIONS OF PEGASIS PROTOCOL

One of the major limitations of WSN is the sensor nodes which are operated on limited power sources. WSNs are often placed in the hard-to-reach locations where changing the sensor nodes battery regularly can be inconvenient and costly [8]. Thus energy conservation of the sensor nodes to maximize the network lifetime is one of the most challenging issues in WSNs. Various routing protocols have been specifically designed for WSN to address the design issues.

Routing algorithms in WSNs might differ depending on the network architecture and application. We have chosen PEGASIS routing protocol for our study, which is widely used routing algorithm in WSNs, for their high energyefficiency, good expandability with minimal clustering overhead. It however has the drawbacks of causing excessive delay for distant nodes, introduces redundancy in data transmission following the selection of one of the nodes as there is no consideration for the energy of the nodes in relation to the location of the base station and it cannot be applied to sensor network where global knowledge of the network is not easy to get.

Eminent researchers have given their contribution to make PEGASIS routing algorithm more energy-efficient. Table 1 reviews these optimized algorithms and provides a comparative summary. Each protocol takes into consideration unique factors and proposes its different version.

	1 d	tole 1. comparative study of c	optimized algorithms	
PAPER TITLE	ALGORITHM	FEATURES	ADVANTAGES	LIMITATIONS
Power-efficient	PEGASIS	• PEGASIS build a chain	Greedy algorithm	• All sensor nodes send
gathering in	with	of sensor nodes using	approach would work	the data directly to the
sensor	Greedy	greedy approach to	Dest	base station no matter
information	approach.	route the data to the	• If the base station is	how distant they are
system [4].		This surgest will be	the sensor node	This process is operation.
		• This approach will be	or	exhaustive which
		energy load equally	• When cost of	results in nodes death
		among the sensor	transmitting data is	results in nodes death.
		nodes	very less compared to	
			the cost of receiving it.	
An energy-	Energy	• Phases of EEPB are:-	• EEPB reduces the	• The threshold used by
efficient	efficient	I. node selection phase	formation of long link	EEPB while forming
PEGASIS in	PEGASIS	II. chain construction	between the	a chain is not certain
based enhance	based	phase	neighbouring nodes.	and complicate to
algorithm in	algorithm(E	III. data transmission	• EEPB not only	determine which will
WSN[9]	EPB)	phase	balances the energy	cause an
		• Enhanced version of	consumption of nodes	unavoidable if valued
		PEGASIS protocol.	but also conserves	inappropriately.
		• EEPB proposed a new	energy on sensors.	• When EEPB selects
		technique to avoid long		the leader, it ignores
		chain between		the suitable proportion
		thenodes based on		of nodes energy,
		distance threshold.		distance between
				nodes and base
An improved	Improved	· IEEDD is an immersed	. This shain building	station.
An improved	anorgy	• IEEPB is an improved	• This chain building	• IEEPB outperforms
efficient	efficient	algorithm which	avoids the formation	article doesn't
PEGASIS	PEGASIS	overcomes the	of long link between	compares both the
based protocol	based	deficiency of EEPB	the neighbouring	protocols in terms of
in WSN [10]	algorithm	• It is operating by	nodes	the OOS parameters
		rounds which contain	• It finds the shortest	the QOD purameters.
		three stages:-	path to link the two	
		I. Chain construction	adjacent nodes.	
		phase	• In the leader	
		II. Leader selection	selection phase	
		phase	IEEPB considers	
		III. Data transmission	nodes energy,	
		phase	distance between	
		• For the node to be a	nodes and base	
		leader it should have	station.	
		minimal combined		
		weight as per		
		weighting method used		
PEGASIS	PEGACIC ANT	DECASIS ANT	• It constitutes the	The working of the
protocol in	protocol uses an	• FEGASIS-ANT Call	• It constitutes the	• The working of the
WSN based on	Ant Colony	ontimization in contrast	transmission distance	fact that the RS
an improved	Optimization	to the local	and makes the path	receives information
ant colony	algorithm(ACO	optimization achieved	more distributed.	about the nodes
algorithm[11])	by original PEGASIS.	• In greedy approach	position and their
		• The ACO approach	the distance between	remaining energy in a
		constructs the chain in	the nodes gradually	timely manner.
		such a manner that the	increase as the chain	
		inter-nodal distances	is constructed.	
		never exceed the	However ACO	
		threshold distance so	makes sure that	
		that it can enable all	distances not	
		nodes to become	becomes extremely	

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Improved algorithm of PEGASIS protocol introducing double cluster [12]	PEGASIS with double cluster head(PDCH)	 leaders. PEGASIS-ANT uses the energy factor to maximize the lifetime, in the processes of chain building and leader selection. PDCH use hierarchical chain topology to reduce time-delay and to avoid long chaining. In PDCH instead of one, double cluster head are used in a single chain to improve the load balance. 	 large. It also balances the energy consumption between the nodes. This algorithm has prolonged the network lifetime. PDCH balances the load of every node and increase network lifetime It outperforms PEGASIS protocol by eliminating the overhead of dynamic cluster formation. It preserves robustness of the sensor network. As the energy load is distributed among the nodes, the network lifetime increases and hence the quality of the 	 Selection of two cluster heads might increase network overhead in terms of delay. Nodes of secondary chain don't get a chance to participate in the selection of main cluster head.
A survey of energy efficient hierarchical cluster based routing in WSN [13]	Hierarchical PEGASIS (H-PEGASIS)	 H-PEGASIS is an extended version of PEGASIS protocol. Its objective is to decrease the delay of transmission packets to the BS. To avoid collisions and signal interference among sensors two approaches are invested:- CDMA to avoid signal interference. II. Only spatially separated nodes are allowed to transmit at same time. 	 network. H-PEGASIS proposes a solution to the data gathering problem by considering energy delay metric. This ensures parallel transmission and reduces the delay significantly. In order to reduce the delay in PEGASIS simultaneously transmissions of the data message are pursued. 	 Compared with LEACH, the two algorithm PEGASIS and H-PEGASIS reduces the overhead of creating cluster but both of them are not suitable for heavy-loaded network. Becausewhile choosing a routing path they do not consider the energy condition of next hop. They are not suitable for sensor network where global knowledge is not easy to obtain. In WSN there are number of nodes, delay in data transmission is very obvious. So in this case PEGASIS and H-PEGASIS do not scale well.
Modified PEGASIS in WSN to increase network lifetime [7]	Proposed algorithm	 In this paper modification is being carried out in increase decision parameters in which route data will be transfer called cidel. Cidel is actually defines as the response of the node means how 	• They proposed modified PEGASIS Hierarchical techniques which can reduce the energy consumption and increase network lifetime so that more nodes will remain	 In this paper there is no comparison of proposed algorithm with other routing protocol except PEGASIS protocol. The simulation parameters are also not clear

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		 quickly node is giving response. Cidel = Throughput – Ceffective It is define as expected and actual response of the node Ceffective is defined as distance*Transmission distance*Transmission *overhead 	 exist. Number of nodes that becomes dead is less than the number of nodes in previous model 	
Energy aware PEGASIS- based hierarchical routing protocol for wireless sensor network [14]	EAPHRN	 Authors have proposed a new hierarchical routing protocol for fixedsensor networks, termed as EAPHRN. The idea is to find a low cost chain that covers all nodes of the network as in the PEGASIS [4] protocol. The proposed protocol (EAPHRN) double the lifetime of the network than PEGASIS. 	 It tries to increase the lifetime and throughput of the network. It uses a new algorithm for chain construction which is more efficient than the PEGASIS protocol. It also uses a new chain leader election method that plays a very critical role in the energy saving. 	• In this paper EAPHRN is not compared with CHIRON [15].
An Improved Energy- Efficient BBO- Based PEGASIS Protocol in Wireless Sensors Network[16]	PEG-BBO	 BBO is a population based global optimization technique developed on the basis of the science of biogeography [17]. In every round, BBO is implemented with PEGASIS to get the shortest chain. 	 BBO results presented by researchers are better than other optimization techniques like Ant Colony Optimization, Particle Swarm Optimization, Genetic Algorithm and Simulated Annealing. BBO adopts a effectivemethod to build short the chain. It keeps theenergy consumption balanced to further prolong the lifetime of WSN. 	• The performance of PEG-BBO is not compared with other optimization technique.

V. CONCLUSION

Various researchers have optimized the original PEGASIS routing protocol and proposed new algorithms to make it more energy-efficient. We have studied these algorithms and presented a comparative study of the same, summarized in the form of a table.

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