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Efficient Data Aggregation and Dissemination Protocol for IoT enabled Wireless Sensor Network

Dhotre Virendrakumar A[1*];Dr. Verma, Avnish Raj[2];Thigale Somnath B[3]; Gadekar Prakash R[4]; Dr.Junnarkar Aparna A[5]

[1,3,4] *1Ph.D Research Student MUIT, Lukhnow, India*

[2] *Ph.D Guide MUIT, Lukhnow, India*

[5] *Professors, PES Modern College, Pune, India*

Abstract:

The increasing interest of using the Internet of Things (IoT) for the real time applications related to smart remote and automatic monitoring of tasks leads to several research challenges as well. Since from last decade, number of methodology presented for the IoT enabled wireless communications based on end user applications such as smart traffic monitoring, irrigation management, health monitoring, disaster and security monitoring, weather monitoring etc. Apart from the traffic monitoring, most of the other IoT enabled applications are based on Wireless Sensor Networks (WSNs). The well-known and widely studied research problem of WSNs is limited processing capabilities and battery life of sensor nodes. For IoT enabled WSNs, the key tasks is to aggregate the on-field data periodically and disseminate it to the remote station in order to take the decision through the actuators connected to WSNs. The period process consumes more sensor energy; therefore it needs the energy efficient data aggregation and dissemination algorithm. In this paper, we proposed the novel Efficient Data aggregation an dissemination using Optimized Tree based clustering (EDOT) for IoT enabled WSNs. The novelty of EDOT approach is that it forms the clusters based on tree construction only when there is data collected by on-field sensor nodes. The EDOT consists of three phases such as tree formation from sink to source sensors in network, after tree formation the clusters formed, finally the data aggregation and dissemination phase. In this paper, we presented the model of EDOT by considering three phases and its performance evaluations as compared to state-of-art methods. The simulation result proves that EDOT improved the efficiency over the existing methods.

Keywords: data aggregation, data dissemination, clustering, tree based clustering, energy efficiency, internet of things.

I. INTRODUCTION

The general visualized of the Internet of Things (IoT) is nothing but the communication and integration of things to perform the smart operations. The dominance of IoT leads to a novel context of upcoming services and applications. These sensors and actuators such as surveillance cameras, home appliances, and environment monitoring sensors etc. are typically equipped with different kinds of microcontrollers, transceivers, and protocols for communication of sensing and control data [1]. These real life objects, either sensors or actuators, are connected with each other to transfer their sensed data to centralized servers, where information is collectively stored and made available for particular users with proper access rights [2] [3]. The network characteristics of IoT using these wireless technologies are quite different from those for traditional wired or wireless networks because the number of devices participating in communication is very large. In addition, traffic per IoT device is typically not so much because each IoT device senses and transfers a small amount of data to a corresponding IoT server, although data generated from a huge number of objects may collectively have some impacts on the network performance [4].

The key requirement of IoT enabled WSNs is that they should operate stably and sustainably for a longer period without any need for human intervention. Devices in such IoT networks will typically

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operate based on battery power sources, and hence, energy efficiency is naturally of utmost importance in device management. Considering the WSN domain, energy efficiency for battery operated sensor nodes and lifetime enhancement have been research issues since from long time [5] [6], where Medium Access Control (MAC) layer protocols focus on adjusting the duty cycle for sensor nodes, and routing layer protocols are designed for data aggregation and many-to-one transmission. Similarly, since IoT devices operating in the IoT network paradigm are also battery operated, battery consumption should be kept in mind during IoT network deployment. The realization of cost reductions to achieve green networking is the research objective of this paper. Many energy efficient schemes for WSN have been proposed in the recent past such as hierarchy [6] and exact [7] [8] ones, however there are many holes related to efficient data aggregation and dissemination methods.

The network lifetime enhancement is mainly based on the approach used for data aggregation and dissemination in WSNs as the sensor devices periodically collects the field data and disseminates it to the sink node. The data aggregation approach effectively reduces the energy consumption as compared to data centric routing. The data aggregation used to reduce the communication cost by eliminating the redundancy and forwarding just the fewer aggregated information which in turns leads the energy consumption reduction. For WSNs, one the key problem is guaranteed sensed data transmission to the sink node especially in presence of failed sensor nodes. This problem becomes sever for the data aggregation and dissemination methods. Therefore for any data aggregation technique, the key requirements such as build routing tree with fewer number of messages, increased number of overlapping routes, reliable data transmission, and higher data aggregation rate.

In this paper, we present the outline and model for the proposed EDOT routing protocol for energy efficient data aggregation and dissemination in IoT enabled WSNs. The EDOT is based on efficient tree based clustering approach in which first tree build from sink node to all the source sensors, after that cluster formation performed on that tree to select the coordinator and relay nodes for the data aggregation and dissemination, finally the routes established and data transmission phases performed. In section II, the review of different energy efficient protocols for IoT enabled WSNs presented. In section III, the model for EDOT presented. In section IV, the simulation results and discussions presented. In section V, conclusion and future work described.

II. RELATED WORKS

In this section we briefly presented the recent energy efficient works presented for IoT enabled WSNs related to data aggregation and dissemination. There are number of conventional data aggregation and dissemination protocols designed for WSNs under the clustering and tree based categories, however in this paper we reviewed the most recent works reported for IoT based applications to reduce the energy consumption.

In [9], author proposed Ring Routing protocol to diminish the vitality utilization by WSN nodes. They designed protocol as creative, scattered and vitality proficient portable sink routing protocol which is expected for time delicate application, which intend to decrease these overheads while saving energy of versatile sinks. The Ring Routing is various levelled versatile sink protocol which depends on virtual ring synthesis which can be effortlessly reconfigurable and in addition available. Further in [10], energy efficient routing solution for the IoT enabled applications proposed based on the clustering approach.

In [11], author presented the energy constraint problem of devices in IoT applications as an optimization problem. To conserve the energy of device nodes, the routing protocol first aggregates devices into clusters based on a number of different features such as distance from base station, data/message length and data sensed from the environment in the current epoch. Then, a cluster head is elected for each cluster and a directed acyclic graph (DAG) is generated with all the cluster heads as nodes. Edges represent communication intent from transmitter to receiver and the edge weights are computed using a formulated equation. The minimum cost path to the base station is computed to allow for efficient real-time routing. Sleep scheduling is also optionally used to further boost network energy efficiency. The proposed routing protocol has been simulated and outperforms existing routing protocols in terms of metrics such as number of active nodes, energy dynamics and network coverage.

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In [12], author investigated that how IoT has pick up fame as the quantity of smart devices being utilized as a part of everyday human life having system lifetime as a requirement. In giving availability between nodes, going of routing data assumes a conspicuous part. They distinguished that most extreme energy of smart devices is used in routing the information (or) control bundles. Their goal was to address the holes in improving the system utilization, which thus augment the system lifetime. In these ways, so far the writing survey made on versatility, energy proficiency, Quality of Service (QoS), arrange lifetime, node sending with Wireless Sensor Networks (WSN) viewpoint.

In [13], author proposed efficient cross breed energy aware clustering communication protocol for green IoT network computing; Hy-IoT, yet also gives a real IoT network architecture for taking a gander at the proposed protocol compared to commonly existed protocols. Efficient cluster-head selection underpins the use of the nodes energy contents and consequently increases the network life time and additionally the packets transmission rate to the base station. Hy-IoT used various weighted election probabilities for selecting a Cluster-head in perspective of heterogeneity level of the region.

In [14], author resuscitated Internet of Things (IoT) devices is exceptionally utilized in various fields such as natural checking, organizations, quick home etc. Under such instance, a cluster head is selected among the different IoT devices of WSN based IoT network to keep up the tried and true network with efficient data transmission. To accomplish the efficient cluster head selection, they used Fuzzy C-Means (FCM) clustering calculation.

In [15], author proposed IoT related issues mainly on energy efficiency. The expansion of these contraptions in a communicating– actuating system that makes the Internet of Things (IoT) fascinating, wherein sensors and actuators mix consistently with nature around us, and the data is shared crosswise over stages to build up a typical working picture.

In [16], proposed the various routing solutions for subscribe methods that include content and context-based routing for IoT enabled WSNs. They designed the Energy-Efficient Content-Based Routing (EECBR) protocol for the IoT that minimizes the energy consumption in WSNs.

Apart from the above works, some of the methods proposed for green IoT and energy efficiency in different domain.

In [17] [18], authors discussed the need for green IoT and the various software and hardware based technologies required to enable its realization. Energy efficient inter-node communication and improved routing techniques have been identified as the issues that need to be addressed to facilitate large-scale adoption of green IoT.

In [19], the different approach proposed wherein a priced public sensing framework is proposed for public data delivery gathered from cloud and heterogeneous resources. The work is data centric, focused on supply and demand chain of public data from mobile phones.

In [20], author proposed data collection in cellular devices using device to device communications in an IoT and Smart City setting. This results in more efficient resource utilization and minimizes energy consumption. They use one device that aggregates data from several surrounding devices and then sends the data to cellular station, instead of each device sending data individually. In [21], an overview of using traditional WSN protocols for achieving device to device communication in IoT has been presented.

The protocol designed in this paper is different from above works and mainly designed based on hybrid approach (consist both tree formation and clusters) for efficient and reliable data aggregation and dissemination with goal of energy consumption reduction with higher network throughput. The EDOT protocol performance is compared with recent Hy-IoT and method reported in [12].

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