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An Analytical Survey of Energy Efficiency in IoT Paradigm

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Abstract

The Internet of Things is evolving in terms of technology and applications. IoT networks are made up of a lot of smart devices having networking capabilities, also known as endpoints. The battery life of these endpoints is often limited, which has an effect on how long IoT applications can run in the real world. The Internet's current state was developed using a variety of technologies. IoT technology relies heavily on WSNs, which enable the fusion of diverse systems, data, and applications. The findings demonstrate that the suggested structural design can successfully lower energy usage and increase the WSN's course of life. We will outline the causes of energy waste in WSNs in this paper, along with various methods for reducing it.

Keywords: Energy optimization; Energy consumption; Internet of Things (Iot); Wireless Sensor Networks(WSNs)

1. Introduction

IoT, is the interconnection of integrated objects used in everyday life, such as appliances, watches, and automotive features, that employ common communication structures to give new services to users. These connections enable data to be transferred to and from devices in a bidirectional communication flow over a network. The best part of WSNs is that the mote can detect the relevant information and connecting with other motes through processing.

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Some components together make a working IOT ecosystem which are as listed below,

1. IOT devices are supervised for gathering and transmitting data from a single object to others.
2. IOT Network is communication technology used by IOT devices to spread data to other object or devices.
3. IOT connectivity is liable for conveying data to virtual world between devices.
4. IOT cloud is a giant network supporting IOT devices that is liable for computing data.
5. Terminal devices along with user interfaces are being used in helping to manage and configure the system.

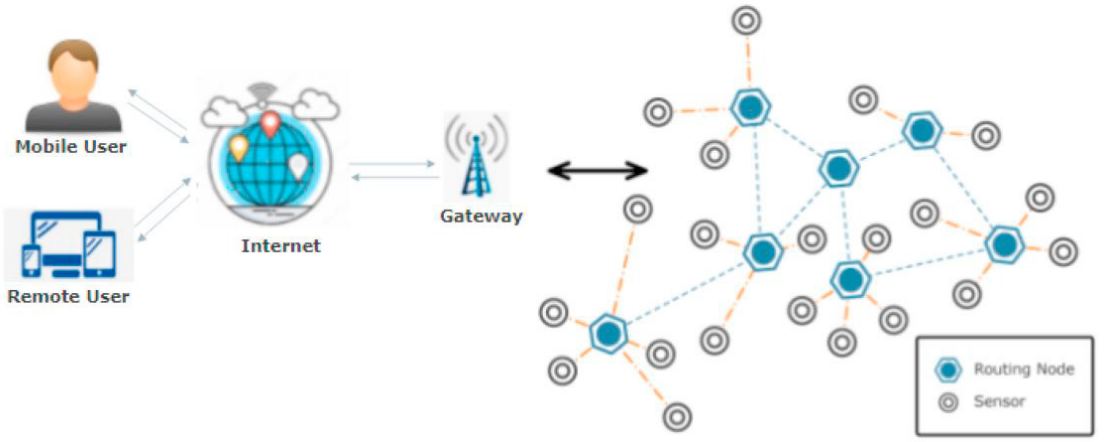

Figure 1: WSN technology [1]

However, because these modules are powered by a battery with a finite life, their lifespan is relatively short. The majority of energy is used in data processing and transfers because scheduling and routing algorithms are inefficient.

IOT can gather a lot of data utilising cutting-edge communication technologies, which can then be analysed for use in decision-making processes. Furthermore, in order to make IOT omnipresent, big data needs for IOT necessitate storage space, cloud computing, and high transmission bandwidth. The IOT devices uses considerably very high amount of energy in filtering and transmission of this enormous volume of data.

From the latest research, it is known that 30% of the energy in IOT devices is wasted. With the continuous expansion of IOT sensors, big data generate large amount of computational pressure and network transmission overhead. As a result of this, it is clear that IoT devices can result in significant energy consumption and waste, and as a result, many major data centres waste more than $10,000,000. Energy management may be the first factor taken into account for any ecosystem when developing a fully integrated IOT strategy that maximises productivity and ultimately achieves cost-saving objectives.

To mitigate these problems, there are many solutions. There is plethora of IOT devices that improves efficiency by identifying the major factors such as where, when and how the energy is consumed and wasted and thus suggesting power saving measures and turning off the device when not in use. This is determined by recognizing the patterns, and triggering remedial actions. This saves a lot of money on operating costs while significantly boosting energy consumption. The main benefit of these devices is its extremely easy configuration, as these are focused on being quick to deploy while not requiring any implementation of heavy infrastructure to operate. The other type of method is to generate a computer model that offload the enumerating functions from the cloud-side to edge when there is high computational overhead which is the main reason for the cause of vast energy consumption.

2. Literature Review

The Internet of Things has piqued the interest of practically every sector, including government, private sector, enterprises, military, healthcare, industries, and researchers. IOT is everywhere around us in almost each and every thing likewise from mobiles to LEDs, from wristwatches to smartphones, from refrigerators to smart TVs and many more. IOT along with cloud computing is very useful in healthcare sector where records of patients and their medical history is matter of life. IOT based WSNs are used to gauge a variety of physical phenomena, including temperatures, rainfall, a volcanic eruption, cyclone warnings etc. by monitoring various sensors.
According to studies, communication and IoT applications typically include one or more of the following connections:

1. People to People(P2P) connection: In this type of connection the data is shared from one user to another user. For instance, the voice calls, video calls, chats, virtual meets etc are form of P2P connection.
2. Machine to People (M2P) connection: This sort of connection allows devices such as motes, computers, and smart gadgets to share data with users for analysis. For example, sensors like anemometers are used at weather stations to keep track of wind speed at a given height in atmosphere.
3. Machine to Machine(M2M) connection: In this type of connection the data is shared among machines without any human interruption. For instance, data shared between two cars about its speed, braking, distance, lane changes, congestions etc.

2.1 An overview on WSNs

Wireless Sensor Networks (WSNs) contains ten thousand of nodules connected and interfaced with each other which are used for keeping track of system's physical and environmental conditions. The main role of each nodule is sensing and communication unit, processing block which contains storage and CPU of system, as shown below:

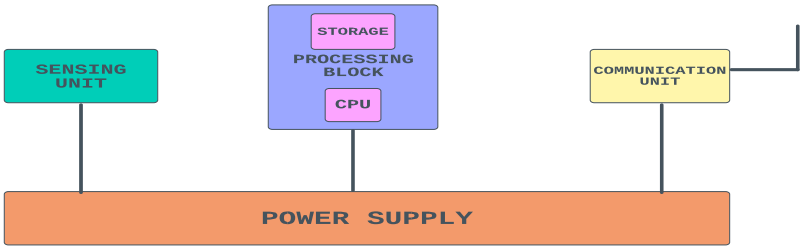

Figure 2: Basic components of WSN [2]

The WSNs consist of the following components:

1. Sensing Unit: It is in control of acquiring data from the sensors and transfiguring it into automated data so that the computer can understand it. And then, it sends this data to the next unit.
2. Processing Unit: A microchip alongside a predefined memory size is present in this component. Before delivering the data to the transceiver, the processing unit gets it from the sensing unit and processes it.
3. Communication Unit: This gadget is in charge for interchange of information alongside other intelligent sensors by integration of receiver alongside a radio transmitter.
4. Power Unit: This unit is in charge of distributing power to the rest of the units. WSNs will cease to function if the power unit fails, hence extending the power unit's working life through energy saving is a critical and competitive issue in WSNs.

2.2 Sources of energy wastage:

The processing, transmission, and receiving of data to meet the application's requirements is the primary source of energy waste in WSNs. Thus, reducing the transmissions of data will eventually decrease the energy wastage of these smart devices. It is known from the studies about communication unit that a huge amount of energy is expended in certain ways that does not provide any valuable additions to the application, likewise:

1. Collision: When packets approach the mote simultaneously, a packet collision occurs.
2. Overhearing: Due high nodule density all the mote in the transmission range acquires the packet even though they are not preferred junction.
3. Control Packet Overhead: Additional storage, transmission capacity, processing time, and other assets are all combined to perform an operation.
4. Redundant Data: Nodules are distributed haphazardly which means that there will be some regions which will be monitored by two or more sensors simultaneously.
5. Distance: One of the most essential aspects of energy efficiency is the transmission distance between nodules. A nodule can connect with its linked CH nodule, the ultimate destination, and other nodules via a single hop or several hops.

2.3 Classification of energy consumption solutions

Several methods exist that can reduce energy usage in an efficient manner. Some of these techniques are: -

1) Routing Protocols: The most important issues about IOT based on WSNs in the modern world centre on the generation of massive amounts of data and how the best method is chosen for transmission of such vast volumes to the end destination. Various authors have implemented several routing algorithms to conserve energy.

I. Cluster-Head Nodule Selection:

a) LEACH [Low Energy Adaptive Clustering Hierarchy]: It's in the middle of the mass intriguing tactic; this strategy uses probabilistic approach to elect the CH nodule. A schedule is created for every nodule in the collection to submit its data after the network is informed of the CH nodule's selection.

b) HEED [Hybrid Energy-Efficient and Distributed]: It's another approach that is frequently used to choose CH nodules. In this approach, the CH nodules are divided in equal and uniform manner in the sensing field. The residual energy and nodule proximity to its neighbours are the major factors dependent on the CH nodule.

c) PEGASIS [Power-Efficient Gathering in Sensor Information Systems]: It's a different kind of Cluster Head nodule selection method. A protocol chain is built between the motes in order for transmissions to take place.

II. Manipulating the Location of Base Station: In this protocol all the nodules are directly connected to sink regardless of the distance, and information is gathered in sensing field. To collect this data, the sink moves along a predetermined course. The suggested solution includes the concept of a Mobile Sink, which collects data from the sensing field while reducing distances and thereby increasing the network lifetime.

2) Scheduling Algorithms: About a CH nodule, motes generally form, many-to-one flow pattern. Overflow is mostly caused when a nodule's transit load exceeds its buffer capacity, resulting in only some packets being sent successfully and forcing packet retransmission. The suggested protocol offers a scheduling mechanism to address the issue of varied border nodule scheduling, hence minimizing energy usage and extending network's course of life.

3) Aggregation Methods: Classification of few cells exists in a very particular way in sensing field where every cell chooses one nodule to perform as cell head for every cell in the sensing field. As a result, the cell head nodule is the only nodule that sends data; it gathers data from its associated nodules, filters out any redundant information, and then sends the remaining information to the final location.

3.Comparison table

Table 1. a list of some of the techniques used in this study

Protocols	Fixed Mobility	Hop Restraint	Utility of Location	Sort of Protocol	Network Strength (Energy Efficient)	CH Nodule
LEACH [3]	✓	Single hop	✖	Routing	✓	Randomly
LEACH-C [4]	✓	Single hop	✓	Routing	✓	an energetic cluster nodule
E-LEACH [5]	✓	Multi-hops	✓	Routing	✓	a nodule with the most energy left over
HEED [6],[7]	✓	Single hop & multi-hops	✓	Routing	✓	Based on the large residual energy, the CH nodule was chosen.
H-HEED [8]	✓	Single hop & multi-hops	✓	Routing	✓	The H-HEED finds the cluster centre and gives a CH to the nodule that is closest to it.
E-HEED [9]	✓	Multi-hops	✓	Routing	✓	The CH nodules are ordered by the minimum length between them and the BS.
PEGASIS [10]	✓	Multi-hops	✖	Routing	✓	Randomly
SPT [11]	✓	-	✖	Scheduling	✓	-
EDF [12]	✓	-	✖	Scheduling	Reduce latency	-
Dual core processor [13]	✖	Single hop	✖	Scheduling	Reduce latency	-
LH [14]	✓	Multi-hops	✖	Scheduling	✓	The CH and BS are closed nodules.

4. Research gaps:

The above literature review presented many methods for minimizing wastage of energy and increasing the network lifetime. Still there are some gaps and limitations in the above explication. In discipline of sensing, mote rely on other intermediate nodules to advance the data, and even multiple motes transfer their data through other bounds to use CH nodules to connect to the BS. The CH nodule may enhance when other nodules transfer their data to it from all around it. Some of these packages possesses high possibility of redelivering from the CH nodule.

5. Conclusion:

The IOT network is expanding quickly all around us, and it has a significant impact over internet connecting the world. Since majority of WSN are battery-powered, how much power they use will determine how long they last. Our energy-saving method's main objective is to keep motes active for longer periods of time in order to increase the lifespan of WSNs network. This papers aim is to give an abstract overview of the IoT and WSN technology that helped bring about the IoT revolution, as well as to describe various sources of energy waste in WSN technology and to propose solutions to these problems using various methods such as routing protocols, scheduling algorithms, and aggregation methods that aid in increasing energy efficiency in the IoT environment.

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