Challenges, Issues of Energy Efficiency in IoT devices and an analysis of battery life power consumption in IoT devices and Applications.

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Abstract

Internet of Things is a modern emerging innovative technology. In this technology various sensing devices are used widely for different applications. In this technology the energy consumption of devices is one of the important issues and biggest challenges to giving energy efficiency of the IoT devices. It is a very essential one because all the sensing devices are energy constrained. The actuator, Battery powered sensors and other devices are connected to the Internet for operation on every day. The actuator and sensing devices share the information through a specified platform till the power is available in it. So, minimize the power consumption and efficiency of energy of IoT to be improved. This paper presents the challenges, issues of energy efficiency and battery power consumption of IoT devices. To minimize the energy used by the internet of devices or increasing the battery capacity will increase the lifetime and minimize the battery power consumption and reduce the total cost of ownership of the product.

Key words: IoT, IoT Devices, Battery Life and Power.

I Introduction

The name Internet of Things was coined in 1999 by British technologist Kevin Ashton.\textsuperscript{[14]} Internet of Things (IoT) is a network of physical devices which can sense, accumulate and transfer data over the internet without any manual intervention. \textsuperscript{[13]} The Internet of Things (IoT) is the network of physical devices, vehicles, buildings and different things embedded with electronics, software, sensors, actuators, and connectivity supporting them to collect and exchange the data.\textsuperscript{[11]} The Internet of Things (IoT) expands the common concepts of anytime and anyplace to the connectivity for anything.\textsuperscript{[19]} It has developed due to the merging of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.\textsuperscript{[19]}

Challenges and Issues of IoT devices

The Internet of things (IoT) is an intangible grouping of technological capabilities that enable not only the interconnectivity of useful devices but also the environmental control of useful experiences. The IoT may be viewed as a multiplicity of connected environments in which user can be controlled by experiences. The Environments are populated by sensors, controllers, and other objects,
which are principally powered by electricity. As a result, the development of the IoT affects the requirement for renewable energy and energy consumption efficiencies. In this paper, we discuss optimizing Power consumption in the IoT smart applications. For Optimizing, minimizing power consumption and increasing the lifetime of battery in IoT devices and applications.

Internet of Things (IoT) is an emerging technology and energy consumption is one of the important issues. It is crucial because the devices are energy constrained. Battery-operated sensors, actuators, and everyday objects are connected to the internet. Significant progress has been made in this paradigm. This paper presents the issues and ways to minimize the energy consumption in IoT environment.

**Power Consumption of Devices**

The devices which connected to the IoT over the network consuming the power while the device is processing itself, such as sensing, receiving and transmitting the data continuously. While the process is performing continuously the power consumption will also increase and the storage of power will decrease and the lifetime of device battery power will be less. It is important to identify/Calculate that How long the device will perform/process?, How to receive and send the data from or to other devices without any loss and how to manipulate the data over the net while the power of device get decrease[5].

**Organization of the Paper**

Organization of the Paper given as follows. Section I give the Introduction on IoT, Section II illustrates the review of literature, Section III describes IoT Devices and Applications, Section IV provides IoT Architecture, Section V shows the Calculating Battery Life in IoT and an analysis of Power consumption and VI gives the conclusion.

**II. Review of Literature**

Perković, Toni et al.,[1] This paper mainly relates to further extension of wireless interrogation range and smarter control of power constraints, while also providing new applications. Once these requirements are improved, new applications in different user domains will emerge and further increase IoT market size. IoT could be implemented in many different environments.

Sebastian et al.,[2] This paper presents the issues and ways to minimize the energy consumption in IoT Environment. This paper describes the overview of Energy efficiency of IoT devices on the network.

Paula Raymond Lutui et al., [3] In this paper discussed optimizing energy consumption in the IoT smart environment of a home. Optimization by simple design is adopted as the best strategy for planning and regulating energy consumption.

H. Jayakumar et al.,[4] In this paper discussed, An overview of the challenges involved in designing energy-efficient IoT edge devices and describe recent research that has proposed promising solutions to address these challenges.

AntarShaddad et al.,[5] In this paper proposed a new common taxonomy that bring-all-together and covers the major energy-conservation techniques introduced in the reviewed categorization papers or proposed recently for IoT-based WSN.

**III IoT Devices and Applications**

**IoT Devices:** An Internet of Things IoT device is a part of hardware with a sensor that transmits data
Internet of Things (IoT) devices, support, integrated and basically smart devices which have support for internet connectivity and are able to interact with the other devices over the internet. The following is the different types of IoT devices consists of wireless sensors, software, hardware, actuators, sensors and other computer devices. The IoT standard devices are basically included and these devices can be embedded into computer devices, laptops, smart gadgets, smart watches, mobile devices, smartphones.[15][20]. The devices can be classified into the three different most important major groups is consumer, enterprise, and industry.[21]

**IoT Applications.**
The IoT application includes Smart environments and smart spaces in a various field such as Aeronautic, Logistics, Medical Science, Transportation, Industries, Home and Home appliances, Smart Vehicles, Educations, Safety services, Healthcare, Tourism and Manufacturing, Broadcasting and Communications and the IoT also offers various chances for a large range of automation and commercial applications.[22]

**IV IoT Architecture**
The Internet of Things (IoT) Architecture can be categorized into a Three-layered architecture which shown in the following figure [1]. This Architecture includes the following layers such as perception layer, network layer and application layer. This architecture contains the following group of three fundamental building blocks and primary functional layers [12][13][16].

**Application Layer**
Cloud / servers
Data processing and storage, big data processing with specialized services

**Network Layer**
Routers and Gateways
Discover, connects and translates devices
Gateways for data filtering, preprocessing and moving it to the cloud over a net

**Perception Layer**
Sensors, Actuators, smart devices and edge devices
Sensors gather data from the environment; actuators turn things on or off

**Battery Management System**
Battery Management Systems manage the output, charging and discharging and provide reports on the status of the battery pack. To confirm that the batteries are charged properly and their life and use are optimized. The battery management functionality is Monitoring, Computation, Environment management and Communication. The rechargeable battery capacity reduces, and these needs to be computed by the battery management system to enable it to know the full charge level and capacity. IoT systems require power supply design to be integrated with the system design in order to maintain high efficiency[11].

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**Fig 1: Overview of Architecture**
Optimize battery life in IoT devices

The Internet of Things (IoT) continues its fast development, IoT devices and Application areas such as smart environment. Organizations that make the correct choice for device operation at the end of battery life can delight customers and gain a good advantage. [17]

Battery life is important key in IoT applications

Each and every IoT devices consuming power, energy and stored in the Battery. The battery lifetime is most important challenges of the energy efficiency of IoT devices over the network [24].

Several IoT applications rely on small, non-rechargeable batteries, so optimizing battery life is important for many reasons. The most clearest reason is that customers desire long operating life. In some cases, a long battery life may be essential to a project’s economic feasibility, and early failures of sensors and actuators may lead to extremely high alternate costs. [17]

To understand how IoT products consume battery power, manufacturers use various tools to execute battery drain analysis. The IoT devices, the current waveform are highly variable, with fast switching between operational modes in the tens or hundreds of milliamps and sleep modes measured in micro- or nano-amps. To meet this challenge, The battery life of IoT devices can be extended by a large factor is proper design techniques are implemented [17].

Battery Life of IoT Devices.

The battery life of an IoT device can be determined by a simple calculation using the battery life calculator and the battery capacity divided by the average rate of discharge. [18]

As batteries are regularly the largest part of an IoT sensor system, engineers frequently have a limited choice of which one to use. With a wide range of processors, communications technologies and software algorithms, and the system can be designed to achieve the required lifetime. [18]

Battery Life Calculator

The battery life calculator allows, we have to enter the following parameters for our processor, communications device, sensor and battery capacity, dischargerate, sleep time as well as software and hardware code executes and then estimates the battery life of IoT devices. [18]

V Calculating Battery Life in IoT and an analysis of Power consumption

Calculator for estimating a battery life in IoT. we have to enter the following input data in the form for calculating the battery life in IoT devices and applications. [23]

The following table 1 presented the battery capacity and discharge rate has been given and from this table calculation, we can find that the battery life hours and power consumption. From this table, if the battery capacity and discharge rate are increasing the battery life hours is also increased. [23]
The following graph shown in the Figure 2 which is increasing the battery lifetime in hours with relevant data on battery capacity, Discharge Rate, Software and hardware duration execution time. The estimated result of battery lifetime in hours shown in the graph 1[23].

![Graph](image)

Table 2: Sleep Time Run hours and Power consumption

The following graph shown in the Figure 3 which is increasing the battery lifetime in hours with constant battery power, Discharge Rate, and various ranges of sleep time and estimated power battery life.
in hours and power consumption average per hour.[23]

![Graph](image)

**Fig 3 : Sleep Time-Run Hours**

### VI Conclusion

It is concluded that the various IoT devices and Challenges, issues and an analysis of battery lifetime and power consumption in IoT Applications, and optimizing battery lifetime in IoT devices had been discussed. From the above result, we found that, if the battery capacity and discharge rate is increasing the battery life time hours is also increased. And also If the range of sleep time is increasing with constant battery capacity and discharge safety, the result of battery lifetime hours is also increased and obtained optimum power consumption. The Minimizing the energy used by the IoT devices or increasing the battery power will increase the lifetime of the battery and reduce the total cost of the IoT product.

### Reference


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