Challenges, Issuesof Energy Efficiency in IoT devices and an analysis of batterylife power consumption in IoT devices and Applications.

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Abstract

Internet of Thing 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 biggestchallenges 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 in 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

Thename Internet of Things was coined in 1999 by British technologist Kevin Ashton.[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. [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.[11]. The Internet of Things (IoT) expands the common concepts of anytime and anyplace to the connectivity for anything.[19] it has developed due to the merging of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. [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 impacts the requirement for renewable energy and energy consumption efficiencies. In this paper, wediscuss 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 consumptionand VI gives the conclusion.

II. Review of Literature

Perković, Toni et al.,[1] Thispaper 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 IoTEnvironment. 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 ThingsIoT device is a part of hardware with a sensor that transmits data

from one position to another over the Internet. 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 includedand 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 includesSmart 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 offersvarious 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].

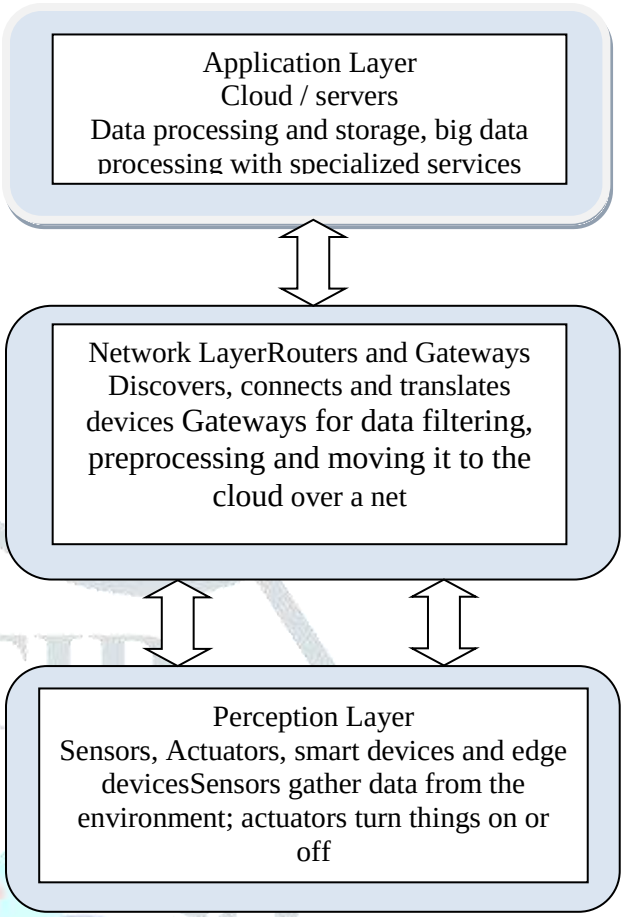

Fig 1: Overview of Architecture

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.IoTsystems require power supply design to be integrated with the system design in order to maintain high efficiency[11].

Optimize battery life in IoT devices

The Internet of Things (IoT) continues its fastdevelopment, IoT devices and Applicationareas such as smart environment,Organizations that make the correctchoice 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

Eachand 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 mostclearest 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 howIoTproducts 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 frequentlyhave 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 IoTand an analysis of Power consumption

Calculatorfor estimating a battery life in IoT. we have to enter the following input data in the form for calculating the battery life in IoTdevices 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]

Table 1 : Battery Capacity and Discharge Rate

Software		
Duration of code execution - 2 Sec		
Sleep time - 5 Sec		
Hardware		
Consumption during code execution - 10 mA		
Consumption in sleep mode* - 5 mA		
BATTERY CAPACITY	DISCHARGE RATE	LIFE HOURS
100	10	14
200	20	24
300	30	32
400	40	37
500	50	38

The following graphshown 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]

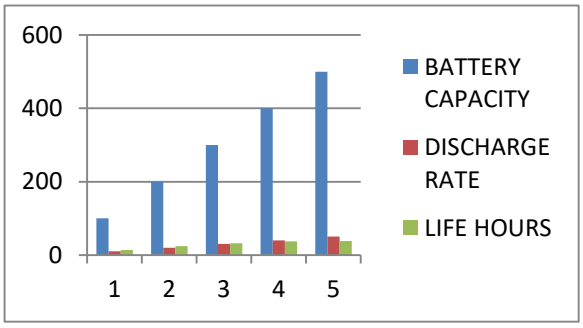

Fig 2 : Battery Life in Hours

The following Table 2 given the different range of sleep time with constant battery capacity and discharge rate. From this table calculation we can find that the battery life hours and power consumption. If the range of sleep time is increasing with constant battery power and discharge the result of battery life hours is also increased and obtained optimum power consumption.

The result of power consumption can be calculated from this table with the various ranges of sleep time and constant battery power and discharge safety. The result estimated that average power consumption per hour varying from 1.67mAh to 0.21 mAh.[23].

Software				
Duration of code execution - 2 Sec				
Sleep time – From 10 Sec to 100 Sec				
Hardware				
Consumption during code execution - 10 Ma				
Consumption in sleep mode* - 10 microA				
Battery Capacity	Discharge	Sleep Time	Run Hours	Power Consumption
100	10	10	53	1.67
100	10	20	98	0.92
100	10	30	141	0.63
100	10	40	185	0.49
100	10	50	228	0.39
100	10	60	270	0.33
100	10	70	313	0.2
100	10	80	354	0.25
100	10	90	396	0.23
100	10	100	437	0.21

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]

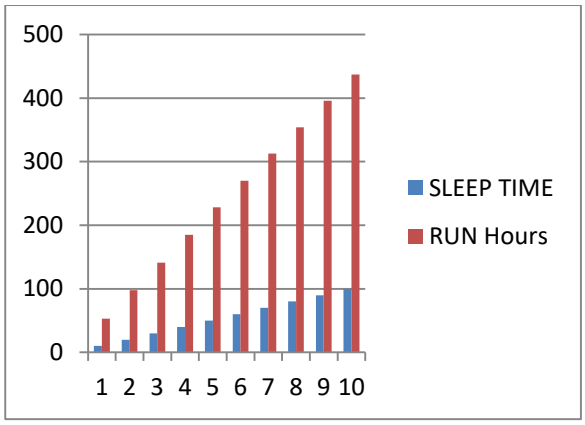

Fig 3 : Sleep Time-Run Hours

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 IoTproduct.

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