Big Data Collection: Analysis and Processing of Efficient IoT Based Sensor

Shruthi BM[1], Pruthvi PR[2], Parashivamurthy BM[3], Priyanka KR[4]
[1,2,3,4]*Assistant.Professor, Dept of CSE, GSSS Institute of Engineering and Technology for Women, Mysuru*

***Abstract-* Internet of Things (IoT) provides to everyone new types of services in order to improve everyday life. Through this new technology, other recently developed technologies such as Big Data, Cloud Computing, and Monitoring could take part. In this work, we survey the four aforementioned technologies in order to find out their common operations, and combine their functionality, in order to have beneficial scenarios of their use. Despite the boarder concept of a smart city, we will try to investigate new systems for collecting and managing sensors' data in a smart building which operates in IoT environment. As a bases technology for the proposed sensor management system, a cloud server would be used, collecting the data that produced from each sensor in the smart building. These data are easy to be managed and controlled from distance, by a remote (mobile) device operating on a network set up in IoT technology. As a result, the proposed solutions for collecting and managing sensors' data in a smart building could lead us in an energy efficient smart building, and thus in a Green Smart Building**

I. INTRODUCTION

In recent years, with the significant advances in computer and communication technologies, which are new big leaps in the digital world, a term called ''Internet of Things'' (IoT) made its' appearance. IoT is a sector that is rising really fast. After all, many consider a technological review, because by interpreting IoT, it changes the everyday life of people. It changes the way of moving, working, transforming even entire cities. Everything becomes smarter since the devices communicate with each other, carry out work independently, and display measurements and results. Another term used to describe the large amounts of data produced by all these inter-connected devices is called ''Big Data'' (BD). The most common type of BD is the IoT-Big Data. It can also be said that IoT and BD are interdependent technologies and should be developed jointly.

In the cloud environment, the management and analysis of data transmitted takes place. This new technology called "Cloud Computing" (CC) or just "Cloud" provides better storage capacity, low-cost, scalability, flexibility, efficiency, durability, and reliability we address a subset of IoT, namely ''Wireless Sensor Networks'' (WSNs). They usually consist of small sensing devices, with few resources, which are wirelessly connected
to each other. These devices are also referred to as Wireless Network Nodes (or Motes in the Contiki Operating System) and can communicate with each other and with the Internet.

They are sensory because they can collect information from their environment through their specific sensors, which they then process and transmit to the Internet. It is worth noting that the WSN nodes can move by taking measurements from different points continuously. They are also smart enough to deal with faults on the network. Together with their other advantages, they are easy to install and use. Conversely, one of the major drawbacks is the limitation of power consumption by the nodes which are usually battery operated. All these technologies described above can be converged in entire systems to support and implement efficient solutions for Smart Cities. Some of these solutions are the reduced cost and the more comfortable, safer, and friendlier environment. A Smart City consists of many components such as Smart Grid, Smart Buildings, Smart Citizens, Smart Security, Smart Infrastructure, Smart Technology, and many others.

2. RELATED WORK

For the purpose of this paper we study and analyze previous literature which has been published in the field of Sensor Data Collection & Management in Smart Buildings. The following paragraphs present the papers which contributed significantly in our study.

Previously they have proposed a framework for IoT environments that is based on localized data processing and decision making. Efficient management is provided by this framework for the local sensor network. The proposed master unit makes a collection of data from the network of the installed sensors which were located in various places within and around the house and intelligently identifies the dependencies among them. Furthermore, with the aim to extract knowledge locally, the sensors are turned in real time in order to minimize the redundancy in usage and power consumption.

Also there is an assessment of the opportunities along with the criticism for a fully IoT enabled and controllable intelligent building against the well-established and legacy automation systems in a fair and transparent approach.

In order to take measurements about the temperature, the humidity, and the light in a building, the authors inpresent an IoT-based sensing and monitoring platform which is wirelessly connected. Also, in there is a development of an Android application through which data is transferred from Laboratory Virtual Instrument Engineering Workbench (LabVIEW), which is a platform and a development environment, to a smart mobile device through which data are monitored remotely.

The authors present the design and implementation details of an Artificial Intelligent based smart building automation controller (AIBSBAC). This design has the capability to perform intelligently adaptive to user-preferences, which are focused on improved user comfort, safety and enhanced energy performance.

We can observe that most of the relative work papers are involving and trying to improve issues related to Quality of Services (QoS). In addition to this, most of the previous works deal with the Efficiency and propose both Indoor and Outdoor Surveillance Environment. Moreover, from the other hand, only one paper deals with the Security issue, and two of them deal with the Transmission Speed issue

3. PROPOSED WORK

Concerning the related work and the comparative analysis, we designed and simulated a topology-architecture system for a smart building, in order to offer energy efficient solution by using the collected and managed sensors' data. Based on Fig. 1, we implemented a system that includes sensors that took measures for temperature, movement, light and moisture with the aim to achieve a better management of the building and also to make the building "smart" and efficient. As we can observe by Fig. 1, in the low level of the building, there will be a Cloud server that would help to building's management and store the valid information from sensors.

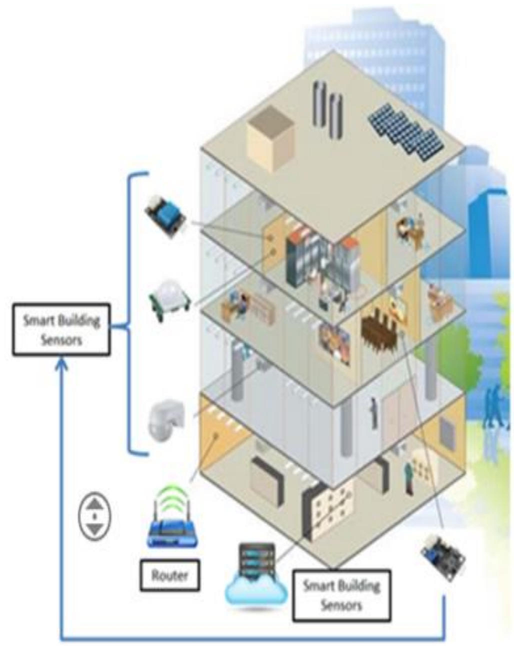

Fig 1. Smart Building Components

More specifically, in Fig. 2 we can see the communication between the various sensors that can be installed in the building and the Cloud Server with the users. The users would have remote access to sensors' data, and also they could manage the information of the data in order to be able to make some actions. For example, through the remote access a user could receive a signal that there is a high temperature with the aim to activate the air conditioning before going home. Additionally, using the analyzed, from the cloud server, measurements which were recorded by the motion sensor, the user will be able to understand if there is someone in the house, which can offer "security" sense.

Fig 2. Smart Building Connection

Fig. 3, demonstrates the architecture of the proposed system, and the logic of communication between the user, the sensors, and the whole smart building. The topology of the network would be hybrid, relaying on star and mesh topologies. This could offer a reliable network, easy to be managed in error detecting and troubleshooting.

Fig 2. Proposed Architecture

The mesh topology which already is and will be more popular in the future provides many benefits. One of these benefits is the tolerance that it has in errors. The star topology, which is widely used in home networks, provides also fault tolerance but

since the middle connection point is working properly. Also, the installed Cloud Server would operate autonomously by using a voltage stabilizer (UPS) to avoid any problem. All the users could easily connect to the network through the Wi-Fi connection of the building and remotely through their mobile providers.

The installed network will support the communication protocol IPv6 and a Network Adaptive Multisensory Real-time Transmission Protocol (NAMRTP) proposed in previous work. This protocol can transmit from the remote environment to the database real-time multisensory data in a reliable way.

4. SIMULATION USING CONTIKI OS

In this section, it is described an operating system investigated by A.Dunkeland which is called Contiki. In Fig. 4 is presented the proposed simulation using the Contiki Operating System (OS) and its applications to simulate the network and extract from the network nodes measurements for the data collected and transmitted. Also, these data can be stored in specific files for analysis at future time. The Contiki OS is open source and was designed for small and smart devices which are not expensive and provide low power consumption. Also, it is used for the collection of the large amount of data. Furthermore, we used Contiki Simulator instead of the lack of hardware resources. Forth simulation of our networking real-time we use the Cooja emulator.

Fig 4. Simulating in Cooja Emulator

The new simulation is shown in Fig. 4 above, where there are several windows. The one on the left-up corner is the ''Network'' window where we can see our network topology. From this window we can also access every node in our network so that we can configure it or take measurement for it. The second window is the ''Simulation Control'' window from where we can ''start'', ''pause'', make a ''step'' forward, and ''reload'' the simulation. The window on the top-right corner is where we can take notes, and that is why named ''Notes'' window. The window in the middle called ''Mote output'' is where are printed for each node all outputs of serial ports. The last window observed when we create a New Simulation, is the ''Timeline'' window. Since we have built our IPv6 over Low-power Personal Area Network (6LoWPAN) shown in Fig. 4 above, we can use more tools such as the Radio Messages tool from the menu Tools.In the "Radio messages" window, we choose the "6LoWPAN Analyzer with PCAP''from the menu Analyzer. With that choice we made and after we start the simulation, the network traffic (data packets) is saved in a PCAP file for future analysis. Another useful tool is the Power Tracker which can be found in the menu Tools with the name "Mote radio duty cycle". With this tool we can calculate the percentage of power used by every node in the network separately, and the average power used by all nodes.

5. EXPERIMENTAL RESULTS

Now our simulation is ready to start, and aping can be executed in a new terminal for any address which belongs to a node in the network. The results are presented in Fig. 5, where from the "ttl" and the "time (ms)" the hops of each node from the router are noticeable. More accurately, the border router has ttl = 64, the node which is one hop away has ttl=63, the node which is two hops away has ttl=62, and soon.That can be observed in the next Fig.5. The same is observed with the transmission time which is lower at the nearest to the router hops.

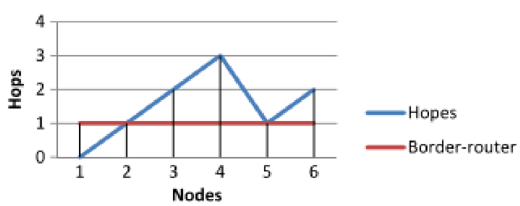

Fig 5. Hops per node from the Border Router

With the ping that was executed are also provided information about the duration of transmission and the packet loss which is described by the following Eq.(1):

$$TDS=TDR+PL \quad (1)$$

where TDS ,TDR and PL represent the data sent, the total data received, and the packet loss respectively. As we already said, information are provided about the protocols used for the communication between the nodes, for example, the IEEE 802.15.4, the IPv6, the 6LoWPAN, the Constrained Application Protocol (CoAP). Moreover, by opening a browser (e.g. Firefox) and typing the IPv6 address of the border router, it prints as output the neighbors and the routes. By typing the IPv6 address of any other node, there are printed the temperature and the light.The temperature shown in Fig.6 is same and stable for all nodes. This could be described by the following Eq(2):

$$TT = T1=T2=T3=T4=T5=T6 \quad (2)$$

where TT is the Total Temperature and T1 to T6 are the temperatures of nodes 1 to 6.

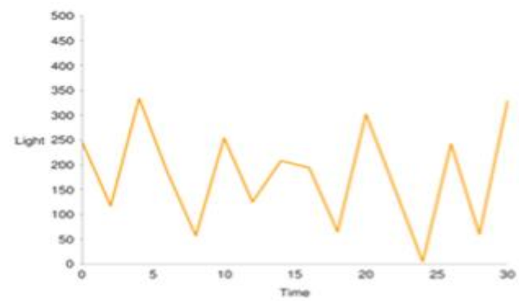

Fig 7. Light in Node 2

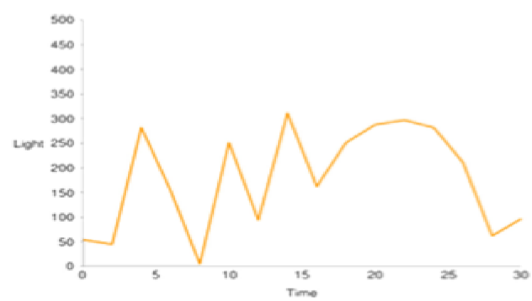

Fig 8. Light in Node 3

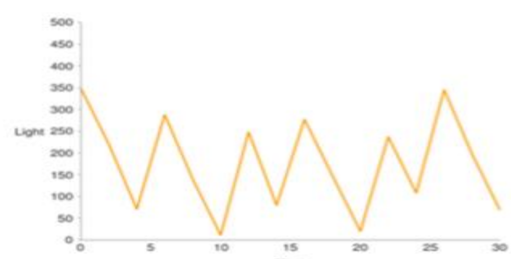

Fig 9. Light in Node

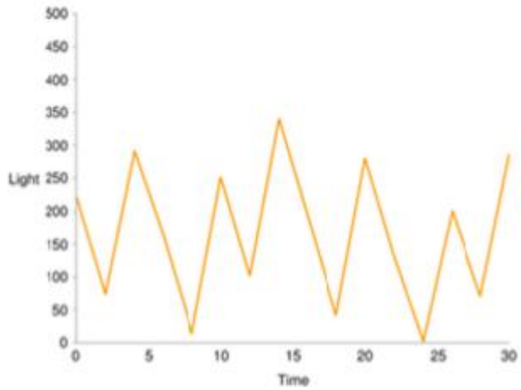

Fig 10. Light in Node 5

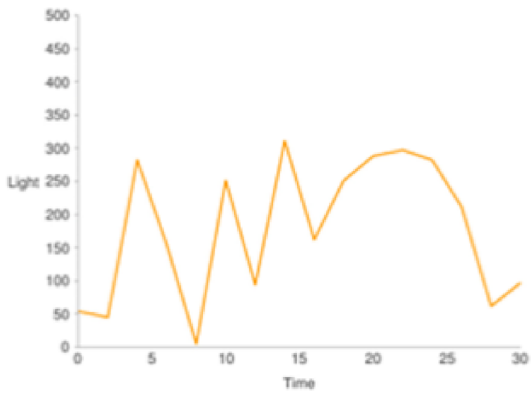

Fig 11. Light in Node 6

After we stop the simulation, we can open Wire shark and then, open the ".pcap" file created. As we already said, this file contains all packets transmitted. So, using Wire shark, we can observe, various information about the communications. With our proposed system we can achieve energy efficiency with the use of the collected and managed sensors data. In contrast with the previous works, we implemented a system that includes sensors that took measures for temperature, movement, light and moisture with the aim to achieve a better management of the building and also to make the building "smart" and efficient. In our proposed system the users would have remote access to sensors' data, and also they could manage the information of the data in order to be able to make some actions. Furthermore, with the use of the analyzed data, measurements which were recorded by the motion sensor, the user will be able to understand if there is someone in the house, which can offer "security" sense.

6. CONCLUSION

New and better solutions for making Smart Cities more efficient implanted and presented by the technologies surveyed in this work. Cost reduction, safer environment, comfortable and friendly applications could be achieved through a system which can exploit all the abilities of the technologies we studied. With multiple sensors installed in a Smart Building we can achieve a better monitoring system of the whole building. The proposed systems implemented in a simulation environment of Cooja Contiki. This paper surveyed Internet of Things, Cloud Computing, Big Data and Sensors technologies with the aim to find their common operations and combine them. Moreover, regarding smart city concept, we tried to propose new methods in order to collect and manage sensors' data in a smart building, which operates in IoT environment. Finally, the proposed solutions for collecting and managing sensors data in a smart building could lead us in energy efficient smart building, and thus in a Green Smart Building. In future research, we recommend that the use of the Internet of Things is blended with the technology of Monitoring, despite the use of sensors, with the aim to achieve optimum results in its use, under a Cloud environment. Additionally, we would further examine the methods and the solutions for collecting and managing sensors data in a smart building with the aim to make a beneficial use of the network of the building. Moreover, we have already. started to implement the proposed system with the use of an Arduino Board and compatible sensors in our university campus. Also, this could lead us in reducing the energy, and thus the cost of the energy that used in the building. This can be the field of future research.

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