Sleep Apnea Detection By Integrating IoT

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Abstract- *Obtrusive sleep apnea (OSA) is one of the censorious sleep disorders because it has an immediate impact on the quality of life. It has several side effects. So, there is a crucial requisite of real-time detection in healthcares. There are several systems for OSA detection. Nevertheless, even with the encouraging results that this system provide provides, this do not act upon all the treatment. On the basis of the argumentation, this scrutiny confer an ingenious system for both to recognize and reinforce of treatment of OSA of aged people by analysing numerous factors such as sleep habitat, sleep status, physical movements, and physiological framework, in addition the utilization of open data accessible in smart cities. Our system architecture performs two styles of processing. On the one hand, a pre-processing based on ethics that ensures the sending of real-time updates to answerable for the care of elderly, in the circumstances of an exigency state. This pre-processing is substantially established on a fog computing approach carried out in a smart device operating at the edge of the network that furthermore provides progressive interoperability assistances: technical, syntactic, and semantic. Firstly, a batch data processing that facilitate a definitive inquiry that analytically details the conduct of the data and a predictive inquiry for the advancement of assistance, such as envisioning the minimum contaminated ground to execute rustic activities. This mechanism adopts big data apparatus on cloud computing. Elseways, a batch data processing that permit a descriptive analysis that statistically details the behaviour of the data and a predictive analysis for the development of services, such as predicting the minimum contaminated sites to carry out outdoor activities*

Keywords- Internet-of-Things, big data, interoperability, sleep monitoring, health monitoring, open data, fog computing, cloud computing.

I. INTRODUCTION

Throughout the decades, we earthlings experience modifications in our body-system and in our livelihood. One of these modification is the variation of sleep that take place with age. Particularly, obstructive sleep apnea syndrome (OSA) is one of the most customary and menacing respiratory disorders that happens during sleep. OSA includes the barrier occlusion of the upper respiratory tract for minimum of 10 seconds and that averts actual oxygenation of the blood, even over 2030timesan hour of sleep. Taking the fact into account, number of interruptions per hour and by utilizing the apnea-hypopnea index (AHI), OSA can be grouped into 3 categories from higher to lower extremity; if these interruptions happen betwixt 5 and 15 times per hour, call‘‘mild’’, if these interruptions happen betwixt 15 and 30 times per hour, call ‘‘moderate’, and if these respiratory interruptions happen more than 30 times per hour, call ‘‘severe’’. In this context, an architecture of an OSA detection system based on the Internet of Things (IoT) and Big Data is offered. The three-layered architecture unifies Fog and Cloud Computing abilities to bear both detection and therapy of sleep apneadis order by creation of several facility consisting information visualization, data analysis, remote monitoring and real-time alert notifications. The suggested arrangement visualizes assisting health professionals in medical conclusion making.

II. LITERATURE SURVEY

Zhu et al. suggested a mechanized arrangement for the long term observing of the standard of sleep of the aged people in a particular surrounding. The system utilizes a piezoelectric transducer kept under a pallet to calculate the respiration, heart rate and the parameters of the body movement of elderly at the time of sleep. The gathered figures is passed on to database servers through the Internet. Likewise, a non-intrusive arrangement for assessing sleep standard was suggested by Nam et al. The system was furnished with multimodal sensors, which consisted a pressure sensor and a three axis accelerometer. Multimodal sensors detect several physiological framework, such as the body activity, the heart rate, and the respiratory rate, as well as the stance of elderly during sleep. The information gathered from the system is conveyed over a wireless network of sensors build on ZigBee technology to a manageable and transportable recording device and to a personal computer.

III. SYSTEM ARCHITECTURE

The IoT layer acquires and accumulates the data from numerous heterogeneous origin and transmits them to the fog layer. Fog layer issues the basic operations to offer consistent interoperability and connectivity between the distinct heterogeneous devices involved in the arrangement. This layer is also accountable for the pre-processing of the sensor data required for monitoring possible unfavourable occurrences for elderly relating to OSA and to retaliate in real-time by dispatching alerts to those accountable for the healthcare of the old adults so that they can undergo immediate assistance. The information from the fog layer is collected, processed, and examined at the cloud layer using generic enablers supplied by IoT platforms and algorithms constructed on Big Data, so that one may explore new knowledge and thus, assist medical decision-making. Ultimately, the outcomes of the processing can be envisioned in a web application through a graphical user interface (GUI), which transforms the inspected data into rich context to lead the treatment of the OSA.

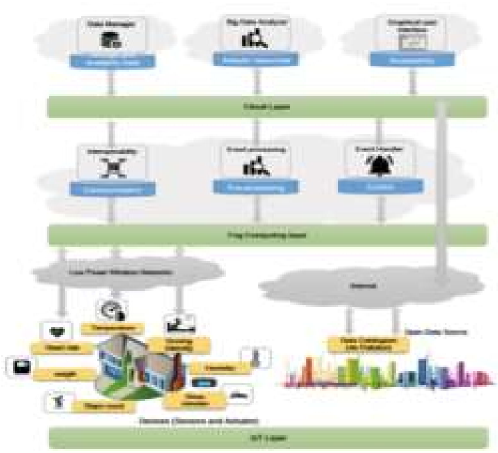

Fig:1 System Architecture

IoT Layer

The IoT layer is the base of the whole system since it obtains information from numerous heterogeneous origins through numerous wireless networks. IoT nodes present in the old person's residence, mobile devices kept by the elderly and open data from smart cities. The IoT nodes and mobile devices are composed of sensors that calculate multiple specification such as the sleep habitat, the sleep conditions, physical movements, and physiological criterion. In addition, the IoT layer uses criterion related to air pollution which are obtainable in the open data archieve of smart cities, taking competitive advantage over preceding works, that targets completely on physiological criterion monitoring. All the criteria have been tabbed because they have a explicit accord with the OSA and/or a high effect on the development of the treatment of this ailment, and they influence the QoL of the elderly. Additionally, wireless networks allow for the transference of information to the fog layer through low power wireless automation.

Fog Layer

The fog layer authorizes interoperability of the heterogeneous origins of the information and the pre-processing and knowledge production of them by a fog computing perspective.

In fog computing, a set of edge gizmos are positioned in betwixt the sensing tools and the cloud in so that one may enhance the cloud assets to the edge of the network with the goal of attaining upgraded execution by processing capabilities, storage, networking, and so on, close to the end devices. In this context, the fog layer includes a Smart IoT Gateway where IoT protocols, notifications, data pre-processing services and control are consolidated. The fog layer consists of the following main modules: Wireless communication and interoperability, an event handler and an event processor as shown in Fig. 2.

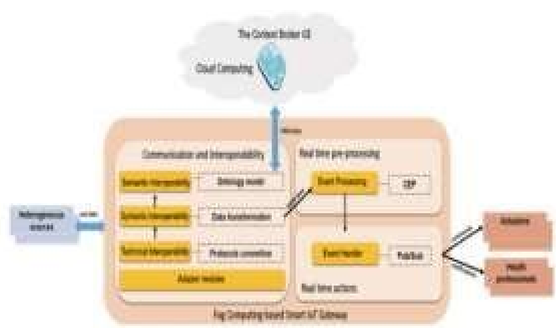

Figure 2:Fog Layer Architecture

Cloud Layer

Cloud computing is presently the favoured model to tackle computation-intensive data process, analysis tasks and large storage, because of its scaling and maturity potential, as they permit operations to grow and shrink in-line without down-grading, which enormously eases the trouble of smart devices. This layer is accountable for adequately analysing, storing, and managing all the information gathered by the system. With the context that the system is critically associated to the health standard of old age persons, the accessibility and inquiry of the data are crucial to assist medical decision-making. This layer consists of the following functional modules: Big Data analyzer, web application and data manager.

Data Manager

Data Manage acts as a central repository and is accountable for administering and supplying permit to data appearing from the fog layer. The Data Manager is supplied by Firewire Platform known as the GE Context Broker Orion. Interfaces that permits the updation, elimination and registration of these bodies, additionally for the regaining of context data to any legitimate party in consuming this information through Subscription executions as shown in Fig. In the arrangement, the Big Data analyser subscribes to the Data Manager to attain the online information.

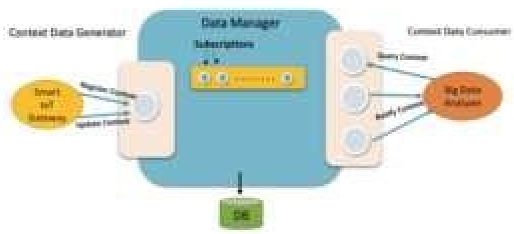

Figure 3: Data Manager

Big Data Analyser

It is able to operate and examine the information receiving from the fog layer. The analyser performs four modules:machine learning,batch processing,data integration and services.

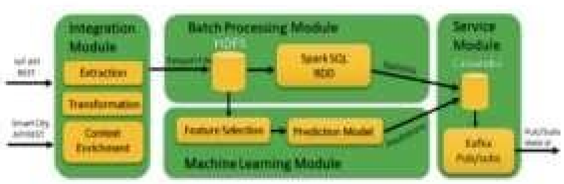

Figure 4: Big Data Analyser

The machine learning module utilizes the information contained in the batch processing module through pre-processing and prediction effort in order to supply a prediction service for the places with less pollution

The batch processing module supplies storage and the processing of the information which were unified in the integration module

The data integration module permits for the data combination, Which are received from the fog layer and the city open data

The service module provides interim data storage for both the descriptive examining and the predictions made.
Also a publish/subscribe mechanism for access to this data by the applications

IV. TESTED IMPLEMENTATION

In order to assess the performance of the suggested arrangement, firstly we detail the application of each component used in the layers of system architecture

Mobile App

It is build for the Android operating system includes numerous classes made using android studio; the physical activity class is used to administer the weight and step count reviews, the sleep class is used to administer the minutes of sleep and heart rate reviews, and the local database is used to store interim data in the phone. The android application analyses the minutes of the sleep/wake condition and number of steps, heart rate records and also takes weight readings of a wristband Garmin Vivoactive 3, a Heart Rate Monitor Arduino 101 and a BM Series Medical Precision Body Weight Scale, respectively. These wearable gizmos are wirelessly connected to a smartphone through Bluetooth.

Smart IoT Gateways

The smart IoT gateway preliminary version has been achieved using a Raspberry Pi 3 model B as equipped with a 1.2 GHz Quad-Core ARM Cortex processor, 1 GB of RAM and which is perpetually attached to an electrical power supply and located in the elderly's residence. The Raspberry utilizes numerous communication modules to permit the interoperability of heterogeneous tools operating with different wireless communication technologies. For instance, the gateway unifies a 6LowPAN module arranged as an edge router to collect the data from the temperature and humidity sensor HTS221, which is unified on the IKS01A1 STM32 board. Furthermore, a tunnelling virtual network adapter is constructed on the edge router to move IPv6 packages to IPV4 and vice versa by utilizing the tunslip6 tool running on the Contiki operating system.

Servers

Three types of server that provide different operations were executed using virtualization technologies operating on a private server. The server includes these hardware features: a FUJITSU server with an Intel Xeon E3-1220 v5, 3.00 GHz CPU with 64 GB of memory. The server is administered by the vSphere platform, which permits for the formation of virtual machines. The virtual machines were grouped for each functional module of the cloud layer, utilizing the server shared physical holdings.

V. CONCLUSION

QoL(Quality of Life) has turn into a need in community that will continue to be even more crucial if we acknowledge that in the future the number of elderly people will constitute more than 14% of the world's population. OSA is among the most adverse diseases that most compromises the QoL of the adults who go through it and causes important complexities that can adversely affect their health. The continuous analysing and the operation of multiple criteria related to OSA will lead to the notifying of health professionals, emergency centres, and relatives at the right time so as to be helped on time, so that one may improve their QoL, and even retain their lives. Cutting-edge technologies such as IoT and Big Data have been developed to make intelligent and universal systems focused on the healthcare of elderly and on medical care. IoT can be used as appliance to support the detection and control within a health ecosystem, whereas data analysis technologies can be utilized to do decision-making. A system build on a 3-level architecture for holding up real-time monitoring of OSA in adults and leading their medication has been suggested and performed. The system is executed using heterogeneous and nonintrusive tools,low-power technologies, big data technologies, components of standard platforms, IoT protocols, and fog and Cloud computing approaches

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