IoT Driven Healthcare System For Remote Monitoring of Patients

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Abstract- *Among the panoply of applications enabled by the Internet of Things (IoT), smart and connected health care is a particularly important one. Networked sensors, either worn on the body or embedded in our living environments, make possible the gathering of rich information indicative of our physical and mental health. Captured on a continual basis, aggregated, and effectively mined, such information can bring about a positive transformative change in the health care landscape. In particular, the availability of data at hitherto unimagined scales and temporal longitudes coupled with a new generation of intelligent processing algorithms can: (a) facilitate an evolution in the practice of medicine, from the current post facto diagnose-and treat reactive paradigm, to a proactive framework for prognosis of diseases at an incipient stage, coupled with prevention, cure, and overall management of health instead of disease, (b) enable personalization of treatment and management options targeted particularly to the specific circumstances and needs of the individual, and (c) help reduce the cost of health care while simultaneously improving outcomes.*

Keywords- remote health monitoring; IoT; visualization; analytics

I. INTRODUCTION

Recent years have seen a rising interest in wearable sensors and nowadays many devices area unit commercially accessible for private health care, fitness, and activity awareness. additionally to the niche recreational fitness arena catered to by current devices, researchers have conjointly thought of applications of such technologies in clinical applications in remote health watching systems for future recording, management and clinical access to patient's physiological data. supported current technological trends, one will pronto imagine a time within the close to future once your routine physical examination is preceded by a two–three day amount of continuous physiological watching victimization cheap wearable sensors.

Over this interval, the sensors would ceaselessly record signals related to together with your|along with your} key physiological parameters and relay the ensuing information to a information coupled with your health records. once you show up for your physical examination, the doctor has accessible not solely typical clinic/lab-test based mostly static measurements of your physiological and metabolic state, however conjointly the a lot of richer longitudinal record provided by the sensors. victimization the accessible information, and assisted by call support systems that even have access to an oversized corpus of observation information for alternative people, the doctor will build a way higher prognosis for your health and advocate treatment, early intervention, and life-style selections that area unit significantly effective in up the standard of your health. Such a unquiet technology may have a transformative impact on international tending systems and drastically cut back tending prices and improve speed and accuracy for diagnoses.

II. BACKGROUND

Most proposed frameworks for remote health monitoring Most planned frameworks for remote health watching leverage a 3 tier architecture: a Wireless Body space Network (WBAN) consisting of wearable sensors because the information acquisition unit, communication and networking and therefore the service layer. As an example proposes a system that recruits wearable sensors to live varied physiological parameters like force per unit area and vital sign.

Sensors transmit the gathered data to an entree server through a Bluetooth affiliation. The entree server turns the information into AN Observation and measure file and stores it on a foreign server for later retrieval by clinicians through the net. Utilizing an analogous cloud based mostly medical information storage, a health watching system is bestowed within which medical workers will access the hold on information on-line through content service application. Targeting a particular medical application, WANDA A finish to finish remote health watching and analytics system is bestowed for oversight of patients with high risk of failure.

In addition to the technology for information gathering, storage and access, medical information analysis and image area unit vital elements of remote health watching systems. Correct diagnoses and watching of patient's medical condition depends on analysis of medical records containing varied physiological characteristics over a protracted amount of your time. Addressing information of high spatiality in each time and amount makes information analysis task quite frustrating and error prone for clinicians. Though the employment of knowledge mining and image techniques had antecedently been addressed as an answer to the same challenge, these strategies have solely recently gained attention in remote health watching systems.

While the arrival of electronic remote health watching systems has secure to revolutionize the traditional health care strategies, group action the IoT paradigm into these systems will additional increase intelligence, flexibility and ability. a tool utilizing the IoT theme is unambiguously addressed and distinctive at anytime and anyplace through the net. IoT based mostly devices in remote health watching systems don't seem to be solely capable of the traditional sensing tasks however can even exchange data with one another, mechanically connect with and exchange data with health institutes through the net, considerably simplifying came upon and administration tasks. As exemplified in, such systems area unit able to give services like automatic alarm to the closest tending institute within the event of a vital accident for a supervised patient.

III. SYSTEM ARCHITECTURE

Data Acquisition is performed by multiple wearable sensors that live physiological biomarkers, like ECG, skin temperature, rate, EMG muscle activity, and gait (posture). The sensors connect with the network although AN intermediate information someone or concentrator, that is usually a sensible phone set within the section of the patient.
The Data Transmission elements of the system area unit to blame for conveyance recordings of the patient from the patient's house (or any remote location) to the information center of the tending Organization (HCO) with assured security and privacy, ideally in close to period of time. Typically, the sensory acquisition platform is supplied with a brief vary radio like Zigbee or low-power Bluetooth, that it uses to transfer device information to the concentrator. Aggregate information is additional relayed to a HCO for future storage victimization web property on the concentrator, generally via a smartphone's wireless fidelity or cellular information affiliation. Sensors within the information acquisition half type a web of Things (IoT)-based design as every individual sensor's information are often accessed through the net via the concentrator.

Often a storage/processing device in vicinity of a mobile client, sometimes referred to as a cloudlet, is used to augment its storage/processing capability whenever the local mobile resources do not fulfill the application's requirements.

The cloudlet can be a local processing unit (such as a desktop computer) which is directly accessible by the concentrator through WiFi network. In addition to providing temporary storage prior to communication of data to the cloud, the cloudlet can also be used for running time critical tasks on the patient's aggregated data. Moreover, the cloudlet can be used to transmit the aggregated data to the cloud in case of limitations on the mobile device such as temporary lack of connectivity or energy.

Cloud Processing has three distinct components: storage, analytics, and visualization. The system is designed for long term storage of patient's biomedical information as well assisting health professionals with diagnostic information. Cloud based medical data storage and the upfront challenges have been extensively addressed in the literature. *Analytics* that use the sensor data along with e-Health records that are becoming prevalent can help with diagnoses and prognoses for a number of health conditions and diseases. Additionally, *Visualization* is a key requirement for any such system because it is impractical to ask physicians to pore over the voluminous data or analyses from wearable sensors. Visualization methods that make the data and analyses accessible to them in a readily digestible format are essential if the wearable sensors are to impact clinical practice.

IV. DATA ACQUISITION AND SENSING

Physiological data is acquired by wearable devices thatcombine miniature sensors capable of measuring various physiological parameters, minor preprocessing hardware and a communications platform for transmitting the measured data. The level of applicability of these biomarkers to diagnosing four common disease categories is also indicated in the table.
The wear ability requirement, poses physical limitations on the design of the sensors. The sensors must be light, small, and should not hinder a patient's movements and mobility. Also, because they need to operate on small batteries included in the wearable package, they need to be energy efficient. Though the battery may be rechargeable or replaceable, for convenience and to ensure that data is not lost during recharging or battery replacement periods, it is highly desirable that they provide extended durations of continuous operation without requiring charging or replacement.

The low energy operation requirement can also pose a challenge for the quality of the data captured in terms of the achievable signal to noise ratio. Recent designs, of flexible sensors that can be placed in contact with the skin in different body parts are particularly attractive for medical applications because, compared to alternatives, the close contact with the skin allows measurement of more physiological parameters and with greater accuracy. There have also been efforts to prolong the operational lifetime of wearable sensors by incorporating low power device and circuit level techniques and energy harvesting methods.Moreover, utilizing intelligent sensing methods on system levelcan further increase the operational longevity.

Energy efficient sensing mechanisms have been studied in the related context of wireless sensor networks (WSNs) that are used to sense physical phenomenon in a distributed fashion.

Although the sensor deployment in our health monitoring system is more concentrated compared to WSNs, existing methods for WSNs can be revisited to suit our needs. The proposed energy efficient sensing approaches revolve around assigning sensing tasks to the nodes based on their relative distance so as to sense the maximum amount of physical information while minimizing the energy consumption by removing possible redundant sensing tasks andby allocation of tasks based on the energy availability at each sensor. Similar mechanisms can be applied to our system by defining and using a dynamic context that is based on energy availability and the health condition of the patient. For example, as indicated in Table I, individually sensed biomarkers have different levels of applicability for specific health conditions. When energy is severely limited and the vulnerable condition of the patient mandates focus on a specific biomarker, the other sensors be powered off in order to extend the lifetime. AnIoT based sensing architecture facilitates the implementation of such schemes for improving energy efficiency adaptively by allowing dynamic utilization of sensors based on the context. In conventional data acquisition systems where sensors passively transmit the gathered information, such intelligence and flexibility may not be achievable.

Also by offloading the decision making process for sensing task assignment to the cloud, more sophisticated algorithms can be applied without requiring manual intervention by the patient to manipulate the sensors or the software on the data concentrator.

Energy limitation of these devices necessitates the use of suitable low power communication protocols, as the communication can account a significant part of the power consumption in sensing devices.

Bluetooth low energy (BLE) is another wireless communication protocol suitable for low power short range communication suitable for the unique requirements of applications such as health monitoring, sports, and home entertainment.

The original Bluetooth protocol was designed to support relatively short range communication for applications of a streaming nature, such as audio. BLE modifies the framework by utilizing much longer sleep intervals to decrease the overall energy consumption. BLE achieves higher energy efficiency in terms of number of bytes sent per Joule of energy. When using the aforementioned communication protocols, an intermediate node (data concentrator) is necessary to make sensors data and control accessible through Internet. To further realize the IoT concept, IPv6 over Low Power Wireless Personal Area Networks (6LoWPAN) has been proposed to seamlessly connect energy constrained WPAN devices to the Internet.

V. CLOUD DATA STORAGE AND PROCESSING

Data aggregated by the concentrator needs to be transferred to the cloud for long term storage. Offloading data storage to the cloud offers benefits of scalability and accessibility on demand, both by patients and clinical institutions. Also, utilized with analytics and visualization (described in subsequent sections), cloud hosting and processing can reduce costs at HCOs and provide better diagnostic information. In this section, we outline such could architectures and discuss issues that impact long term medical data storage on the cloud.

a) Hybrid Cloud/Cloudlet Architecture: Cloudlet is a limited resource computing and storage platform that eliminates the need to outsource resource intensive tasks to the enterprise cloud. Cloudlet computing has been introduced as a potential solution to deliver low latency to time critical tasks for health monitoring applications via body area networks. Communication between concentrator and cloudlet is realized through WiFi interface. Direct connection between these two entities reduces data transfer latency for time critical tasks on aggregated data. LTE access provided in concentrator can in turn be used for direct data transfer from the concentrator to the cloud bypassing the cloudlet, while exposing the data to the latency imposed by mobile network.

b) Context-Aware Concentration via Smart Devices: As previously indicated, smart phones can at as concentrators in IoT infrastructure as today's smart phones can use both LTEand WiFi as the backhaul network. Data aggregation can be carried on either in cloudlet (thorough the WiFi connection between concentrator and the cloudlet) or the cloud (LTE). In studies, the former compared with the latter, has been shown to provide ten times the throughput and to require only a tenth of the access time, and half the power. Aggregated data, however, needs to be finally be stored in the cloud to allow distributed access and reliable storage. To effectively partition data aggregation tasks between cloud and cloudlet, context aware concentration may be utilized. Context can account for the current and expected status of the patient. For example, when the patient is in a critical condition requiring time critical monitoring of biosensor data, data concentration may be the preferred choice.

c) Privacy of the Data Concentrator: Although personally identifiable information can be removed before transmitting sensed data information, the system is still prone to aggregate disclosure attacks that can infer information via pattern recognition approaches. Context aware data concentration, while offering some benefits, may also make sensed information vulnerable to aggregate disclosure attacks by allowing intruder to infer a patient's health information through network traffic analysis from concentrator to mobile back haul. Standard encryption techniques can be employed to ensure security in such settings.

d) Secure Data Storage in the Cloud: Privacy is of tremendous importance when storing individual's electronic medical records on the cloud. According to the terms defined by Health Insurance Portability and Accountability Act (HIPAA), the confidential part of medical records has to be protected from disclosure. When the medical records are outsourcedto the cloud for storage, appropriate privacy preserving measures need to be taken to prevent unauthorized parties from accessing the information. Secure cloud storage frameworks have therefore been proposed for use with sensitive medical records. Secure medical data processing on the cloud remains a challenge.

VI. SUMMARY AND CONCLUDING REMARKS

In this paper, we reviewed the current state and projected future directions for integration of remote health monitoring technologies into the clinical practice of medicine. Wearable sensors, particularly those equipped with IoT intelligence, offer attractive options for enabling observation and recording of data in home and work environments, over much longer durations than are currently done at office and laboratory visits.

This treasure trove of data, when analyzed and presented to physicians in easy-to-assimilate visualizations has the potential for radically improving healthcare and reducing costs. We highlighted several of the challenges in sensing, analytics, and visualization that need to be addressed before systems can be designed for seamless integration into clinical practice.

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REFERENCES

[1] Jawbone Inc., "Jawbone fitness trackers," accessed April 2015. [Online].Available:https://jawbone.com/up/trackers

[2] FitBit Inc., "flex: Wireless activity + sleep wristband," accessed April 2015. [Online]. Available: https://www.fitbit.com/flex

[3] Apple Inc., "Apple watch," accessed April 2015. [Online]. Available: https://www.apple.com/watch/

[4] A. Pantelopoulos and N. Bourbakis, "A survey on wearable sensor-based systems for health monitoring and prognosis," *IEEE Trans. Sys., Man,and Cybernetics, Part C: Applic. and Reviews*, vol. 40, no. 1, pp. 1–12, Jan 2010.

[5] D. Son, J. Lee, S. Qiao, R. Ghaffari, J. Kim, J. E. Lee, C. S. Hwang, N. Lu, T. Hyeon, , and D.-H. Kim, "Multifunctional wearable devices for diagnosis and therapy of movement disorders,"*Nature Nanotechnology*, pp. 1–8, 2014.

[6] A. Page, O. Kocabas, T. Soyata, M. Aktas, and J.-P. Couderc, "Cloud- Based Privacy-Preserving Remote ECG Monitoring and Surveillance,"*Annals of Noninvasive Electrocardiology (ANEC)*, 2014. [Online]. Available: http://dx.doi.org/10.1111/anec.12204