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Study on Concept of Fog Computing Application in Healthcare Internet of Things on ECG Features Extraction

[1]Shahazad & [2]Dr. Awakash Mishra

[1]Research Scholar under the faculty of Computer Application at SSSUTMS, Sehore-MP. (India)
[2]Dean (Academic & Student Affairs) Bengal College of Engineering Durgapur-12, West Bengal (India)

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ABSTRACT

Fog computing offers a versatile and powerful answer for defeat the expanding preparing and networking requests of Internet of Thing (IoT) devices. Fog computing, likewise named edge computing, can address those issues by giving versatile assets and services to end clients at the edge of system, while cloud computing are increasingly about giving assets circulated in the core arrange.

In this paper, we upgrade such a wellbeing checking framework by abusing the idea of fog computing at smart gateways giving propelled strategies and services, for example, installed data mining, dispersed capacity, and notification benefit at the edge of system. Especially, we pick Electrocardiogram (ECG) highlight extraction a vital job in finding of numerous cardiovascular infections. ECG signals are analyzed in smart gateways with highlights removed including pulse, P wave and T wave by means of a flexible layout dependent on a lightweight wavelet change instrument.

1. Introduction

The Internet of things (IoT) will be the Internet of future, as we have seen an enormous increment in wearable innovation, smart grid, smart home/city, smart associated vehicles. International Data Corporation (IDC) has anticipated that in the time of 2015, "the IoT will keep on quickly grow the customary IT industry" up 14% from 2014. Since smart devices are typically deficient in calculation control, battery, stockpiling and bandwidth, IoT applications and services are normally sponsored up by solid server closes, which are for the most part sent in the cloud, since cloud computing is considered as a promising answer for convey services to end clients and give applications flexible assets at low cost.

Nonetheless, cloud computing can't tackle all issues because of its own downsides. Applications, for example, real time gaming, increased reality and real time gushing, are too latency sensitive to send on cloud. Since data centers of clouds are situated close to the core organize, those applications and services will endure unsatisfactory round-trip latency, when data are transmitted from/to end devices to/from the cloud data center through numerous gateways. Other than this, there are additionally issues unsolved in IoT applications that typically require portability bolster, geo-circulation and area mindfulness.

Fog Computing empowers another type of applications and services, and that there is a productive exchange between the Cloud and the Fog, especially with regards to data management and analytics. Fog Computing stretches out the Cloud Computing worldview to the edge of the system. While Fog and Cloud utilize similar assets (networking, figure, and capacity), and offer a significant number of similar instruments and traits (virtualization, multi-tenure) the augmentation is a non-trifling one in that there exist some key contrasts that originate from the Fog raison d'etre. The Fog vision was imagined to address applications and services that don't fit well the worldview of the Cloud. They include:

Applications that require low and unsurprising latency—the Cloud liberates the client from numerous execution subtleties, including the exact information of where the calculation or capacity happens. This opportunity from decision welcome as a rule turns into an obligation when latency is at premium (gaming, video conferencing).

Geo-conveyed applications (pipeline observing, sensor systems to screen the earth).

Fast mobile applications (smart associated vehicle, associated rail)

Large-scale dispersed control frameworks (smart grid, associated rail, smart traffic light frameworks).

An efficient IoT-empowered healthcare framework architecture which benifits from the idea of fog computing. Utilizing this architecture, we show the viability of fog computing in IoT-based healthcare frameworks regarding bandwidth usage, QoS affirmation, and crisis notification. What's more, we use ECG highlight extraction at the edge of the system in our usage as a contextual investigation. In rundown, the key commitments of this work are as follows:

Low-latency data handling and low bandwidth use at smart gateways (i.e., edge of the system

Bolster different sensor hub types, correspondence protocols, working frameworks at smart gateways (i.e., heterogeneity, and interoperability)

Real-time fast communication at smart gateways in the event of crisis (i.e., real-time push notification)

Real-time and on-line analytic at the fog layer even if there should arise an occurrence of poor association with the cloud (i.e., topographical appropriation, area mindfulness, graphical UI

2. Fog Computing

Fog computing is a layered model for empowering pervasive access to a common continuum of adaptable computing assets. The model encourages the arrangement of dispersed, latency-mindful applications and services, and comprises of fog nodes (physical or virtual), living between smart end-devices and incorporated (cloud) services. The fog nodes are setting mindful and bolster a typical data management and correspondence framework. They can be sorted out in clusters - either vertically (to help disconnection), on a level plane (to help organization), or with respect to fog nodes' latency-distance to the smart end-devices. Fog computing limits the demand response time from/to upheld applications, and gives, for the end-devices, local computing assets and, when required, organize network to unified services.

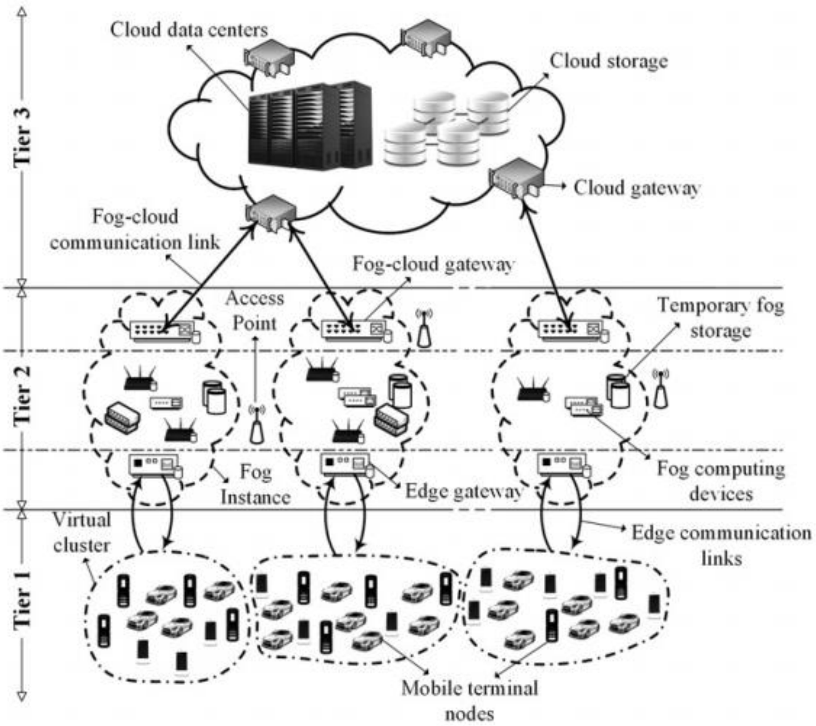

Figure 1: fog computing architecture

The Main Obstacles for Adoption of Fog Computing Broadly, obstacles for a wide selection of Fog Computing can be arranged as inherent, e.g., accessible innovation or physical limitations, and outer obstacles, e.g., privacy legislation. In this segment, we will give an outline of both.

2.1 Inherent obstacles

As inherent obstacles we see those that outcome from the simple thought of utilizing fog assets. In particular, these can be technical limitations, for example, a given limit of computational power, coherent requirements, for example, having exchange offs in disseminated systems, or basically showcase imperatives, for example, the way that there are currently no overseen edge services.

O1: No Edge Services While the cloud is advantageously usable with its administration based utilization display, there are currently no edge foundation services where register or capacity limit could be provisioned on-demand. We trust that oversaw edge services will undoubtedly enter the market at some point or another; conceivably even as fog services in participation of cloud suppliers and network bearers. Currently, Amazon is making first strides toward that path through their Green grass "benefit" which gives software to edge devices. Be that as it may, since there is currently no real way to really "rent" on-demand edge limit, this implies fog application suppliers currently need to assemble, oversee, and run their very own physical edge "boxes" including cloud joining.

O2: Lack of Standardized Hardware While there are some prepared to-use, off-the-rack edge "boxes", these arrive in an assortment of flavors, e.g., with respect to figure power. On the other hand, Raspberry Pis, Beagle Boards, or custom arrangements can be utilized. This prompts a wide heterogeneity of edge hub equipment which has two impacts: First, software stacks should be adjusted or may not run all over. Systems that can really run wherever are probably not going to completely tap the capability of the particular equipment assets. Second, application architectures should have the capacity to manage such various asset limits. This requires very modularized applications that can convey a few or all administration highlights relying upon the nodes where they are running.

O3: Management Effort Since Fog Computing is basically about conveying data and calculation closer to end clients, thick fog arrangements will result in high quantities of fog nodes. These all should be overseen, e.g., when scaling, introducing updates, or refreshing setups. As there is currently no overseen fog framework benefit, this management exertion is left with application suppliers. In examination small on-start data centers, this requires colossal exertion.

O4: Managing QoS Complexity of systems commonly increments with the quantity of nodes in the system and their topographical dissemination. This is because of issues and faults – going from straightforward ones, for example, network latencies, message reordering, or message misfortune to confounded faults, for example, network partitioning or byzantine disappointments. For the most part, systems can adapt to these issues yet despite everything they influence QoS and their exchange offs. In extensive scale geo-circulated systems, every one of these issues turn out to be progressively articulated and faults happen all the more often – basically dependent on probabilities and the expanded number of dispersed nodes. In the meantime, fog application areas, for example, IoT or independent driving really have more grounded quality necessities on framework services as the potential effect of "things turning out badly" is substantially more extreme and influences the physical world. E.g., faults in a social network may lose a private message; indistinguishable faults could result in wounds and deaths in the event that they influence security basic usefulness of self-ruling autos.

O5: No Network-Transparency Distributed systems inquire about has constantly attempted to shroud dispersion, i.e., those applications will keep running as though they were running on a solitary machine. Throughout the years, increasingly more of these transparencies should have been relinquished for different QoS objectives. What has still stayed covered up so far is the network design; e.g, cloud services uncover some essential abnormal state data on their setup and dispersion (e.g., accessibility zones and regions in AWS) and vigorously depend on network virtualization. Be that as it may, in Fog Computing, the interconnection of nodes on a legitimate dimension should never again be possible in discretionary routes as the hidden networks may be, truth be told, pretty much hierarchical; e.g., two geologically close edge nodes might be associated specifically, on the following higher chain of command level, at the Internet backbone level or anyplace in the middle.

3. System and gateway architecture

A health observing system often includes a few devices to gather bio-data from a human body and transmit the data to a handling or representation gadget by means of wires and links for checking and determination. A few disadvantages exist in such system, for example, unsupported portability and remote observing which cause numerous burdens for the two patients and specialists. For instance, health of diabetes and cardio vaculus should be constantly observed every minute of every day. At the point when the ordinary system is connected for this methodology, these patients must convey numerous devices and links amid significant lot of observing hours and off base data is obtained because of development exercises of these patients. A health checking system dependent on WBAN can handle these disadvantages successfully through its qualities of versatility and remote transmission. Despite the fact that there are different kinds of health observing WBAN-based systems intended for particular bio-data and maladies, they have three fundamental parts including sensor nodes, a gateway and a back-end part. The detailed portrayal of these segments is displayed in the following.

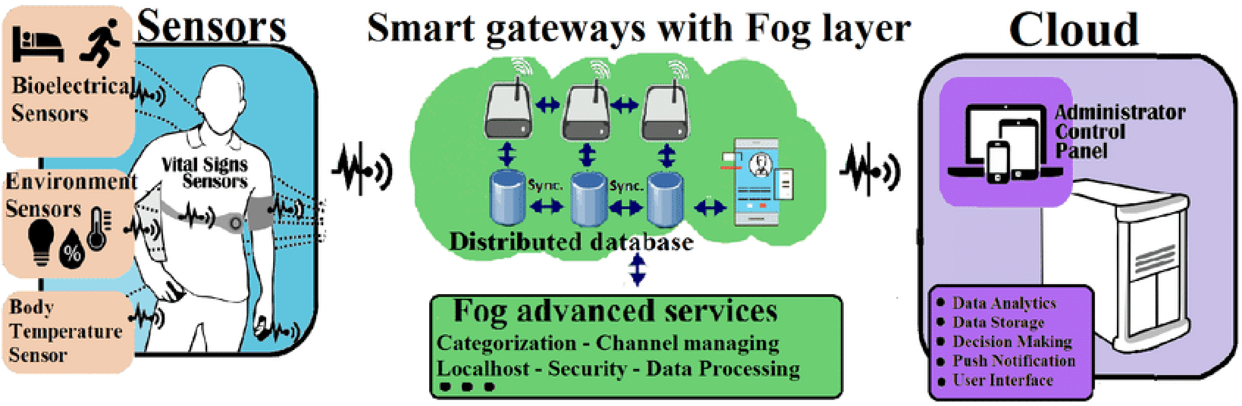

Figure 2: IoT-based health monitoring system architecture

3.1 Fog networking

Because of situated at the edge of Internet, fog network is heterogeneous. The obligation of fog network is to interface each part of the fog. Nonetheless, managing such a network, keeping up availability and giving services upon that, particularly in the scenarios of the Internet of Things (IoT) everywhere scales, isn't simple. Developing strategies, for example, software-characterized networking and network function virtualization are proposed to make adaptable and simple keeping up network condition. The work of SDN and NFV can facilitate the usage and management, increment network versatility and lessen costs, in numerous parts of fog computing, for example, asset designation, VM movement, traffic observing, application-mindful control and programmable interfaces SDN "When SDN idea is actualized with physically (not simply intelligently) brought together control, it takes after the fog computing ideas, with fog gadget going about as the unified controller." In the fog, every node ought to have the capacity to go about as a router for adjacent nodes and resilient to node portability and beat, which implies controller can likewise be put on the end nodes in fog network. The difficulties of incorporating SDN into fog network are to oblige dynamic conditions as versatility and questionable remote connection. The nearest work proposes a few plans for SDN-based mobile cloud architectures for mobile/vehicular impromptu network (MANET/VANET), and demonstrates the achievability by accomplishing high parcel conveyance proportion with adequate overhead.

1) **Medical sensor node:** is a piece of a few physical devices including implantable or wearable sensors which are coordinated to a little remote module for social occasion logical and medical data, for example, temperature, area, stickiness, SpO2, ECG, EMG, and EEG and then transmitting the data to a gateway by means of a specific correspondence convention, for example, Wi-Fi, Bluetooth, ZigBee or 6LoWPAN. Contingent upon treatment techniques for different infections, particular bio-data and the relevant data are deliberately engaged in different health observing WBAN-based systems.

2) Gateway: assumes a vital job in such a WBAN-based system since it associates a profusion of sensor nodes with a remote cloud server. At the point when a gateway does not function appropriately or bottle-neck happens at a gateway, the entire system will be influenced. Subsequently, real-time bio-data can't be properly gotten to at a cloud server.

3) Back-end part: comprises of a cloud server and back-services which can be different from systems to systems contingent upon advances and services offered. A cloud server is utilized for putting away, handling and broadcasting data while back-end services are in charge of speaking to real-time data for investigation and representation.

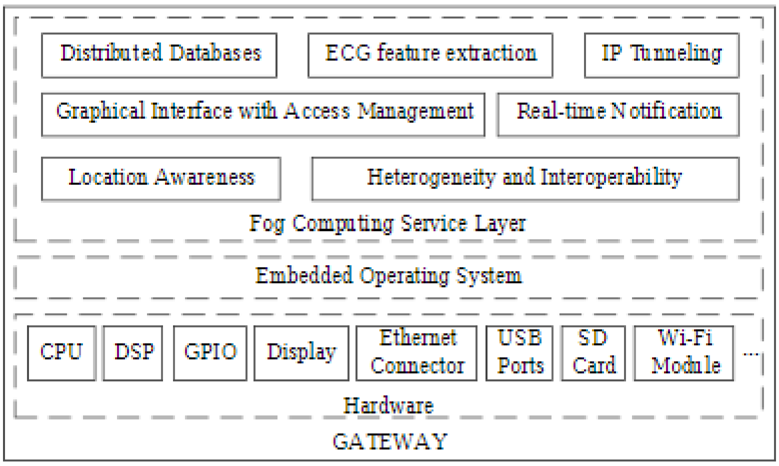

Figure 3: Operational gateway structure

1) Hardware layer: A hardware layer operates as center product between an embedded operating system and every physical segment. Center product gets the operating systems guidelines for designating physical hardware to gateway services. The hardware layer allows just a single service to have consent to get to the part at a time. Whenever at least two services need to get to a similar segment, the rest must trust that its turn will gain consent.

2) Embedded operating system: There are two sorts of embedded operating system utilized in a smart gateway incorporating one sort in the embedded router and another sort in sink nodes. The embedded operating system in a sink node must be light-weight, compact, and does not require specification of powerful hardware. Conversely, the operating system in the embedded gateway shouldn't be extremely compact since it needs to give different devices, and management components to guarantee that real-time data is transmitted into a remote cloud server and all fog computing service function legitimately.

3) Fog computing service layer: The fog computing service layer assumes the most fundamental job in a gateway since it contains a profusion of cutting edge services for exemplifying functionalities of a regular gateway as well as performing attributes of fog computing. Subtleties of these services are portrayed in the following.

Distributed databases contain a static look-into capacity, a universally useful capacity, and a synchronized stockpiling. The static look-into capacity contains static and fundamental data required for a few services and calculations (e.g., security with client name and secret phrase, references for data getting to and get to management); in this way, the static database is kept unblemished for all cases aside from the instance of system heads. The universally useful capacity putting away high data rate approaching data is utilized for both the fog computing service and graphical UI. The broadly useful database size can differ contingent upon specific applications. The synchronized stockpiling is as a stock of briefly natural data and bio-data which are sent from sensor nodes with a low data rate, for example, temperature, and mugginess. Besides, it has duty regarding refreshing data at a remote server.

ECG feature extraction: ECG feature extraction has been handled and conveyed in numerous inquires about because of its imperative job in numerous applications, particularly in healthcare area. For instance, notwithstanding help specialists checking and offering medicines to numerous sicknesses identified with cardiovascular all the more efficiently, it recognizes a few variations from the norm of the heart.

Heart rate is a standout amongst the most concerned features extricated from ECG since it gives an outline of the heart which is fundamental for crisis services and diagnosing numerous illnesses. Besides, through heart rate data, some moment strategies may be connected to keep the heart operating regularly. For example, an exercise individual can diminish the exercise intensity level when heart rate is high since heart rate is relative with the exercise intensity.

$$\text{Heart rate} = \frac{60}{\text{R-R interval}}$$

The calculation is structured so that a few parts of the calculation can be reused for separating other data other than R-R interim, P wave, T wave and heart rate. For example, ventures of filtering ECG signals and the strategy for figuring an edge esteem are two reusable parts of the calculation in spite of the fact that parameters of these strategies may fluctuate contingent upon which parts of ECG signals, medical doctors need to analyze.

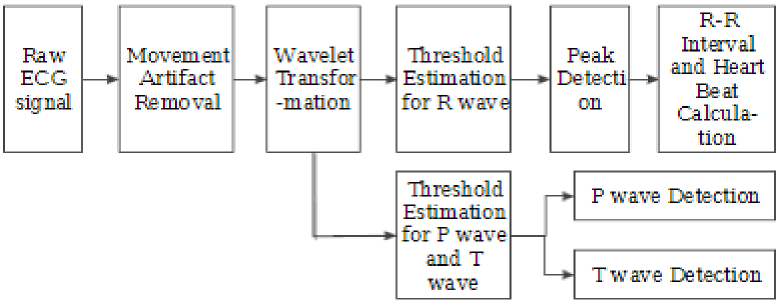

Figure 4: The ECG feature extraction template

4. Smart gateway implementation

Our smart gateway is worked by consolidating different embedded hardware including Pandaboard and a 6LoWPAN sink node, as appeared in Fig. 5. Pandaboard is utilized in our execution since it is developed from the OMAP 4 platform which is a power efficiency and superior system-on-chip. The processor of the OMAP 4 platform includes double core ARM Cortex-A9 MPCore in which the speed of each core is more than 1 GHz. The processor is reasonable with our application because of its qualities, for example, power efficiency, symmetric multiprocessing, hardware quickening agent arrangement (i.e., a programmable advanced flag processor). Furthermore, the platform bolsters non-volatile and volatile recollections through elite and exhaustive controllers. Therefore, external memory, for example, 64 GB SD card can be attached into Panda board for filling in as a system stockpiling. Also, Pandaboard is fit for managing different correspondence protocols, for example, Ethernet, Wi-Fi, and Bluetooth through different interfaces and pre-integrated hardware modules.

Graphical UI is worked by MySQL database, PHP utilized as server-side scripting and JavaScript (JQuery) for HTML content age, for example, plotting diagrams. All systems for access management, confirming username, secret word and checking the quantity of login times are worked in PHP with the help of MySQL database.

A 6LoWPAN sink node comprises of three parts, for example, the Olimex Ethernet module [18], the TI Smart RF06 board, and the CC2538 module, appeared in Fig. 6. The Ethernet module is utilized for data conveying between the 6LoWPAN sink node and Pandaboard. The CC2538 module assumes liability for accepting data from sensor nodes through 6LoWPAN while the TI Smart RF06 board is utilized for interface arrangement and investigating.

5. Experiment results and demonstration

As per MIT-BIT Arrhythmia database, ECG signals were recorded from 47 subjects by two-channel wandering ECG system and the chronicles were digitized at 360 examples for every second per channel with 11-bit goals over a 10 mV extend. Also, the database recorded an extensive number of insights and records identified with ECG data, for example, an aggregate number of ordinary heart thumps and different sorts warm pulsates amid 30 minutes recording time of every individual. Because of these insights, ECG data in the MIT-BIT Arrhythmia database is an appropriate candidate for our examinations. At first, ECG data was put away in the gateway stockpiling and then handled with the fog computing service. At long last, ECG features (e.g., heart rate, P wave and T wave) were removed. So as to have a closer view to our proposed layout functionality, we connected the file"101" from MIT-BIT Arrhythmia database into the format.

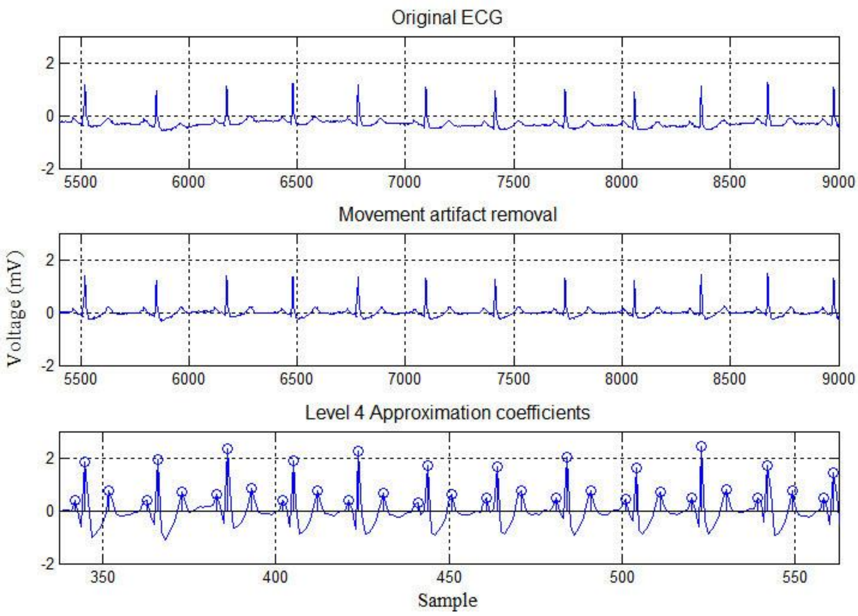

Figure 5: ECG processing implementation

With the aim of introducing benefits of fog computing towards a healthcare IoT system, latency of transmitting different crude ECG data from the gateway to a remote cloud is contrasted and an aggregate latency of handling the fog computing service and transmitting preprocessed ECG data. The examination results appeared Table I are accomplished through Wi-Fi whose data, for example, network condition, data rate,frequency and connection quality are given in Table II. If there should be an occurrence of fog computing, a volume of data transmitted over Wi-Fi is small in light of the fact that handled data including heart rate,P wave, and T wave is transmitted

TABLE 1 DATA RATE AND LATENCY COMPARISON

Data rate (Mb/s)	Raw data		Fog computing			Improvement	
	Data size(B)	Latency (ms)	Data size(B)	Process-ing(ms)	Transmit-ting(ms)	Data size reduc-tion(%)	Latency reduc-tion(%)
18	240000	106.6	⩽15840	≈ 96.3	⩽6.6	⩾93	⩾3.5
12		152.2			⩽9.5		⩾30.5
9		213.3			⩽13.5		⩾48.5

TABLE 2: INFORMATION OF WI-FI NETWORK

Network condition	Data rate	Frequency	Link quality
Not busy	18Mbit/s	2.437GHz	53/70
Busy	12Mbit/s	2.412GHz	51/70
Busiest	9Mbit/s	2.402GHz	50/70

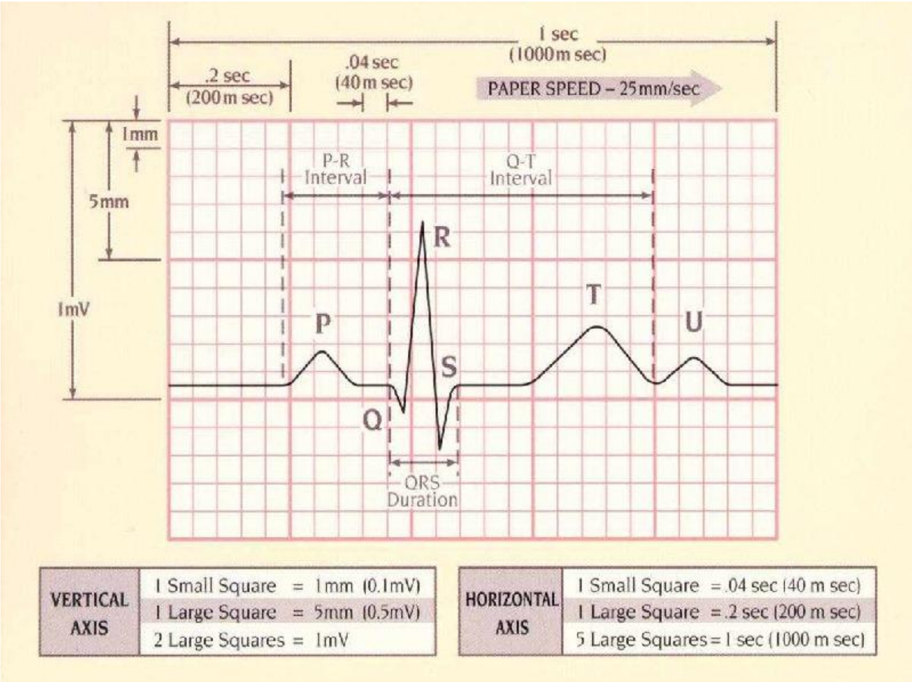

Figure 6: ECG waveform

6. Conclusion

We present fog computing at a gateway for enlarging health checking systems. We have actualized fog computing services including interoperability, distributed database, real-time notification instrument, area mindfulness and graphical UI with access management. What's more, we present a flexible, light-weight layout for ECG feature (e.g. heart rate, P wave, and T wave) extraction. The exhibit and results demonstrate the accomplishments given by the smart gateway. The format dependent on wavelet change can be utilized for separating different ECG features by distinguishing different parts of ECG waveforms (e.g. PR interim, and QT interim), or separating EMG, EEG features. likewise talks about meanings of fog computing with comparable ideas, gives delegate applications which will advance fog computing, and notices different parts of issues we may experience when plan and actualize fog computing systems.

References

[1] C. Chen, H. Raj, S. Saroiu, and A. Wolman. ctpm: a cloud tpm for cross-device trusted applications. In NSDI, 2014.

[2] B.-G. Chun, S. Ihm, P. Maniatis, M. Naik, and A. Patti. Clonecloud: elastic execution between mobile device and cloud. In Eurosys. ACM, 2011.

[3] Cisco. Iox overview. http://goo.gl/n2mfiw, 2014.

[4] E. Cuervo, A. Balasubramanian, D.-k. Cho, A. Wolman, S. Saroiu, R. Chandra, and P. Bahl. Maui: making smartphones last longer with code offload. In Mobisys. ACM, 2010.

[5] H. T. Dinh, C. Lee, D. Niyato, and P. Wang. A survey of mobile cloud computing: architecture, applications, and approaches. WCMC, 2013.

[6] C. Dsouza, G.-J. Ahn, and M. Taguinod. Policy-driven security management for fog computing: Preliminary framework and a case study. In IRI. IEEE, 2014.

[7] C. O. Rolim, F. L. Koch, C. B. Westphall, J. Werner, A. Fracalossi, and G. S. Salvador, “A cloud computing solution for patient’s data collection in health care institutions,” in ETELEMED’10. Second In- ternational Conference on eHealth, Telemedicine, and Social Medicine,2010. IEEE, 2010, pp. 95–99.

[8] S. Yang and M. Gerla, “Personal gateway in mobile health monitoring,”in 2011 IEEE International Conference on Pervasive Computing and Communications Workshops (PERCOM Workshops), March 2011, pp.636–641.

[9] J. W. Yoon, Y. K. Ku, C. S. Nam, and D. R. Shin, “Sensor network middleware for distributed and heterogeneous environments,” in NISS’09.International Conference on New Trends in Information and Service Science, 2009. IEEE, 2009, pp. 979–982.

[10] W. Shen, Y. Xu, D. Xie, T. Zhang, and A. Johansson, “Smart border routers for ehealthcare wireless sensor networks,” in 2011 7th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM), Sept 2011, pp. 1–4