An Effective Health Tracking And Monitoring System With Amazon Web Services

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Abstract- *Mobile service and wearable devices have become a new area of interest in recent year. People likewise focus closer on the problem of e-health. Cardiovascular disease is a sort of serious disease that jeopardizes the health and life of human beings which has been widespread concern by academic and practice researchers. In any case, the automated observing and prevention of heart disease, cardiovascular disease and other issues have not been effectively resolved. In this paper, combine AWS Computing, Internet of Things, large information investigation with ECG Monitor technologies, by utilizing mobile medical as a stage to design Internet of Things based AWS ECG intelligent observing system. The development of the system not just in time to capture and send unusual ECG signal, yet in addition improve heart disease and cardiovascular disease in patients with the treatment of timeliness and success rate by utilizing the enormous information processing technology. Our experiments show that, it can effectively screen and protect the lives of patients with heart disease and cardiovascular disease.*

Keywords- Smart Healthcare, Internet of Things; ECG, monitoring system,AWS Computing, E-health, multi-key search, DES3.

I. INTRODUCTION

In today's society, with the development of people’s living conditions, people's attention to health is gradually increasing. However, as a serious threat to human health, heart disease, the incidence of cardiovascular and cerebrovascular diseases show a growing and younger trend annually. With the tactic of informational technology, traditional medical care product is being replaced by the intelligent medical technology taking the utilization of Internet to help the medical treatment phase[1], because the IoT is that the one among the key technologies to upgrade traditional health care products so it gains attention, with the utilization of Internet to realize wireless, network and real-time, internet technology has been widely utilized in the medical monitoring system, but at the present, the application of IoT remains within the primary hardware stage[2], with the utilization of portable equipment.

The main contributions of this text are as follows:

(1) Clinically, when patients have in sudden heart condition and other diseases, it's difficult to catch the abnormal ECG in time, so it's difficult to more accurately treat patients. In this paper, the Intelligent ECG monitoring system supported the cloud are often visually to capture the ECG signal of the sudden situation, which may reduce the probability of sudden death thanks to heart attacked.
(2) Real-time ECG detection images and data presented in the AWS Synchronization network platform which eliminates the essential medical environment at the value of travel and expecting detection of time-consuming consumption and greatly improves the efficiency of the inspection;
(3) The monitoring data once are saved, we will use large data processing technology, regular data analysis, if encountering data abnormalities, it can suggest that further desirable treatment of patients can provide ECG historical monitoring data and abnormal data early warning and monitoring feedback to upper level of medical units for diagnosis and treatment reference.

This paper extends a number of our earlier works [3, 4] and in several substantial aspects. First, we apply the kNN and Skyline to mobile ECG processing application. Second, we describe the implement detail of the ECG monitoring system. Finally, we add the assumptions and more experiments detail to evaluatethe scalability and therefore the performance of our kNN and skyline algorithms.

II. RELATED WORKS

Professor Kevin Ash-ton of the Massachusetts Institute of Technology (MIT) in 1999 first proposed the concept of IoT[5] which is really to increase the client side to any goods and objects between the exchange of data and communication on the idea of the "Internet". The structure group of the IoT includes the perceptual layer, the transport layer and therefore the application layer.

There are several distributed spatial index methods likeR-tree and Grid-based index [6]. The BUD scheduling[7]algorithm and therefore the ELB algorithm [8] are more efficient butcan only be utilized in spatial space.

AWS computing may be a computing method supported the Internet, by which the sharing of hardware and software resources can provide the knowledge needed by computers and other devices [9]. Since large data must be allocated to the work of an outsized number of computers, it must reach the same framework on achieve this function, so large data is inseparable from the support of cloud computing [10]. Fig.2.1 may be a large processing methods and tools.

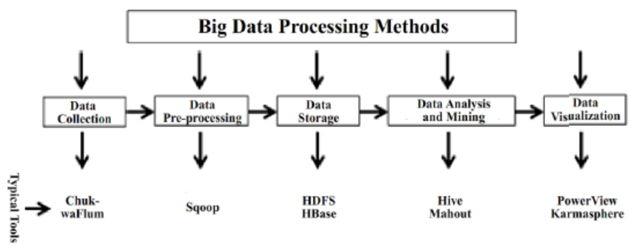

Figure 1.1 Big data processing method.

In this paper, the Intelligent ECG Monitoring system takes use of advanced materials networking, sensors, wireless network, data fusion, big cloud processing and visualization technology to realize the mixing between patients and medical personnel also as medical equipment to further achieve the targets of improving diagnosis and treatment process and repair quality, thus improve the hospital's comprehensive management level and achieve more in-depth intelligence of guardianship work.

III. OVERALL DESIGN OF ECG MONITORING SYSTEM PRODUCTS

At present, traditional ECG remote monitoring is that the application of Remote monitor system. The normal ECG monitoring platform website used the terminal components include ECG Holter and heart BP machine. The 2 parts have advantages and drawbacks, those are, the previous may be a recording device, can to record ECG data of cardiovascular disease patients for an extended time, and then the record signal was finally sent to the hospital monitoring ECG department equipment through playback, display and analysis of ECG signals, the patient's illness to form judgments[11]. This type of ECG monitoring equipment has the advantage of continuous recording for an extended time. But its drawbacks are also obvious which may only record ECG signals but not be transmitted remotely, and also cannot collect ECG signals for real-time analysis. After patients use it, it had been sent to the hospital by the hospital dedicated equipment to the ECG signal reading, playback and analysis, as a results of it, there is a memory function flash card rather than ECG Holter now. The present ECG BP machine can record a couple of minutes of patient's ECG data signal, but when the patient feels the disease is close to attack, it can immediately telephone the hospital to transmit the ECG data signal by the sound coupling to possess the doctor to diagnose, but it's extremely difficult for a patient to finish such a series of rescue operation [12].

In this section, we've designed a "heart electric vest "hardware products supported the previous work, and introduce related technical implementation. Subsection Bdescribes the operating scheme of the cloud system.

A. Smart ECG Monitoring System Framework

To solve these problems, our new system uses portable ECG monitoring vest, using 3G/4G wireless communication technology and monitoring Center (such as home data center and Community Monitor Center) for digital communication, data periodically use cloud synchronization technology to dump to medical cloud data center for cloud storage and historical data analysis. We mainly adopt the wireless transmission and data synchronization technology supported the mobile end, which may monitor it automatically in order that the user are often not limited by time and place, and without any awareness.

As shown in Figure 2.1, the monitoring system is especially composed of the object-networking collection equipment layer, the carrying network layer, the AWS processing system and therefore the data service system and the application layer software platform, which are described intimately as follows:

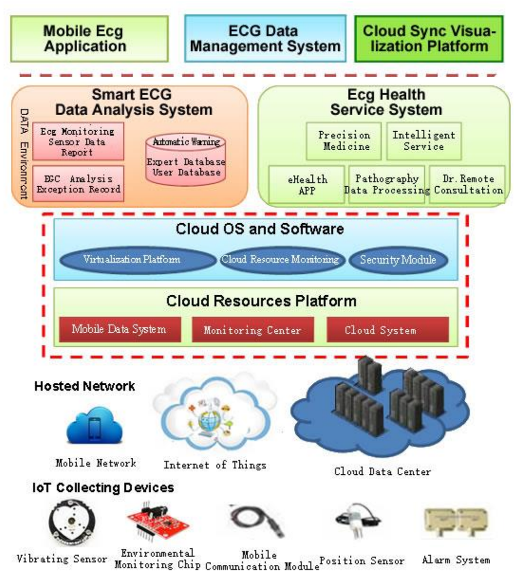

Figure 2.1 ECG Monitor System

IoT acquisition equipment includes active electrodes, pulse sensors, other micro-components (power supply regulator chip, level converter, etc.), environmental monitoring chip, positioning sensor, alarm then on. The core component of the network layer is that the mobile communication module, which transmits data to the monitoring center by using the wireless transmission technology. It's liable for the knowledge amplification and therefore the initial processing, then transfer it to the terminal host of the Monitoring Center. This part issued to complete the knowledge preparation work of the mobile processing system before entering the platform. Sub-monitoring Center, using the ARM7TDMI structure of the Samsung S3C44BOX [13] as management and processing parts of a number , we've adopted a platform that can be embedded OS uclinux supports, as shown in Figure 2.1 of the kid Monitoring Center processing system, including the embedded OS uclinux, TCP/IP protocol stack, mobile communication module and wireless base station, the wireless base station data are going to be cached locally, and periodically automatically synchronizes to the cloud service network, which can get on the appropriate cloud server.

AWS server is especially composed of intelligent ECG data analysis system and ECG Medical health service system. If there is a drag will automatically alert, the latter is mainly for the utilization of ECG doctors, the prison doctor or doctors are often supported data analysis system data for reference decision-making and to supply patients with remote diagnosis and treatment.

Application layer software platform is especially the mobile ECG applications. On the one hand, it shifts the visualization of ECG data into the cloud chart data, on the one hand it can calculate large data results and feedback them. We use some real-time data analysis algorithms to perform abnormal monitoring and alarm feedback. Users can independently use the system to finish the platform task. Additionally, the community or hospital can perform multiple platform tasks,that is, it can present variety of private ECG data image.

In this way, the workstations of every monitoring center receive real-time ECG data through the info gateway of the IoT.

B. Cloud System Operation Program

Specific cloud server and workstation gateway as shown in Figure 2.2, the info collected by the ECG vest is first cached locally, and is transferred to the monitoring workstation through the wireless communication interface when the preset time window and space for storing size threshold conditions are met and therefore the network connectivity status is allowed.

However, due to the limited computing and storage capacity of the monitoring station, the general macro data can be synchronized to the medical service cloud using cloud synchronization technology. Medical cloud Server includes distributed file data storage and distributed database query processing and other services, our cloud system on the one hand, periodic summary of knowledge, automatic formation of visual reports (including ECG data and pictures, etc.)feedback to the user, on the opposite hand, using the spark real time data analysis system, using the distributed Skyline algorithm, a neighborhood of the info task is decomposed into the monitoring station for the Sub task calculation, then the task in the cloud is filtered and merged. , an equivalent principle we also use the Distributed kNN query algorithm and therefore the medical expert database within the ECG anomaly data to approximate query. These processing algorithms are described intimately in Section III.

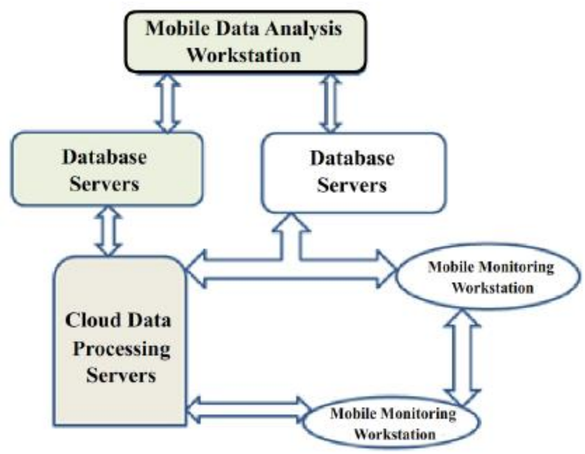

Figure 2.2 Cloud Services and Workstation Gateway

If there's an abnormal situation, it'll call the service system through the mobile terminal software or mobile during a real-time way, and feedback to patients and therefore the responsible doctor to advance early warning reminders. The ECG are going to be used at an equivalent time because the user and therefore the doctor, and choose whether to hunt further medical treatment.

IV. SYSTEM DESIGN

A. Mobile ECG Data Acquisition System

The core of Heart Electrical Vest Product is that the ECG data acquisition system, we use the open source Keyes ECG measurement Module AD8232. The AD8232 is an integrated front end, which is suitable for pulse monitoring for signal conditioning of cardiac biological signals. It's a low power, single-leading, pulse monitor analog front launched for all kinds of important signs monitoring applications.

The system uses open source Arduino development. Its essence may be a set of integrated amplifier circuit and noise elimination circuit of optical pulse sensor [14]. We put it in the guide module of the guts electrical vest. In order to make sure the effectiveness of the detection, we have modified the hardware, the first circuit which is composed by 2 two-way limit protection circuit and diode, which can limit the interior or external high-voltage interference in order that it'll to not make the present reversal and lose the effect thanks to full excitation. The ECG signal issusceptible to interference with signals like AC electromagnetic, and isn't properly diagnosed, moreover, the intensity of ECG signal is far smaller than that of interference signals, and therefore the transmission signal of ECG and input ECG signal is within the common mode, which needs a good common mode rejection ratio. So our preamplifier chose the American analog devices.

B. Workstation ECG Monitoring processing System

Our distributed processing system includes a monitoring processing system and a cloud detailed data analysis system.

The main task of the system is to research and calculate local ECG data in real-time, monitor the patient's sudden situation and analyze the info, and frequently maintain the normal work of every a part of the terminal system. The workstation can see all the changes within the smart terminals and the patient's use. The monitoring processing system can remove data from the cloud server and even be responsible for transmitting the info from the monitoring station back to the cloud server and displaying it within the AWS visualization platform.

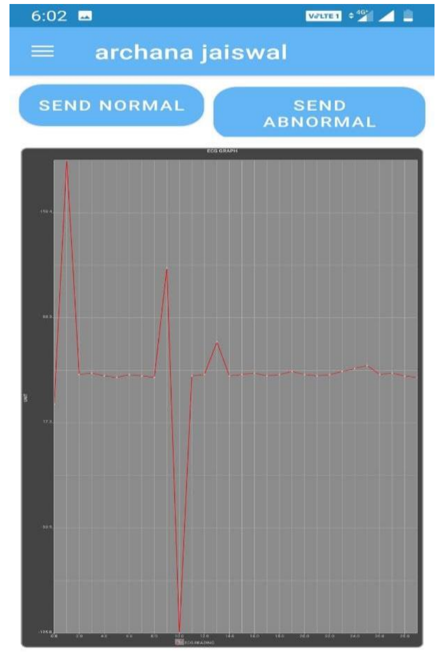

Figure3.1 ECG Data of Monitoring Workstation

At present, the real-time detection algorithm for dynamic ECG signal is studied tons. The QRS Wave Groups to occupy an outsized proportion within the energy distribution of ECG signal, and therefore the QRS Wave group is distributed within the middle and high frequency region of electrocardiogram [15], and therefore the ECG is detected and analyzed, and therefore the results are transmitted to the doctor. Figure 3.1 is that the initial processing ECG data of the workstation. The most algorithms utilized in this paper include, because the dynamic ECG detection algorithm isn't the stress of this text, so it's not detailed here.

The main task of the system is to mix large data technology, cloud computing technology and intelligent ECG system.

V. DISTRIBUTED TEMPORAL SPATIAL QUERY

A. Distributed Skyline Multi-factor Filtering Algorithm

We first designed Skyline query calculation a distributed environment [4], by the user at any end initiated Skyline real-time query request S(q), then the skyline query is randomly divided into Sub tasks and sent them to all or any the monitoring workstation S (i), the workstation sought them in the local query, and eventually summary the local query result, and sought them within the cloud again having Skyline query, and finally get the worldwide Skyline query result set. But because this method must transmit tons of knowledge to every server processing local skyline query, we design a replacement Skyline query algorithm supported spark:

Skygrid, to compress data transmission and processing cost through reasonable local partition, distributed domination region labeling and grid pruning technology. We use an inverted index to hold out the distributed processing. The local result set is obtained through the monitoring workstation local Skyline query by an estimated way, then the worldwide Skyline query is returned to the ultimate result.

Algorithm 1 SkyGrid

Input: Inverted index G, Query point q, pi ∈Scnd
Output: SkyGrid(q) // the Skyline of query point q
LocalSkyline():
1. Initialize set Scnd = Skyline(G, q);
2. Initialize TG = G;
3. while TG <>∞ do
4. for each point pi ∈Scnd do
5. Mark all pi dominate Ci , j =0 //
6. end for
7. end while
8. returnScnd
GlobalSkyline():
9. for each point pi ∈Scnd do
10. if pi ∈ (Ci, j=0) then
11. Vcnd = Scnd–{pi}; //false hit
12. end if
13. end for
14. returnVcnd

As shown in algorithm 1, the MRsky algorithm is split into three processes: data partitioning, local pruning, and global totals. within the global summary stage, the worldwide skyline is not any longer computed, and therefore the final skyline result set is obtained by using the local skyline mesh markers to prune directly.

B. Distributed kNN Anomaly Matching Algorithm.

After Skyline query, we'll get a knowledge set satisfying the condition of ECG anomaly monitoring and query, we use distributed kNN query algorithm to approximate the ECG anomaly data in doctor database. so as to use spark for kNN queries, suppose we get the ECG datum set S, the ECG anomaly datum set R within the doctor library after Skyline filtered, then, consistent with the definition of kNN query, if the closest set of knowledge points in R and S data is found, it's suspected exception data. First, we'd like to partition the purpose set R and S supported the inverted index, assign the task to the monitor workstation decomposition operation consistent with the partition, then calculate the worldwide kNN value within the cloud. the method of using spark IVkNN (kNN outlier detection) is described intimately in algorithm 2. We place files that contain the partition values of R and S supported the inverted index. The hosts then distribute the files during a distributed cache. The monitoring workstation reads Ri∈R and Si∈S partition values for every partition from the distributed cache, generating key-value pairs. during this way, the thing in R and its possible k-nearest neighbor is entered into the local computed results. Global kNN receives a pair of Ri and every one points between the Si which are progressively read, perform specific tasks on a group of pairs of identical key value pairs of VCM, then make kNN queries.

Algorithm 2: IVkNN

Input: Dataset R, S
Output: IVkNN(R, S)
LocalkNN (k, v) :
1. if dataset Ri∈R then
2. VCm ←getPartitionID(R.partition);
3. output(VCm, (k, v));
4. else
5. for each pivots P in S do
6. ifdist(s, P) <dist(r, P) then
7. pid ←getPartitionID(S.partition);
8. output (VCm, (k, v));
9. end if
10. end for
11. end if
GlobalkNN (k, v) :
12. parse P from <VCm, (k, v)>
13. compute the kNN(r, S)
14. Output key-value pairs <r, kNN(r, S)>

Finally, after checking all the partitions of Si the worldwide kNN will output kNN (r, S) (line 14th). The algorithm outputs the key value pair.

VI. EXPERIMENTS

In this section, we use the techniques presented during this paper to create a model for the detection of cardiac ionization groups in mobile medical networks [16] supported the web of things, and to check our methods in real and simulated 2datasets.

A. Experiments Settings

In this part, we evaluate and compare the performance ofthe proposed algorithm through a series of experiments with different distributions and found out a standard server cluster consisting of 32 nodes, each node installed Redhat Linux server OS, 8GB memory, dual-core CPU,73GB hard disc and spark latest version, the experimental platform may be a general-purpose computer Linux operating system, DFS block default size is 64MB.The real DataSet (RDS) that we utilized in the experiment is the ECG data provided by the guts Department of Dalian Hospital (the clinical data of the patient's wisdom ECG wearable equipment [17] that has been collected for nearly three years, including GPS information and ECG, environment information), including about 180 million data points. The first data is approximately 1G bytes before being decompressed, then 100G after decompression. In this experiment, we used a subset of 1.5 million data points, each of which contained seven dimensions, and that we took out the positioning and ECG dimensions to experiment, as shown in Table 4.1.

In the following experiments, we selected a real 2G-scaleECG DataSet and a simulation dataset generated by a random number generator. The simulation dataset is described intimately in Table 4.1 to follow the info distribution of positive and indirect correlation. Its dimensions are from2 to 5, and therefore the base is from 128k to 4096k (that is, more than4 million points).

In this section, we've 4 experiments to verify the feasibility and efficiency of the skyline and kNN algorithm of the anomaly detection model. The 1th experiment is that the result set filtering with the Skyline query is compared with the normal ECG query method, and therefore the skyline can be effectively wont to satisfy the multi-factor condition. The2nd experiment is to detect anomaly results by kNN query, and compared with traditional kNN algorithm, our algorithm has high scalability and execution efficiency in large data environment.

B. Skyline Query Result Set Quantity Analysis

Table 1 result point number on rs and sds

Data distribution	RS	Positive SDS	ReverseSDS
Traditional Filteringalgorithm	3.7×103	5.2×103	5.1×103
Skyline Filteringalgorithm	3.3×103	2.3×103	3.1×103

Unreal data set and simulation data, the effect of the skyline on pruning ability is evaluated, and therefore the effect of different data distribution on pruning effect is analyzed.

In order to point out the results of the experiment more clearly, we measured the results of the synthetic data of different data distribution 10 times, and put the typical value into table 4.1, which shows that whether the info is positive or inverse, the filtering pruning efficiency of the Skyline query algorithm is that the highest, because the subspace Skyline query is that the residual data after pruning, and it only must scan a part of the index file during the execution of the algorithm, therefore the data points are going to be more accurate. In addition, the experimental results show that if the simulation data of direct correlation distribution is employed and therefore the pruning ability is best , because the direct correlation datasets has the strongest pruning ability, which may prune more skyline leads to advance, and reduce the computational cost of the subsequent steps. This also validates the effectiveness of our Skyline pruning algorithm.

A. Distributed kNN Query Results

In this experiment, we compared the query time and scalability supported inverted kNN (IVkNN) [3] and indexing Method (VkNN) in 2D datasets. We considered the change of n over time. Figure 4.1 by changing the info sizen of R and S to check the results, our approach takes less time than traditional query methods. additionally, we will see that our kNN query time increase isn't significant, because we use distributed indexing and query methods. The IV kNN method has better performance than VkNN.

In this experiment, we also studied the consequences of various k on the performance of our proposed technology. By changing the k from 5 to 100 on the particular data set and therefore the synthetic dataset respectively. Our IVkNN query performance is additionally better than the first algorithm, and costs less time. for little k values, kNN queries are determinant factor of performance. for giant k values, communication overhead is becoming a more important determinant of IVkNN and VkNN methods. The experimental results show that our method can effectively reduce the communication overhead.

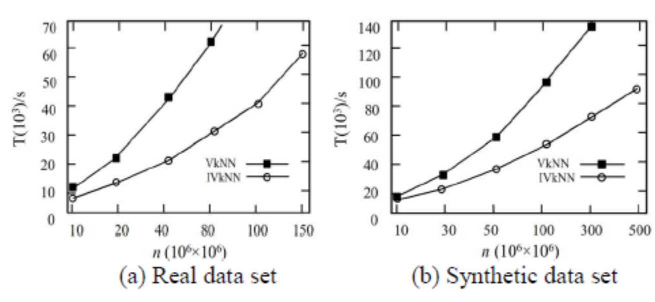

Fig. 4.1 Execution time of VkNN and IVkNN method with different k

The above experiments show that both the distributed Skyline Query and therefore the kNN query algorithm are above the previous execution efficiency. By using Skyline, the result set after pruning is more accurate and little , in order that the kNN input file set becomes smaller, can also effectively2017 IEEE 19th International Conference on e-Health Networking, Applications and Services (Healthcom)reduce the kNN query time. The 2 collaboration can well achieve a quick ECG monitoring feedback user experience.

VII. CONCLUSION

This paper presents a way of intelligent cloud ECG monitoring supported IoT. We designed the ECG vest based on portable wearable technology for terminal data acquisition, and found out a monitoring workstation for data preprocessing and cloud dump. We use the wireless communication network to synchronize the ECG data within the AWS. Besides, the advanced Skyline algorithm is employed to search for the condition of the multiple-stranded element, and the distributed kNN query algorithm is employed to match the anomaly data, and therefore the experimental results show that the algorithm proposed during this paper is efficient in filtering.

Real-time query performance and distributed scalability are better than the prevailing algorithms. Therefore, the tactic of this paper is possible and efficient.

Finally, we developed a system of intelligent AWS monitoring platform, the utilization of users can at any time through the mobile terminal to see their own ECG health situation, the heart specialist also can be supported abnormal warning feedback data, timely reading ECG waveform map, and give remote diagnosis.

At present, our system has been within the Dalian area clinical application, and won the Dalian Science and Technology Progress Award, but at the present, the system research and development application also deals with the primary stage, the way to improve the accuracy of knowledge monitoring [19, 20], effectively reduce the value of intelligent monitoring and merchandise size [21, 22], the way to apply artificial intelligence like depth learning within the system is that the future needs of further research direction and subject.

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