Monitoring and Mining Stream Data for Medical Applications

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***Abstract*— This paper describes the development of component technologies for medical applications in a wireless body area network. This environment is composed of a network of sensor devices attached to the human body. It will provide human body data in the form of streaming data. This data could be monitored and also mined in order to provide useful information for medical applications. Techniques to monitor and perform mining on such data is suggested as a component technology framework.**

Keywords- Stream Data; Monitor; Mining; Medical application

I. INTRODUCTION

Wireless Body Area Networks are one of the most suitable technologies that consist of a set of mobile and compact intercommunicating sensors, either wearable or implanted into the human body, which monitor vital body parameters and movements. These devices communicate through wireless technologies and transmit data from the body to a home base station, from where the data can be forwarded to a hospital, clinic or elsewhere, real-time. The WBAN technology is still in its primitive stage and is being widely researched. The technology, once accepted and adopted, is expected to be a breakthrough invention in healthcare, leading to concepts like telemedicine and mHealth becoming a reality. The wireless communication technology and resource allocation method for the WBAN communication physical layer, and the network architecture and protocols for the upper layer, as well as the data processing and mining technologies for the medical application service layer need to be developed. The sensor does not have enough power to send data to the server so we use real time data monitoring in wireless body area network using a query language to check data and perform data classification in wireless body area networks.

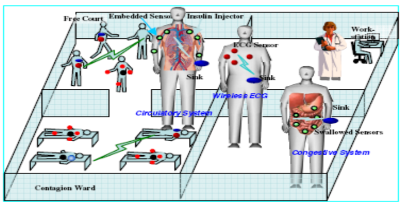

Figure 1. Architecture of WBAN

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II. BACKGROUND AND SIGNIFICANCE

A. *Wireless communication*

Recently, there has been active discussion on wireless communication between human body sensor and personal smart terminal for WBAN. Currently the IEEE 802,15.4 Zigbee is the most powerful technology among the existing wireless transmission technologies that satisfies the technology required by WBAN. The former research does not satisfy the channel and service scenario required by WBAN, instead it assumes it is WPAN. WBAN is different from WPAN, whose sensor can exist in human body and move duplicate in various cell, therefore new wireless technology is being developed to solve the problem.

B. Medical Applications

Medical applications can be developed from the medical data provided by sensors in a wireless body area network. Such applications as monitoring stream data and identifying patterns in stream data are possible. A set of components can be collected together to support these applications. WBAN communication physical layer and upper layer component technologies are developed and application layer component technologies related to medical services can be provided. Wireless transmission technologies that improve the existing Zigbee method to support low power communication between the personal device and body sensor could be developed. In addition, in an environment where several WBAN cells exist, a resource allocation method based on the game theory for the power, bit, frequency spectrum, antenna could be developed to enable the WBAN cells to maximize the quality with less power. Additionally the WBAN upper layer component technologies such as developing real-time stream data monitoring technologies and classification technologies to discover new patterns from body and motor sensor data accumulated in the medical sensors could be developed. This is the main point of this paper. Several existing system focus on healthcare systems but only support very simple monitoring or analyzing [1,2,3,4].

III. Stream Data Monitoring Technologies

Saving bio-signal to medical database is possible using a wireless body area network and medical sensors but a doctor cannot monitor all bio-signals in real time. This paper presents a design of a monitoring system for oxygen saturation, which is an important signal in the medical field, as it effectively processes the combination of multiple queries in wireless body area network in real-time.

Real time data monitor needs to check the condition of the data that it gets from the device. To check the condition; we need a condition monitoring language as the query language.

{<StartTime,EndTime>(Condition1,...,ConditionN)[Term][Size][Duration]}

Condition: **X_n OPERATOR C**

Figure 2. Query language for monitoring

The query is divided by brackets. The query time can be set by <start time, end time>, and the query is always executed when no time was set. [Term] and [size] can be set by the user, in the window query which includes < start time, end time> [term] is the interval window being generated. [Duration] is the interval of the query being executed, defined by hour(t), minute(m) and second(s). The window query is executed in a predefined interval time, during the execution time (start time, end time), and [duration] amount of data is generated, and the condition part of the command is checked.

Q1:{(X_2 >100)}

Q2:{(X_2 >100 ,X_4=45)}

Q3:{(X_2 >100 ,X_4=45)[D:10S]}

Q4:{<20100425140500,20100425141000>(X_2 >100 ,X_4=45)}

Q5:{<20100427100030,+5M>(X_2 >100 , X_4=45)}

Q6:{<20100425140525,20100425141000>(X_2 >100 , X_4=45)[T:1M][S:5][D:2M]}

- T: Term(H/M/S)
- S: Size
- D: Duration(H/M/S)

Figure 3. Window query composition

Non-window queries are processed by having a query list. The Window query list has the same size as the number of all window lists. Each node points to window query of every unit. The Window query has query id as an identifier and the value of (start time, end time) input in user query. Beside this, there is information on the biggest size of the window identified beforehand and the expected duration of the window query. This information can be used to calculate how many units of window would be created in the window query execution time.

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In the case of window queries, as previously defined, window creates a window depending on the window execution duration, size of window (i.e., the biggest of data numbers which can be included inside a window, each window's created term and whole working time (start time, end time). Every window has a window ID for the relevant data window query. Moreover, there is an arrangement that saves all data values satisfying the condition in the relevant window query.

IV. Data Mining for Stream Data Technologies

Data mining technologies for stream data analysis are becoming very popular. Among those are classification technologies. Classification can be done using stream data from blood pressure devices. Among the many kinds of bio-signals, abnormal blood pressure affects death rate in Koreans the most. Recent research in blood pressure shows it correlates with various diseases, but there is no research for time-series blood pressure pattern classification. A neural network based approach for time series blood pressure pattern classification can be devised. Considering the blood pressure data has extremely noisy characteristics, neural networks are probably suitable to be used for classifying such patterns. Experiments show that the support vector machine can efficiently classify time-series blood pressure data compared to neural network based on back propagation algorithm.

The stream data could be collected and analyzed in several different intervals such as every hour, every day and one week. Here the data is collected three times a day for the total of one week as shown in Fig. 4.

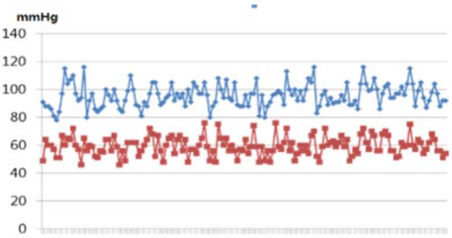

Figure 4. Stream data of blood pressure for one week

In our work we define patterns to be identified by the classifier. The patterns are simplified and are designed to reflect real situations of patient data gradually changing to different conditions. Fig. 5 shows a pattern where the blood pressure is changing from high to normal.

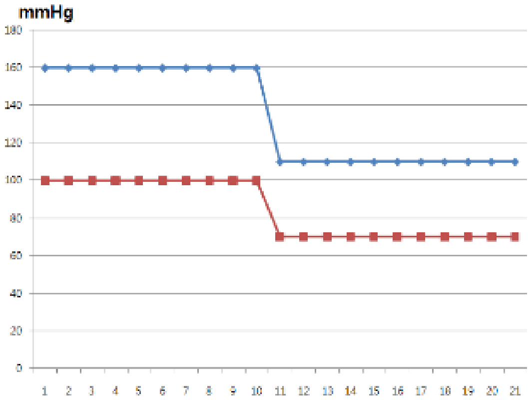

Figure 5. Pattern representative of high to normal blood pressure

The neural network imitates the human brain. The following Fig. 6 shows the backpropagation neural network that is used.

```
input : training data /* blood pressure data */
            /* X = {(x1,t1),(x2,t2),...(xN,tN)}
      training rate
      gradient /* Steepness of sigmoid curve*/
      iteration number
      hidden layer number
      neuron number of each hidden layer
Generate initial weight u randomly
Generate bias = 0.0
/*Learning process*/
for Each Pattern do until iteration number or error
is 0.01
 /*FeedForward*/
 for Each node
    calculate output
    calculate error
 end for
 /*BackForward*/
 for Each node
    assign blame for local error using weight
    update weight
 end for
end for
output : Error
```

Figure 6. Backpropagation neural network

V. CONCLUSION

The medical application components such as the stream data monitoring and mining technologies will promote the advance of WBAN next generation wireless technology. More work has to be done in terms of performing advanced functions on stream data monitoring and assessing the performance of classifying stream data. This work will open new challenges for the medical service areas in ubiquitous professionals for WBAN in the areas of the WBAN communication physical layer, WBAN communication upper layer, and WBAN application layer. Researchers on medical components can be trained and will be able to lead the research in organizations related to medical services in ubiquitous computing services.

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