인퓨전 펌프 모니터링 시스템 개발에 관한 연구

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Monitoring System of The Infusion Pump

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Abstract

The importance of the infusion pump monitoring system has become amplified in accordance with the growth of IoT(Internet of Things) technology and medical devices. A monitoring system can be described as an essential part of infusion pump system because the patient must be observed all the time. Infusion pump monitoring system is significant to have better safety and efficiency. In this paper, we propose an efficient algorithm and scheme in the infusion monitoring system. In particular, the proposed algorithm based on the time of the database interlocking part was found to have a 30% higher efficiency than the conventional method.

1. Introduction

The infusion pump monitoring system has become an important part of the product development in accordance with the growth of IoT(Internet of Things) devices and medical devices. Monitoring technologies are essential elements in infusion pumps. Even today, there are number of researches in the field being actively conducted [1,2]. Furthermore, many infusion pump companies are currently developing various types of monitoring platforms. The monitoring system is being developed into a variety of devices and OS [3]. In particular, [2] were tested for accuracy of infusion pump. Infusion pump's accuracy in the monitoring system is one of the necessary factors to be considered [2]. The real-time data streaming is important as accuracy in monitoring systems. Obtaining information of the patient monitoring data in real time is very important, because that could affect the condition of the patients. Thus, the monitoring system of the infusion pump is a critical part and the safety, effectiveness, real time stream algorithm are the heart elements of the monitoring system. In this paper, we propose a scheme and algorithms for efficient infusion pump monitoring system. In the case of the existing monitoring system, the monitoring system for the management of agriculture had been developed [4]. The type of monitoring system didn't need real time transaction for manager. However, the medical device monitoring of infusion pump obtained information of the patient in real time. This paper study on improving the algorithms for real-time data communication part of the database query. This paper is organized as follow. Chapter 2 describes the schema of the monitoring system, chapter 3 describes the algorithm of the proposed this paper and the results were summarized in chapter 4.

2. The Architecture of the monitoring system

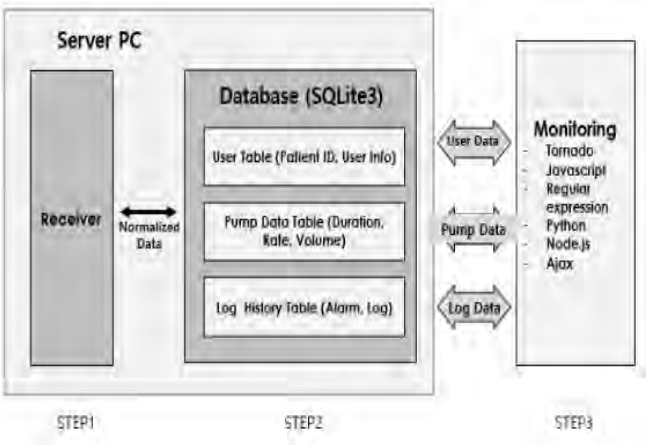

Fig. 1 The architecture of the infusion monitoring system.

Fig. 1 shows the architecture of the infusion pump

monitoring system. The architecture is largely divided into step1, step2 and step3. Step1 is a part that receives data from the infusion pump. The Receiver program was constructed using UDP sockets. In real-time monitoring systems usually come in queries of 1-300. Step2 is a part for data storing from the received data in the database. Step3 displays a useful information for user by using the stored data in the database. When the continuous demand for access to the database, it is very important to the algorithm for the case of real-time query management in the monitoring system because it requires access to the database in step1. Description of the algorithm is to be discussed in the third chapter and this chapter describe each step in detail.

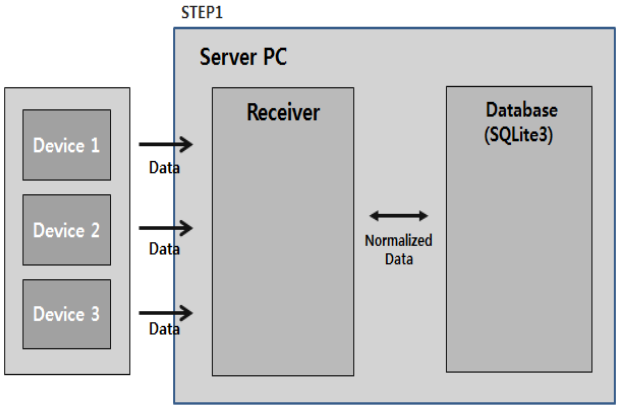

Fig. 2 The architecture of data receiving

Fig. 2 is a representation of the architecture of the data movement in step1. The data received from each unit is streaming in real time. The program was implemented at the receiver based on linux with python language with Server PC has a physical AP. The receiver program was to use udp socket. By including the identifier of the device in the incoming data from each of the devices was used to identify the data, and the identifier code is also a value which is a reference key stored in the database. Assuming that when each of the devices get 1-300 queries per second from incoming data, receiver may be handling a 1-300 of queries. This is not a big problem to handle the incoming data from the respective devices in the receiver portion, but the I/O part of database can cause a deadlock situation by delaying I/O data takes. If the delay caused on the real-time data communications from the monitoring system can affect the quality of the patient's condition analysis. Therefore, problems arising from the delay in the database I/O is critical issue. In this paper to solve this problem, we propose a effective database query management algorithm that is time and volume based algorithms. Database query management algorithm is described in more detail in Chapter 3. Fig 2 shows the data streaming from infusion pump devices that have been tagging with identifiers. Receiver control the data entered into the program by parsing to view fine. The parsing process have simple means of matching. If the code "5F" insert into the receiver, the infusion pump is a way to match the meaning of "5F" by overlapping the information. The most part of the infusion pump device is using a low level data streaming during the data transaction. If Linux-based firmware sends a long string, the process is also inefficient because information transfer is required.

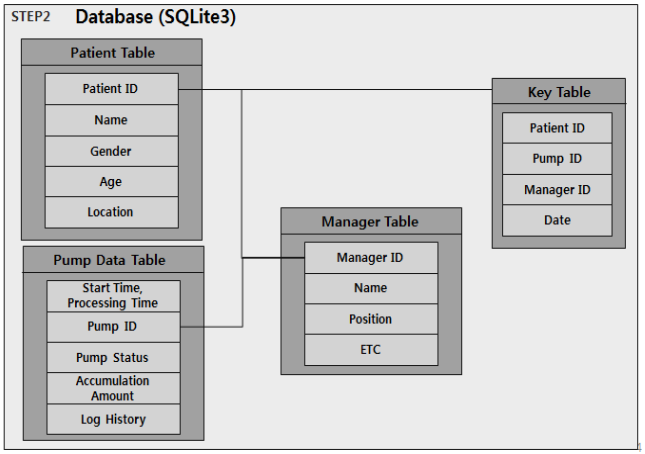

Fig. 3 The structure of database tables

Fig. 3 shows a database structure for the infusion pump and the patient management. Database table is sorted by key managers table to pump data tables, patient information and manage this table ID and the overall table. First, when a patient comes to the hospital to enter personal information, patient information is filled in the Patient Table. The attributes of the Patient ID Patient Table will be added to the Key Table (as indexed properties). If the patient has to use a pump to fill in the task manager is that by matching the patient with the matching pumps The Manager Table. Real-time information being held in the Pump Data Table which was managed by the Key Table. Key management table is an important factor. Because the key table is can view the information of the patient information and the management information and the pump it at a time. In addition, by administrators to query the key table may be coordinated in the future is certain and that the problem occurs more frequently in some devices may

be statistical data. Therefore, the key table which is managed by the keys of all the information must be protected to maintain the integrity is not affected in any operation or other data.

3. The algorithm and performance in the monitoring system

In this chapter, we tested and evaluated the algorithm. OS environment was in the Ubuntu 14.04(linux) 64bit. The algorithm also was not a dispersion treatment for performance measurements. We used the python programming language and the Sqlite3 was utilized for database. The query was tested in the environment when coming from one second to 300. Each experiment was repeated 100 times to calculate the average. The pseudo code below shows the algorithm proposed in this paper.

Pseudo code 1 : The algorithm for database query management

```
1 : Input : Queries
2 : linear_count=0
3 : linear_value=get_average_value()
4 : start_time=get_time()
5 : for Query in Queries:
6 :  linear_count+=1
7 :  if linear_count == linear_value:
8 :     insert Query to database
9 :     linear_count=0
10: end_time=get_time()-start_time
11: if end_time > 0.1 :
12:    insert Query to database
```

Line 1 shows that are coming into the query input. line 2 is a variable for measuring the count value. Line 3 is a function to measure the mean value per second of incoming queries. Line 4 is the time value for determining the time of the insert when the query to the database. Line 5 is when a portion of the statement begins. Line 6 shows increasing the value of linear_count 1. Line 7 is part of the insert and linear_value linear_count the same Query the database side. That is to insert a database query that calculates the average incoming. Line 10 refers a part of measuring time algorithm ends. Line 11 and line 12 are insert parts which in the database, regardless of the algorithm used to calculate the time of the algorithm if more than 0.1 seconds. The algorithm described in the key as follows. A large amount of queries is put in a database to a different size each time. When you insert the database every time if there are 100 queries come a time when you want to insert the condition of 30 queries coming is delayed. Therefore, you need to specify a time limit. The amount of time is different for each incoming query was used to measure this linear algorithm. Once the data is obtained then an average value was used as the value that corresponds to 1/3 to it to linear value.

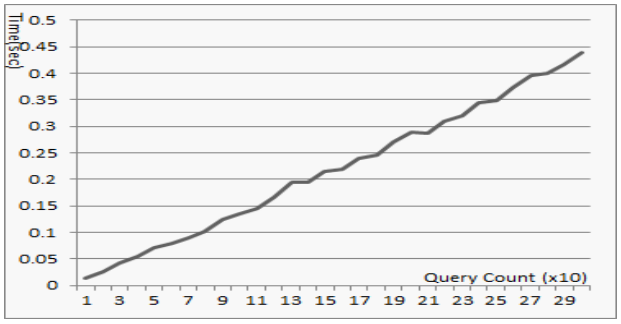

Fig. 4 The time of normal algorithms

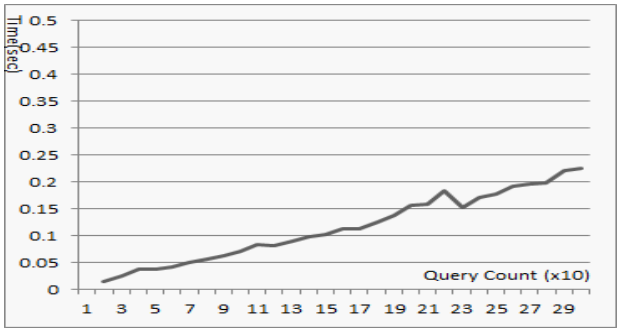

Fig. 5 The performance of linear_value 2

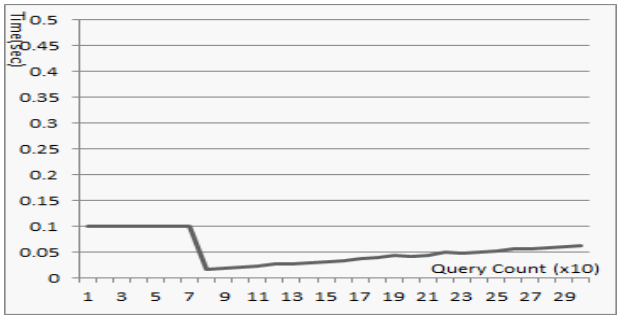

Fig. 6 The performance of pseudo code 1"s algorithm

Figure 4 shows a graph of the amount and the time when the insert query to the database every time the query is coming without applying the algorithm. As it can be seen in the graph, it can be seen that the time continues to increase with increasing amount of queries. Algorithm proposed as a linear value 2. In this algorithm, we except for the parts of the time for the query came example 1 because the test was not applied time limit. Figure 5 shows the performance of the algorithm proposed in this paper. In Figure 5, we can

see that there Query amount of time is 0.1 seconds when 10-70 days because the value linear_value win 7. The query is inserted into the database after 0.1 second, if the inear_value 7, take the time out came the query contains more than 7. Assuming the most common situation is a query 6-10 coming situation can be described as about 30% longer than normal performance method of the algorithm effectively. As well as the present experiment only one thing but considering route to the incoming query is actually the performance of the algorithm is required since more queries in the database will be much higher.

4. Result And future Work

In this paper, we propose a scheme and algorithm of infusion pump monitoring system. The proposed algorithm and schema are more efficient than [4] and real time data stream is also stable. In particular, as for the monitoring system scheme proposed in this paper, the real time data communication was important to maintain a stable data communication. The algorithm proposed in this paper was found to have a time efficient about 30% more than normal method. The contribution of this paper is that studies the reliable data communication. This study will be followed by a more efficient research scheme and algorithms, as well as plans to study how to effectively apply cryptography for securing data communication.

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