Data Reduction In Real Time Database Using Critical And Pivot Points

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Abstract

Data reduction is the important thing in the real time database but the information in this data must not be changed. There are very huge data in the real time system and all these data must not be stored because the restriction in storage media. The general method which is widely used is comparing the recent data with the previous data, if there is change in the value by a factor or large from this factor, the recent value is stored otherwise the current value is not stored. Periodically (daily, weekly or monthly), the data is deleted if there is no need for to it. Here another suggestion is added to this method according which pivot and critical points and specific factor specify the points which can be deleted. This is done according to the increasing and decreasing in the values of data, and then the middle points can be deleted. This deleted data can be retrieved mathematically approximately (near original data). This method has been tested on real data and it's successful.

تقليل البيانات في قواعد بيانات الزمن الحقيقي باستخدام
نقاط الانقلاب و النقاط الحرجة

الخلاصة

بالإضافة إلى الوقت فان تقليل البيانات المخزونة من الأمور المهمة في قواعد بيانات الزمن الحقيقي بحيث لا تؤثر على المعلومات المستخلصة من هذه البيانات. ولأننا نتعامل مع منظومات الزمن الحقيقي فهناك كم هائل من البيانات وليس من المنطقي خزن كل هذه البيانات بسبب التحديد في الوسط ألخزني.من الطرق التقليدية المتبعة بشكل واسع هي مقارنة القيمة المقروءة الحالية مع القيمة السابقة فإذا كان هنالك اختلاف بمقدار محدد أو اكبر من ذالك المقدار فأن القيمة الحالية سوف تسجل و إلا فلا تسجل تلك القيمة. وبشكل دوري (لأيام,لأسابيع أو لأشهر اعتمادا على النظام) يتم حذف البيانات إذا انتفت الحاجة لها. في بحثنا هذا إضافة جديدة لهذه الطريقة وهي استخدام نقاط الانقلاب والنقاط الحرجة بالإضافة إلى عامل يحدد القيم التي سوف تحذف بدون التأثير على المعلومات. وهذا بالأساس يعتمد على الصعود والنزول التدريجي لقيم البيانات وبالتالي يمكن حذف النقاط الوسطية. وهذه البيانات المحذوفة يمكن استرجاعها رياضيا بشكل تقريبي(قريب جدا من البيانات الأصلية).هذه الطريقة جربت على بيانات حقيقية وأثبتت نجاحها.

1- Introduction

There are almost as many definitions of real-time systems as there are books and papers on the subject, this one was chosen which fits the engine control system quite well "Any system where a timely response by the computer to external stimuli is vital is a real-time system".[1]

Real time database takes its specialty privacy from its work on real

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time environment consequently it has different characteristics from conventional database in spite of the misconceptions.[2]

Because the real time has different levels or types there are different algorithms to deal with these different types to cover the characteristics of those types and give better performance of the system .[2]

Real time database is not an independent object but it is part of a system working on these environments, consequently it is restricted to the requirements and the parameters of that system.

In most real time systems we need to store data. These data contain the information which we needed in future time to make report or describe the system operation. Because these systems are real time, the data is very huge. There is limitation in media storage . For these reasons we need to data it should reduction but not affect the information in these data. For these limitations the stored data are selected from all data according to the changing in the value between last two values. In this paper we suggest another simple approach to data reduction by using critical and pivot points.

2- Real-Time System

Real time systems are defined as those systems in which the correctness of the system depends not only on the logical result of computation, but also on the time at which the results are produced. There are many examples of real-time systems which are process control systems, flight control systems, the space station, intensive care monitoring and of humans/robots coordinating to achieve certain objectives.[3,4]

Typically, a real time system consists of a controlling system and a controlled system. For example, in an automated factory , the controlled system is the factory or with its robots, assembling stations, and the assembled parts, while the controlling system is the (real time database) that interacts with the environment from various sensors and human interfaces that manage and coordinate the activities in the factory. Thus, the controlled system can be viewed as the environment with which the computer interacts.[4]

The controlling system interacts with its environment based on the information available about the environment from various sensors.

In a real-time data acquisition experiment, the physical phenomena are measuried has expected limits. For example, the temperature of automobile's cooling system varies continuously between its low limit and high limit. The temperature limits, as well as how rapidly the temperature varies between the limits, depends on several factors including driving habits, the weather, and the condition of the cooling system. This phenomened is useful in data redundancy.[5]

3- Real-Time Databases

A real-time database (RTDB) is a database system where (at least some) transactions have explicit timing constraints such as deadlines. In such a system, transaction processing must satisfy not only the database consistency constraints, but also the timing constraints. Real-time database systems can be found, for instance, In trading programe in the stock market, radar tracking systems, battle management systems, and computer integrated manufacturing systems. Some of these systems (such as program trading in the stock market) are soft real-time systems. These systems are designated soft because missing a deadline is not catastrophic. In hard real-time systems on hand a priori guarantees are required for critical tasks (or transactions). [6]

Most current real-time database work deals with soft real-time systems, that need an integrated approach that includes time constrained protocols for concurrency control, conflict resolution, CPU and I/O scheduling, transaction restart and wakeup, deadlock resolution, buffer management, and commit processing has been identified. Many protocols based on locking, optimistic, and timestamped concurrency control have been developed and evaluated in testbed or simulation environments. In most cases the optimistic approaches seem to work best.[7]

Most hard real-time database systems are main memory databases of small size, with predefined transactions, and hand crafted for efficient performance. The metrics for hard real-time database systems are different than for soft real-time databases.[7]

A real-time database has a demand on the time it may take to find the information asked for, or put another way, the RTDB has to be. predictable. Thus a real-time system must know how long it takes for the database to respond.[8]

5- Simple Approach to Data Reduction in RTDB

This approach depends on the changing in value between last and previous data value. The decision is taken according to factor (permitted changing value, can be denoted by α) the changing value between last and previous reading which must be more than α so that the last value is recorded otherwise it is not recoded [2]. For example if the data which are given by the sensor are in Table (1) (column 2) for the time interval (column 1), the values which recorded if α=0.1, α=1 or α=2 are in column 3, 4 and 5 respectively. These values are plotted in Figure (1). From this figure, the information in the original data is lost (we talk here about two dimension value and time but if we talk about targets tracking which is in four dimensions x, y, z and time this information is very important) if α=2. For these reasons the value of α must be taken carefully according to the system and the out world. The retrieving of not recorded points is very easy by using the projection from the plotted curve.

6- Data Reduction Using Critical and Pivot Points

In this paper we suggest another approach for data reduction in RTDB which depends on critical and pivot points. If we can delete any point which is critical or pivot, we can obtain minimum number of points without changing the information in the data. In Figure (2) we can see the critical and pivot point for the data in Table (1) column (3). How can we delete these points (which are not critical and pivot) from the graph in real times. The critical points may be deleted according to the system. This is done by the following approach, suppose that for two dimensions (value and time) for example temperature and pressure …etc.

First, the value of α is determined according to system (the operation is not affected if α has small value but must not be equal to zero). For the previous example, we take α =0.1. second adding other factor (β) for each dimension. For another example for two dimensions value and time, we take β_v to represent the changing in value and β_t to represent the changing in time. The value of β must be taken according to the system and the accuracy of evaluating the not recorded points.

Each factor (βv and βt) takes two values maximum and minimum.

$\beta_{t\_min} = \beta t \qquad \beta_{t\_max} = 1 / \beta_t$

$\beta_{v\_min} = \beta v \qquad \beta_{v\_max} = 1 / \beta_v$

Any changing in time or value must be between these two values For the last three points:

$P_1(v_1,t_1)$: First point from last three points.

$P_2(v_2,t_2)$: Second point from last three points.

$P_3(v_3,t_3)$: Third point from last three points.

The value of β must be between one and zero ($0 < \beta < 1$) because:

1. if $\beta_t = 1$ this leads to $\beta_{t\_min} = \beta_{t\_max}$ which is not accepted.
2. if $\beta_t = 0$ this leads to $\beta_{t\_max} = \infty$ which is not accepted.
3. if $\beta_t > 1$ this leads to $\beta_{t\_min} > \beta_{t\_max}$ which is not accepted.
4. if $\beta_t < 0$ this leads to β_{t_min} and β_{t_max} negative which not accepted.

The second point P_2 will **not be recorded** if the following formulas is satisfied

$$\beta_{v\_min} < \frac{v_3 - v_2}{v_2 - v_1} < \beta_{v\_max} \quad \ldots\ldots.. (1)$$

$$\beta_{t\_min} < \frac{t_3 - t_2}{t_2 - t_1} < \beta_{t\_max} \quad \ldots\ldots. (2)$$

The formula (2) is used because many values may not be recorded which leads to the time between the two first points in last three points which is large which will affect the graph (information) as in Fig. (3).

From equations 1 and 2, we can conclude the following formula:

$$\frac{\beta_{v\_min}}{\beta_{t\_max}} < \frac{v_3 - v_2}{v_2 - v_1} * \frac{t_2 - t_1}{t_3 - t_2} < \frac{\beta_{v\_max}}{\beta_{t\_min}} \quad \ldots. (3)$$

…………

Then:

$$\beta_{\_min} < \frac{v_3 - v_2}{v_2 - v_1} * \frac{t_2 - t_1}{t_3 - t_2} < \beta_{\_max} \quad \ldots. (4)$$

where

$\beta_{\_min} = \beta_{v\_min} / \beta_{t\_max}$

$\beta_{\_max} = \beta_{v\_max} / \beta_{t\_min}$

We can see that $(t_2-t_1)/(t_3-t_2)$ is positive therefore the negative value for $(v_3-v_2)/(v_2-v_1)$ means that point p2 is pivot point which must be recorded. We must see that the small changing in value will cause neglecting the point according to the value of α.

We can write algorithm for this method with two dimensions (value and time) as follow:

1- Select values for α, β_v, β_t

2- Calculate:

$\beta_{v\_max} = 1/\beta_v$, $\beta_{v\_min} = \beta_v$, $\beta_{t\_min} = \beta_t$, $\beta_{t\_max} = 1/\beta_t$

$\beta_{\_min} = \beta_{v\_min} / \beta_{t\_max}$, $\beta_{\_max} = \beta_{v\_max} / \beta_{t\_min}$

3- Read first value (v_1) from sensor and record it in database and read time(t_1)

4- Read second value (v_2) and time (t_2)

5- If $v_2-v_1 > \alpha$ go to step 7

6- Go to step 4

7- Read next value (v_3) and time (t_3)

8- If $v_3-v_2 > \alpha$ go to step 10

9- Go to step 7.

10- If $\beta_{\_min} < (v_3 - v_2)(t_2 - t_1) / (v_2 - v_1)(t_3 - t_2) < \beta_{\_max}$ go to step 12.

11- Record v_2 and t_2 in database. Let $v_1=v_2$, $v_2=v_3$, $t_1=t_2$ and $t_2=t_3$.

12- Go to step 7.

The program halt can be made in step (7) but here we show the dealing with the equations. The time interval here is constant, i.e. the time is increased by constant value.

This algorithm was applied for the data in Table (1) the result for variable values for β_v and β_t are showing in Table (2). The graph for data in Table (2) are in Fig. (4). We can see in

Figure (4) the curve with β_v=0.75 β_t=0.75 is same as original curve but with less points.

The retrieving of not recorded points can be achieved by using the equation of the line between two known points, and any not recorded point between these two points can be estimated. For example if there are two recorded points (v_1,t_1), (v_2,t_2) and we need to retrieve the value (v_0) at time t_0 where $t_1 < t_0 < t_2$ then we can use the equations (see Figure 5):

$$v_0 = m\,(t_0 - t_1) - v_1$$

where m is the slope of the line

$$m = (v_2 - v_1) / (t_2 - t_1)$$

7- An Equations for More Than Two Dimension

in some applications the input is three dimensions x,y and time (position and time). In this case we must deal with x, t and y, t separately. and we select for each dimension β (β_x, β_y and β_t) The formulas of equation 4 will be as follows:

$$\beta_{xt\_min} < \frac{x_3 - x_2}{x_2 - x_1} * \frac{t_2 - t_1}{t_3 - t_2} < \beta_{xt\_max} \quad \text{.... (5)}$$

$$\beta_{yt\_min} < \frac{y_3 - y_2}{y_2 - y_1} * \frac{t_2 - t_1}{t_3 - t_2} < \beta_{yt\_max} \quad \text{..... (6)}$$

where

$\beta_{xt\_min} = \beta_{x\_min} / \beta_{t\_max}$

$\beta_{xt\_max} = \beta_{x\_max} / \beta_{t\_min}$

$\beta_{yt\_min} = \beta_{y\_min} / \beta_{t\_max}$

$\beta_{yt\_max} = \beta_{y\_max} / \beta_{t\_min}$

These two formulas (5 and 6) must be manipulated separately because if $(x_3-x_2)/(x_2-x_1)$ is negative (pivot point with respect to x-axis) and $(y_3-y_2)/(y_2-y_1)$ is negative (pivot point with respect to y-axis) and dividing these two negative values by them will give positive value (not pivot point).

For four dimensions x, y, z (height) and time the formulas will be:

$$\beta_{xt\_min} < \frac{x_3 - x_2}{x_2 - x_1} \; \frac{t_2 - t_1}{t_3 - t_2} < \beta_{xt\_max} \quad \text{...(7)}$$

$$\beta_{yt\_min} < \frac{y_3 - y_2}{y_2 - y_1} \; \frac{t_2 - t_1}{t_3 - t_2} \text{V} < \beta_{yt\_max} \quad \text{...(8)}$$

$$\beta_{zt\_min} < \frac{z_3 - z_2}{z_2 - z_1} \; \frac{t_2 - t_1}{t_3 - t_2} < \beta_{zt\_max} \quad \text{... (9)}$$

where

$\beta_{xt\_min} = \beta_{x\_min} / \beta_{t\_max}$

$\beta_{xt\_max} = \beta_{x\_max} / \beta_{t\_min}$

$\beta_{yt\_min} = \beta_{y\_min} / \beta_{t\_max}$

$\beta_{yt\_max} = \beta_{y\_max} / \beta_{t\_min}$

$\beta_{zt\_min} = \beta_{z\_min} / \beta_{t\_max}$

$\beta_{zt\_max} = \beta_{z\_max} / \beta_{t\_min}$

Conclusions

In this paper, Data Reduction in Real Time Database Using Critical and Pivot Points is discussed. We conclude the following points:

1. Because the simple equations and the number of points needed to make decision (specific point is deleted or not) are few (three points), this method confirme its successfully for dealing with RTDB.
2. This method is efficient for the data which in wave form format.
3. This approach can be used for data compression in real time systems.

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Table (1)
Data recorded with variable values of a factor (a)

Time unit	Data out the sensor	Data recorded if α=0.1	Data recorded if α=1	Data recorded if
1	30.00	30.00	30.00	30.00
2	30.50	30.50		
3	31.00	31.00		
4	31.20	31.20	31.20	
5	31.40	31.40		
6	31.91	31.91		
7	32.00			
8	32.00			
9	32.01			
10	32.02			
11	32.00			
12	31.00	31.00		
13	30.50	30.50		
14	30.30	30.30		
15	30.10	30.10	30.10	
16	29.70	29.70		
17	29.30	29.30		
18	29.10	29.10		
19	29.00	00.00	29.00	
20	28.50	28.50		
21	28.00	28.00		
22	28.00			
23	28.50	28.50		
24	28.41			
25	28.33	28.33		
26	28.56	28.56		
27	29.00	29.00		
28	29.00			
29	29.50	29.50		
30	30.00	30.00	30.00	30.00

Table (2)
Recoded data by applying the suggested algorithm with variable values of b

Time unit	Data Recorded α=0.1 without β	Data recorded α=0.1 β_v=0.75 β_t=0.1	Data recorded α=0.1 β_v=0.75 β_t=0.25	Data recorded α=0.1 β_v=0.75 β_t=0.75	Data recorded α=0.1 β_v=0.5 β_t=0.1	Data recorded α=0.1 β_v=0.1 β_t=0.1
1	30.00	30.00	30.00	30.00	30.00	30.00
2	30.50					
3	31.00	31.00	31.00	31.00	31.00	31.00
4	31.20					
5	31.40			31.40		
6	31.91	31.91	31.91	31.91	31.91	31.91
7						
8						
9						
10						
11						
12	31.00			31.00		
13	30.50			30.50		
14	30.30					
15	30.10			30.10		
16	29.70					
17	29.30			29.30		
18	29.10					
19	00.00					
20	28.50			28.50		
21	28.00	28.00	28.00	28.00	28.00	28.00
22						
23	28.50	28.50	28.50	28.50	28.50	28.50
24						
25	28.33	28.33	28.33	28.33	28.33	28.33
26	28.56					
27	29.00					
28						
29	29.50					
30	30.00	30.00	30.00	30.00	30.00	30.00

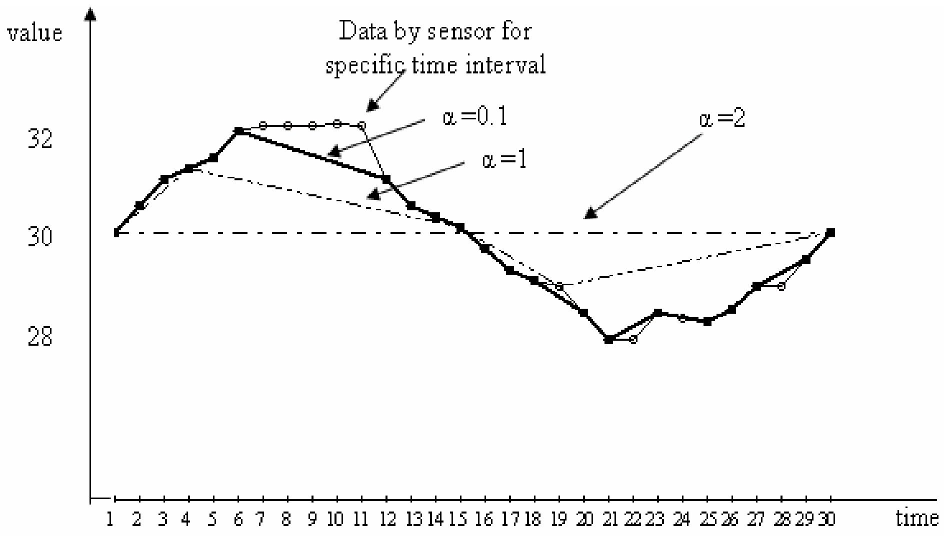

Figure (1) Recorded value for α=0.1, α=1, α=2 with original graph

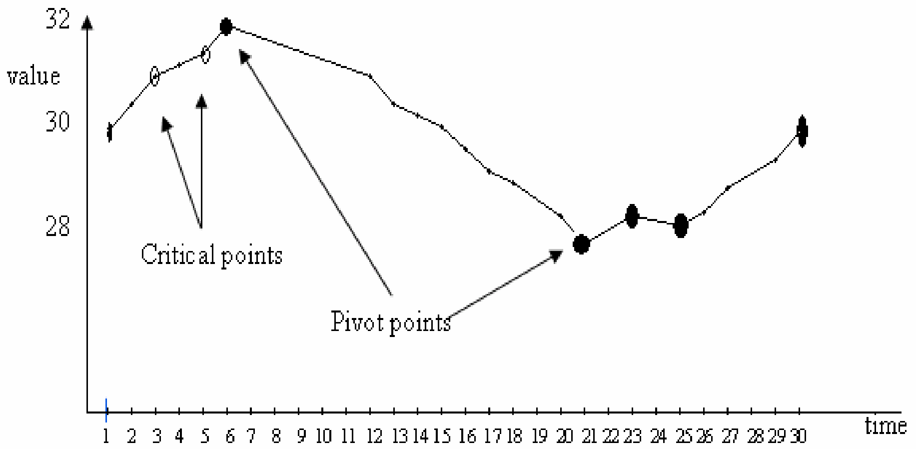

Figure (2) Critical and pivot point

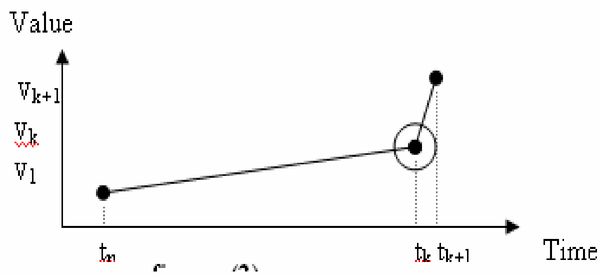

figure (3) The large time interval between the two First points from last three points (result from not recorded points). Where n, k any positive numbers

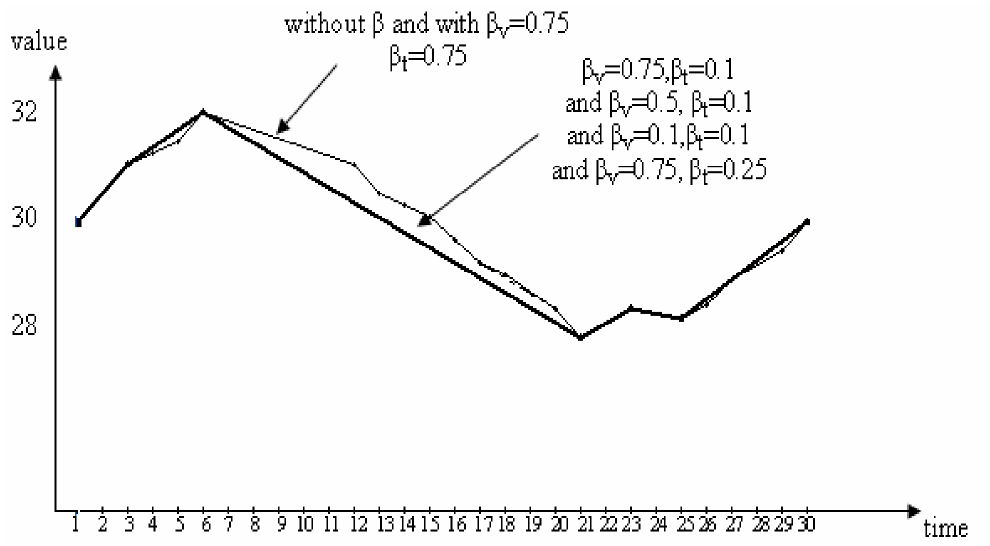

Figure (4) Graphical representation to the Recorded values in table (1)

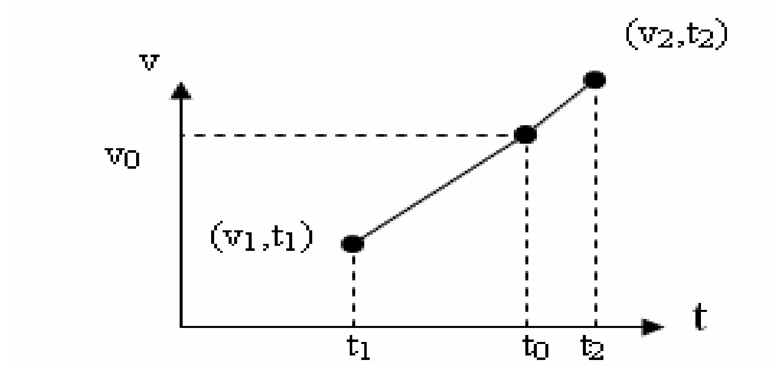

Figure (5) Retrieving point from the line