An Efficient Complex Event Processing Algorithm Based on NFA-HTBTS for Massive RFID Event Stream

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ABSTRACT

This article describes how quickly picking up some valuable information from massive RFID event stream often faces with the problem of long detection time, high memory consumption and low detection efficiency due to its stream characteristics of volume, velocity, variety, value and veracity. Aim to solving the problems above, an efficient complex event processing method based on NFA-HTBTS (Nondeterministic Finite Automaton-Hash Table B+ Tree Structure) is presented in this article. The achievement of this article lies in that we successfully use the union of NFA and HTBTS to realize the detection of complex event in massive RFID event stream. Specially, in our scheme, after using NFA to match related primitive events from massive RFID event stream, we use hash table and B+ tree structure to successfully realize the detection of complex event from large matched results above, as a result, these problems existed in current methods above can be effectively solved by our scheme. The simulation results show that our proposed scheme outperforms some general methods for massive RFID event stream.

KEYWORDS

Complex event processing, B+ tree, NFA, RFID event stream

1. INTRODUCTION

With the rapid development and growing maturity in RFID (Radio Frequency Identification) technology in recent years, a large number of RFID devices have been widely used in many areas of modern life, such as supply chain management (Lee et al., 2008), health care (Kwon et al., 2013), air monitoring (Honda et al., 2014), power network management (Sitthidet et al., 2014), pervasive computing applications (Boytsov et al., 2013) and industrial manufacturing (Son et al., 2014). The wide usage of RFID devices generates massive RFID event stream. However, the characteristics of massive RFID event stream: huge volume, high velocity, many variety, small value and not veracity, etc., makes the existing event processing methods on event stream difficult to rapidly deal with the massive RFID event stream above, thus seriously affecting its whole processing efficiency. So, how to develop a technology to quickly get desired information from massive RFID event stream has become an important issue in this paper.

DOI: 10.4018/IJITSA.2018070102

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Since CEP (Complex Event Processing) (Del et al., 2007) technology can rapidly pick up valuable information from massive RFID event stream by taking advantage of the association between event attributes, matching rules and algebraic operations for users, therefore, it has obtained increasing attention in the field of event stream processing.

In recent, many researches on CEP have been done to detect a complex event from various streams. In the processing systems aspects, some general complex event processing systems, such as Cayuga (Demers et al., 2007), Esper (2010), Estream (Garg et al., 2005), PQS (Cybenko et al., 2007), have been developed to provide the basic processing functions for complex event. In processing methods aspects, some general complex event processing methods, for example, complex event processing method based on petri-nets (Wang et al., 2006), complex event processing method based on diagram (Bai et al., 2009), complex event processing method based on tree (Sun et al., 2009), complex event processing method based on finite automatons (Mei et al., 2009), complex event processing method based on workflow (Zang et al., 2009), etc., and their some optimized algorithms, such as complex event processing method based on timed petri-net (Jin et al., 2008), complex event processing method based on optimized directed graph (Wang et al., 2006), complex event processing method based on compressed composition tree (Li et al., 2010), complex event processing method based on pushdown automata structure (Cao et al., 20114), and so on, have been studied to detect a complex event. However, since these processing systems or methods above need to take many repeatable unnecessary inserting, storage and search operations when detecting a complex event for massive RFID event stream, which can result in long processing time, high memory consumption and low event throughput.

Aiming to solve the problems above, an efficient complex event processing method based on NFA-HTBTS is proposed in this paper. The achievement of this paper lies that we use the union of NFA and HTBTS to successfully realize the complex event detection for massive RFID event stream. Specially, in our scheme, after using NFA to match related primitive events from massive RFID event stream, we successfully use hash table and B+ tree structure to realize the detection of complex event from large matched results, as a result, these problems existed in current methods above can be effectively solved by our scheme. The experimental results show that our proposed schemes are effective to reduce detection time and lower memory consumption and improve event processing throughput compared with some general methods for massive RFID event stream.

The rest of this paper is organized as follows. In section 2, the related works of complex event detection. Our proposed scheme is presented in section 3. The experimental results and analysis with our proposed scheme are shown in section 4. In section 5, we give some conclusions.

2. RELATED WORK

In recent, many studies on CEP have been taken to detect a complex event processing in various event streams. In the processing systems aspects, in the processing systems aspects of complex event, Demers et al. (2007) developed a Cayuge system, which mainly used customized automatic machine to realize complex event detection. Esper Tech company (2010) developed an Esper system, which mainly realize the complex event detection over real-time data stream by using the event match rules, event type inheritance, graph structure of object, event dynamical property, and so on. Garg et al. (2005) developed an EStream system, which mainly completed the detection of complex event in event stream by taking advantage of its integrated event interrogator and predefined rules. Cybenko et al. (2007) developed a PQS system, which mainly used NFA (Nondeterministic Finite Automaton) and invisible Markov technology to realize the detection of complex event. Eugene et al. (2006) developed a SASE system, which realized the detection of complex event over real-time RFID event stream based on use of NFA (Nondeterministic Finite Automaton) and active instance stack.

In the processing methods aspects, some general complex event processing methods, for example, Wang et al. (2006) proposed a complex event processing method based on petri net. Bai et al. (2009) presented a complex event processing method based on graph. Sun et al. (2009) suggested a complex
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