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Research in Complex Event of Intelligent Logistics System's Warehousing and Storage Activities

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Abstract: Complex event refers to many fields, such as finance, telecommunications, banking, automotive, and so on. Especially, it has an advantage of dealing with real-time data stream. However, as the gradually mature of IOT, there being a lot of real-time data stream problem that are difficult to be solved. The research we study is how to tackle these urgent and complicated problems with Complex Event application that oriented Intelligent logistics system and Networking Middleware.

Keywords: Intelligent Logistics System, Warehouse Link, Networking Middleware, Complex Event

1. Introduction

Complex Event in Intelligent logistics system aims to extract information from logistics operating, and these information are so complex compounding with different business logic. thus, it's necessary to definite and describe these information to keep its value, and then, we can get the complex event what we need integrating with business processes and compounding these seemingly scattered information that there is no relation between them. What is the case, what is the event, what is the complex event, and the study of a simple and clear definition of complex events and description language. And the processing model and processing method of the complex event are combined with the storage link business in the intelligent logistics system. Warehousing business can not only be independent as a link, but also can be integrated in the whole supply chain of intelligent logistics, this paper to warehousing logistics as an example, the focus of analysis based on storage business logic complex event processing.

2. Overview of Complex Event

2.1. Complex Event

Complex Event is abstractly combined by two or more atomic events or elementary complex events, also be called the combination of events. the combination of abstract events known as members of the event. In the world of computer science, events are often defined as "a significant change in the state" [1], or "a change in the behavior or state of the past." [2]

2.2. Complex Eventing Processing

The earliest research on complex eventing, Complex Event, comes in discrete event simulation [3], active database [4], the event stream processing [5], and so on. The Complex Event was created in the book of "the power of events ". In this book, Complex Event is a collection of a specific tools and techniques used to analyze and control the complex association of events to drive the information system [6], For example, event B happens after A in 5 minutes, and C finished it within 10 minutes as for B. This association has limitations of order like A, B,C, time as 5 minute, and space for the distance of 100m between A and B, and other restrictions as levels, the system will not respond until the specific mode works. The most fundamental difference between Complex Event and event processing is that Complex Event has the capable of handling more complex patterns.

3. The Definition of Events

Events in the logistics field in general refer to the effective things of the business operation which associated with some labels or not. And, it relates to delivering, warehousing, inventory and order picking. It doesn't work with these events such as statements query, order management, user information and system parameters, etc.

In the warehouse, data acquisition equipment mainly includes RFID reading and writing device, ZigBee with a sensor, a camera, and relates to the storage, pick sheet, storehouse, etc. Based on the characteristics of IOT and Intelligent logistics system environment, these events can be divided into three levels, namely, atomic events, basic events and complex events. Of course, this division is limited in the storage areas. It will be divided into more kinds of complex events if expands the entire logistics link or supply chain.

3.1. Atomic Events

In logistics enterprises, basic tuple can't meet customer demand, such as agricultural products, the traceability of the processing products, cigarettes, and other special goods to prevent commodities fleeing and play other unfair plays. The specific description of the event is based on it in this paper [7], put forward the atomic event of five tuples. As shown below, the items of flow information play an important part to goods' records overall the sales process, as well as the product traceability.

$E=(Eid, Location, Time, Info, Flow), E_i, E_j, i\neq j, E_i.E_id\neq E_j.E_id$

The type of event is used to indicate the information types and nature that are related events when the thing occurs. Among them, Eid, events ID, is used to note its category; location symbolizes the position coordinates of the event, such as RFID read events with the reading and writing device number, which also can be expressed reader collection; time show the point or time segment the event happens, or a time range; info demonstrates the event nature of name-value pairs collection. Info={<info 1,value 1>, <info 2, value 2>, <info n, value n>}, $n \geq 0$, and it can definite the range. A name-value has its tuple with variable names and values and pertain to event instances of a certain event types can point out the variables which contained in different types of events, and it's similar to simple object instances without member functions, attributions of variables are definited in the event types and event instance itself does not describe the nature, such as, RFID output the event for the info = {<tag, FFFF00000000000000000001>}, ZigBee transmit temperature and humidity information of the event for the info= {<temp, 30>, <humi, 30>},flow represents the event flow, as: Flow={<node S1, node e1>, <node S2, node e2>,<node, S N, node e n>}, in the event, V stand for the flow sender, namely, the logistics of the main node set; E represent the receiver, i.e. the receiver main node set.

This paper will definite atomic events of complex event types by the XML, e.g. the RFID reads the specified label set of event types can be defined as follows:

<event Eid = e1>
<location>
<hardware ID>002</hardware ID>
</location>
<time> 20150822090925</time>
<info>
<tag>FFFF00000000000000000001</tag>
<temp>30</temp>
</info>
<flow>
<node s1>A01_14Ex-warehouse</note s1>
<node e1>B01_06En-warehouse</note e1>
</flow>
</event>

From these examples, we can see that atomic events E1 symbolize the position 002 and scan the EPC within 10 seconds (on 9 O'clock 9 minutes 25 seconds, 22th/August/2015) in the time window, and the EPC code is FFFF00000000000000000001. Items with EPC code will be transported to No. 06 warehouse of the B01 enterprise from No. 14 warehouse of A01 enterprise.

3.2. The Elementary Events and Complex Events

Elementary events are specific meaningful event entities which are based on atomic events and abstracted from action and logic, and complex events with different application systems in the business logic aggregated into different complex degrees. If the goods are produced by A and distributed to the sales center B, reader of B will be indicated as followed:

Event instance distribution center B:

Distribution center reader device to capture the tag information of the basic event :

EVENT
e1
<01004001","20150820155523","entrance","FFFF00000000000000000001","A01_14Ex-warehouseTOB01_06En-warehouse">

Sensor to temperature and vibration in packaging of the basic event information:

EVENT
e6<"0100500,"20150820155524","entrance","temp,30","A01_14Ex-warehouseTOB01_06En-warehouse">

A complex event is made up of polymerization:

<Create B Event >
<description> enter warehouse</description>
<event Time>20150820155523-20150820155524</event Time>
<parent ID>SSS0001002003040</parent ID>
<child EPCs>
<EPC>FFFF00000000000000000001</EPC>
</child EPCs>
<action>delete</action>
<location>01002003040entrance</location>
<hardware ID>002</hardware ID>
<temp>30</temp>
<flow>

<node s1>A_Ex-03warehouse</note s1>
</flow>
<Create B Event/>

The above item is a packet storage process of complex event that NO.3 warehouse of manufacturer A removed to NO.1warehouse of distribution center B and temperature and vibration at the entrance of01002003040 of distribution center B. Tags are a carton or pallet EPC and 1 EPC item, warehousing operations would be completed before reader at the entrance have checked the linked link flows of the tagged object and transmit messages to PC whether the batch of goods is from a warehouse or not and correct the updated inventory. The batch of goods will generate alarm goods flowing if one of them makes fault that detection of flow unit is not a producer of A or flow units is not distribution center B. Commodities fleeing are generated.

3.3. Middle Ware Model of Complex Event

The complex event is meaningful event with an start time and an end time which is not constant until in a certain period. Different types of operation rules and matching methods can show complex events behind the information contained in [8]. Complex event types here are divided into two categories, one is sequential type, the other is a hierarchy.

Sometimes sequential complex event model can be generally divided into 4 categories: parallel, selection, time sequence, negative.

A hierarchy complex event model represents the logical level among events, a simple understanding of the events can use "and" and "or" to present the relationship and not related to orders.

Complex event has its unique model in Intelligent warehousing logistics, following the table 1:

Table 1. *Complex event types for example.*

Complex Event models	Events types	Examples
Sequential complex event model	Parallel complex event	Warehousing events: goods warehousing, testing and storage shelves
	Selective complex event	Environmental monitoring events: the status information of the sending item and the surrounding environment information
	Time sequence complex event	Sorting and outbound events.
	Negative complex event	Warehousing events: special items not up to the standard is not allowed to library and storage.
Hierarchical complex event model	Each complex event is aggregated by a lot of events, and the events and complex events have a hierarchical relationship	Inventory events: consists of the shelf information, inventory information, no illegal warehouse information and other events. Supply chain events: a combination of inventory events of supply chain upstream and warehousing events of supply chain downstream, transport events.

4. Study on Complex Event Model of Warehousing Logistics

Complex Even [9] is a technology to get date and analyze data, including event filtering, the hierarchy handling and pattern matching, the users with different responsibilities can access their data information which can be the bottom of the original data, can be reporting information in each stage and can be the enterprise management decision by using Complex Event technology. The information permission is not unchangeable, it can be changed at any time by the system operators' controlling.

This paper are highlighted on analyzing the Complex Event of logistics warehousing business logic, because it already has an in-depth study on data processing and event detection algorithm of complex events, its filtering and detection will not to be studied in the paper. First of all, the logistics business of typical warehouse are analyzed to get the business model, and then, the operator will change model information into the corresponding complex event by the application of complex event description language.

4.1. Analysis of Typical Warehousing Logistics Business

From the perspective of logistics, warehouse management is an storage, custody, management and supply activity of raw materials or finished goods in order to ensure the goods without damage, deterioration and loss and regulate the production, sale and consumption activities and keep the continuity of social production and life according to the requirements of market and customers. The main function of storage are storage, picking and distribution.

4.1.1. Warehousing Business

Intelligent storage management is management system, we need to do some simple preparatory work before they enter the warehouse, for example, we need to give the provisions of goods in warehouse physical distribution unit (carton or pallet) and packaging rules before they enter the warehouse and develop a coding system to the circulation of goods unit and storage and complete label binding by distributing EPC code to the goods and flow unit and this information will be written in the RFID tag with EPC encoding label which is on the storage unit, and circulation of good [10].

4.1.2. Picking Business

The use of LP light guidance assist selection system to help completing the sorting work in the warehouse by displaying the picking items' number and location, workers pick them according to the digital information or number of TS projection device image, and automatic steer the next chosen location before finished in the handheld end that TS project the image of OK.

4.1.3. Library Business

Intelligent warehouse management is to label goods before packaged and bind labels between articles in the box and packages. The goods can be library before RFID access door read the box and the items inside the tag and display information and check them when the packaging box out of the library.

4.1.4. Inventory Management

The inventory management is detect the frame product information and update inventory through the smart shelves which monitor real-time inventory information and update them, the storage system generate replenishment notice and notify the purchaser and supplier delivery if the inventory information is less than a certain range.

4.1.5. Inventory Operations

The use of intelligent vehicle help to complete inventory operation. the roadway between the shelves installed mobile antenna can move along the shelf direction under the artificial operation when receiving the instruction location and state information count.

4.1.6. Environmental Monitoring

Environmental monitoring collect environmental information like temperature, humidity, pressure, and vibration by installing all kinds of sensors applications in the storage environment and storage environment information in the host computer for through the ZigBee network. Achieving environmental monitoring of the production process and ensuring production safety and product subsequent traceability requirements by binding and keeping the real-time environmental information and products encoding.

4.2. Complex Event Model of Warehousing Operations

Different elements achieve different functions based on the above analysis and extract the action elements. Model as shown in table 2 are based on the different business complex event.

Table 2. *Table storage business model.*

Events number	Events name	Model composition	Elementary events
A001-01	Labeling event	encoding + label written	The label is written with the EPC encoding and the tag is attached to the item.
A001-01	Labeling event	encoding + label written	The label is written with the EPC encoding and the tag is attached to the item.
B001-01	warehousing	Goods warehousing + goods information checking+ position displaying+ personnel information recording+ item information reading on shelves+ alarm information	read the item number at the entrance+ screen displaying, environment information, the goods storage location checking, operator recording and environment operation record, the information of goods reading on shelves+ special items of environmental information will not allowed to storage and alarm if they are not in the normal range.
B001-02	Picking events	The synthesis of the picking orders + picking orders position placed + +compound	binding orders and generating the picking orders+ equipment indicate the quantity and the position of the chosen items+ prompting items into a definite position number according to the voice device+ compounding them according to the items order. Note: this sorting is only suitable for the small and multiple batches of electricity supplier terminal customer order picking. For large three-dimensional library, wholesale sales model selection is not to be discussed temporarily.
B001-03	Library events	Generate a library order+ package+test+ inventory+ check information+ record personnel information+ display will be distribution vehicles.	Generate library order +package the chosen goods+ test the packaged items and environment information+ read the packaged items' information in outbound channel+ check the quantity and detailed information of the flow of goods+ display distribution vehicle information+ special items of environmental information will not allowed to storage and alarm if they are not in the normal range.
B002-01	Loss events / error message	Storage + shelf Reading + not picking +not library+ time period does not appear in the absence of goods' information	goods shelves can scan the information before goods warehousing, if not doing the picking and shelf library operation and continuous period of time without any items information will alert.
B002-02	Theft events / error message	Warehousing + shelf Reading + not picking + library + customer information checking is not successful	goods shelves can scan the information before goods warehousing, if not doing the picking and shelf library operation and continuous period of time without any items information, but the information is read at the entrance and check the flow of goods' information and the operation is not complete, it will alert.
B001-04	Inventory events	Read + real -time upload (+ environment detection)	Read the information on the shelf + upload the storage of goods in real-time information to the host computer+ the status of the item and the environment information are detected if it is a special item on the shelves.
C001-01	Environmental testing events	develop standard+ Read + upload + prompt ventilation and other operations.	develop environmental standards to special items+ read the warehouse and other environmental information of the shelves+ upload information to the upper computer within the standard range and information out of the range will warn an alarm and upload the information to computer.
C001-02	Query events	Enter the query condition + returns the result of the query	Select query conditions (including the time, place, shelf, inventory, inventory, environment or status information, or a certain class of equipment, etc.), and generate reports.

Other events like user events, system events and abnormal events are not introduced in detail.

5. Summary

This paper mainly introduces the Complex eventing mechanism, firstly, the origin of Complex Event and con Complex eventtions of simple and complex events have been introduced. Secondly, giving definition of atomic events the basic events and complex events and making an description in language. Proposing the Complex Event model research for logistics and warehousing business by using the complex event semantic rules and operation description in XML language in this chapter.

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