The Location-based Knowledge Management System Development for e-Logistics Application

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Abstract: - Because the transport expenses are more than a half the national logistics expenses, the increase of the transport expenses becomes the cause of an increase of national logistics expenses. To decrease of the logistics expenses, it has to develop logistics management application. Many Transport Companies are serving monitoring position of the transport vehicle, but the position data of the moving vehicle are not adapted logistics applications till now. For these reasons, the manager who takes charge of transport management must keep monitoring and analyzing the movement of the truck to confirm vehicle routing and scheduling. If the manager detects some problems, then he must notify the truck driver of the information or solution. But, it is difficult that the manager monitors the moving vehicles for all day. In this paper, we propose the Location-based knowledge management system using the active trajectory analysis method. This system uses an inference engine to generate the logistics knowledge that can be furnished to the manager.

Key-Words: - e-Logistics, Knowledge management, Inference, trajectory, moving object

1 Introduction
The logistics expenses are the sum of the transport, storage and management expenses. Transport expenses become the cause of an increase of national logistics expenses because the transport expenses are more than 50% of the national logistics expenses.

To decrease of the logistics expenses and to renovate a logistics process, the large Transport Companies are trying to develop logistics systems. The major functions of these systems are to allocate trucks for transport, to plan for transport route, to intermediate between goods holder and a vehicle, to track the vehicle, etc[1, 3, 4, 5].

Expressly, the service to inform customers where goods are located or when goods are delivered does not only satisfy of the customers who want to know about the transport status of their goods, but also improve the trust of the Transport Company. Many people are studying a real-time tracking system the moving object with the GPS(global positioning system), beacon or cell ID. The existent tracking system show users the current position, past position or past trajectory of vehicle at user’s request. However, this is just the monitoring service of the position data of the vehicles. The position of moving vehicle is the important information to be basis of the scheduling, routing and managing transport. But the position data of the moving vehicle are not applied logistics applications to improve transport process till now. The manager who takes charge of transport management has to keep monitoring and analyzing the movement of the truck to confirm movement route and delivery schedule. If the manager detects some problems, then he must notify the news or the solution about the problems to the vehicle driver. But, it is hard that the manager monitor moving vehicles for all day or that the manager communicate to moving vehicle driver.

In this paper, we propose the system that analyzes the position data of vehicle and generates the results to support transport, automatically. This system that we define the LKM(location-based knowledge management system) uses the inference engine to generate logistics knowledge and support manager’s decision about transport process, finally.

Section 2 of this paper presents some opinions on what evaluation is; section 3 explains moving object engine to management the location data of moving vehicle; section 4 describes the LKM and the system architecture; and section 5 summarized and conclude.
2 Motivations

Most transport manager plans for the delivery schedule and route. The goods holder is able to obtain this information through web service and expects that his or her goods are delivered on the scheduled time. For this reason, to observe delivery schedule has effect upon not only the plan to use goods of goods holder but also the credit of Transport Company.

For example, truck A has delivery schedule that consists of the route; depot a->depot b->depot c->depot d. The manager of delivery points or the goods holder already knows expected time to deliver goods. Truck A has to leave depot a and complete the transportation at the appointed time.

Let the notations be as follows;

\[ t = \text{real time} \]  \quad (1)  
\[ p_t = (x_t, y_t), \quad x, y \in \mathbb{R} \]  \quad (2)  
\[ P_t = (x_t, y_t), \quad x, y \in \mathbb{R} \]  \quad (3)

\( p_t \) is the real location of truck A at \( t \) and \( P_t \) is the expected location of truck A at \( t \).

If \( p_t < P_t \), the transport manager has to grasps the cause of transit delay and find the solution for regular delivery. The transport manager is able to request that the truck driver should deliver on schedule or give notice beforehand goods holder of new plan after reschedule delivery. So that, to execute transport schedule within the limits of the possible, it requires the method to manage transport according to location of the moving vehicle.

The LKM to be supposed in this paper tracks the location of the moving vehicle in real time and analyses out the status of transport by comparing the location with the expected location in the transport schedule by itself. We call this function the active trajectory analysis.

3 Moving object engine

The Location-based knowledge management system (LKM) infers logistics knowledge from the position data of moving vehicle. To search the position data or trajectory from moving object database, LKM uses moving object engine.

Moving object engine is the major module of the moving object management system (MOMS) to be proposed in [2]. Many operators are defined in MOMS to search the moving object. To offer there operators, moving object engine has some functions.

- Moving object engine supports moving object index using page file techniques. Moving object index manage effectively moving object data in database and respond quick to query about moving object.

- Moving object engine supports uncertainty processor. Because the moving object data is written at regular intervals in moving object database, all data are not saved. If a user requested these data, then the moving object engine assume the position data that is valid at the querying time using uncertainty processor from database or moving object index.

- Moving object engine supports not only spatio-temporal operators, but also relational operators on spatio-temporal object.

- Moving object engine supports the moving object index creator and management tool.

LKM executes spatio-temporal operators for trajectory analysis with moving object engine, and two modules interchange information each other by packet.

![Fig.1 The MOTE architecture](image-url)
dimensional position and timestamp. It also answers to the user’s query which is related trajectory operation.

4 LKM system
The LKM consists of graphic user interface, inference engine and knowledge base. To design inference engine, we define facts about moving objects and rules about logistics work. The facts are generated through active trajectory analysis method that is proposed in the chapter 4.2

4.1 LKM concepts
The goal of the LKM supports the transport manager’s decision support. We designed the LKM in consideration of three items. First, we used existent inference method. The LKM infers knowledge for moving vehicle using ‘IF fact THEN rule’ logic. There are two kinds of inference strategy.

• Forward Chaining: A→B, if A is in working memory, then B will be executed. This strategy uses the deduction.

• Backward Chaining: A→B, in ‘IF A THEN B’ logic, if necessary, system infer B from A.

   Backward chaining executes only rules that satisfy predefined conditions. But Forward chaining is mainly used in the inference system because design of backward chaining is difficult. In addition, the relationship of some rules to belong to one assumption is represented with ‘OR’ and ‘AND’, like ‘IF fact, THEN rule1 and rule2 and rule 3’.

   Second, to search the position data or trajectory from moving object database, the LKM uses the moving object engine. We explain the moving object engine at section 3.

   Third, we generated the facts about the movement status of objects using the active trajectory analysis method.

   The LKM generate facts using forward chaining in real-time. In the LKM, The properties of rule, fact and inference process are as follows.

• Moving object fact: The facts are the results of analyze trajectory. So, we call facts ‘moving object fact’.

   – The moving object fact is stored in the knowledge base.

   – The moving object fact is the event for the rule or rules.

   – The moving object fact is generated from the position data of the moving vehicle.

   – The basis of the moving object fact generation is the moving pattern of the vehicle and the transport schedule.

• Logistics rule: The logistics rule defines the basic of decision and the action about mo fact using the knowledge of the logistics export. The properties of rules are follows;

   – The logistics rule is stored in the knowledge base.

   – One logistics rule can be the event for the other rules.

   – The achieve strategy of logistics rules is defined as meta-rules.

   – The meta-rules can be the event for the logistics rules.

• Inference process: Using moving object fact and logistics rule, inference engine executes following order.

   – It defines the moving objects facts and logistics rules and construct the knowledge base.

   – It decides the vehicle list and the period to apply the LKM.

   – The LKM searches the position data of moving vehicle in real-time through the moving data management system.

   – The Fact generator produces event and check this event is moving object fact or not.

   – If moving object fact generated, rule scheduler make a schedule for the achievement of the logistics rules.

   – Rule executor runs the schedule of the logistics rules and generate a control message.

   – The manager decides to send or do not the control message.

4.2 Active Trajectory Analysis Method
The purpose of the LKM is to support manager’s decision for logistics work, particularly transport, using the inference engine. The major property of the LKM is active trajectory analysis.

   To analyze effectively trajectory, the following conditions must be considered.

• The moving object data must be managed in real-time.

• For fast trajectory operation, operation algorithms must be designed.
The basis to analyze trajectory must be given. The basis to filter data to be analyzed must be given.

The LKM uses moving object engine to query moving object data or trajectory. Moving object engine saves the moving object data and manages the position or trajectory of moving object in real-time. The position and trajectory of moving object is basis data for active trajectory analysis. Also as the basis to analyze trajectory, we use the routing and scheduling plan that is predefined by transport manager before the transport vehicle leaves.

The result of analysis is able to use fact that is event of inference. For effective knowledge inference, facts are designed using logistics export’s knowledge before logistics manager execute inference.

### 4.3 System Architecture

The LKM consists of two modules, intelligent application and inference engine. Intelligent application has user interface and decision maker. And inference engine has moving object routing and scheduling loader, moving pattern loader/selector, fact generator, rule scheduler, rule executor. Fig.2 shows the LKM system architecture.

- **User interface**: The moving object data have to be filtered because inference cost is too expensive to execute about all data. In user interface, user is able to set up a preference of the LKM. The elements of the preference are inference period set up, SMS manager, fact/rule definition, vehicle id set up.

- **Decision Maker**: The final result of inference is control messages. The knowledge generated from inference engine can request optional actions to another system by logistics manager’s decision. Decision maker writes control message and transmits this message another system.

- **Moving object routing and scheduling loader**: 

![Location-based knowledge management system data flow diagram](image-url)
The routing and scheduling plan is major basis data for analysis moving object data. This plan is saved in routing and scheduling (R&S) database not moving object database. This loader calls the suitable routing and scheduling plan for analyzed data.

- **Movement pattern loader/selector**: In spite of routing and schedule plan, detailed route between delivery points is decided by vehicle driver. Movement pattern loader/selector calls general movement pattern of vehicle from past data.

- **Fact generator**: Facts are generated from the moving object data. Moving pattern loader/selector calls movement pattern and scheduling loader call routing and scheduling plan about the target data of inference. Fact generator makes a factor to be fact using these data and judges this factor can be a fact or not.

- **Rule scheduler**: A fact can use the event of a rule or rules. Also, a rule can use the event of a rule or rules. Rule scheduler calls the rule IDs selected by fact and make an execution list.

- **Rule executor**: Rule executor includes not only rules but also action module. In LKM, rule executor have SMS sender. If necessary, we can design additional action module.

The Fig.3 shows the data flow in the LKM. The input data of the LKM is the current position of moving vehicle and the output data is inferred result. The SMS message is sent by transport manager’s decision.

### Knowledge Base Schema

The knowledge base has the rule schema and the fact schema. In the table 1, DiffTime is a function to define the fact. The result of DiffTime is the status of moving object and it is computed with the functions defined in the PREDICATE attribute. The MoreThan(-20) AND LessThan(-40) means that the position of the moving object delayed more than 20 and less than 40 as compared with schedule.

In the table 2, the ACTION attribute is the function to be executed lastly. In the case, the SMS function send ‘delay warning’ message to driver. The rule is executed by satisfying two condition; PREDICATEFACT and PREDICATEVEHICLE.

Additionally, the fact and rule have a period of validity. If the period of validity is completed, than the fact or rule is not executed any more.

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### Implementations

We implemented the LKM system using JAVA 1.3 and Oracle 9i. The operator system of computer was Windows XP. For simulation of LKM, we make the routing and scheduling data of two districts, Seondong-Gu and Gangdong-Gu in Seoul from 07 Feb 2003 16:00 to 18:00. The Fig.4 (a) shows the graphic user interface of the LKM system and the Fig.4 (b) is test windows that routing and scheduling data compare with real location data of moving truck. This system detected transport delay in the pertinent situation automatically.

However, the execution problems of the LKM are as follows;
- The routing and scheduling data must exist without exception.
- If routing and scheduling data is defective, then the LKM is able to generate the wrong knowledge.
- The fact and rule for transport management is restricted. We have to define various fact and rule.

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### 5 Conclusion

The LKM generates MO fact from the position data of the moving vehicle and valuable knowledge using the inference engine. Also, the LKM support the positive transport management function. We call this function active trajectory analysis. The analysis result is used for the transport manager’s decision support. The manager confirms the current status of the transport and decides the execution of the inferred result.
From now on, we will define the facts and rules to be able to apply in practical business and expand the ability to support the transport scheduling, routing and so on suing the statistics of MO fact or logistics rule.

References: