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# Monitoring Simulation Model for Perishable Food Transportation Based on Mobile Agent

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**Abstract:** For perishable food transportation monitoring process can't effectively monitor temperature, humidity, mechanical damage which lead to food safety issues, this paper puts forward the innovative one model based on Mobile Multi-Agent System (MMAS) for the transport of perishable food monitoring management simulation, through the MMAS autonomous action and coordination, the model monitors transportation security problems caused by possible events effectively. The experimental results show that the model can automatically identify temperature and humidity and mechanical damage of the anomaly information, and promptly report to the police and processing, effectively prevent the happening of the food safety incidents, to reduce economic loss in the transport of perishable food storage.

**Keywords** Ttransportation monitoring, Perishable foods, Mobile agent simulation model, Transport coordination mechanism.

## INTRODUCTION

Transportation monitoring is essential links of cold chain logistics, cold chain logistics monitoring technology development abroad has been relatively mature, formed a complete system of agricultural products cold chain logistics. Development of cold chain logistics in our country develops relatively late and slowly, and has not yet formed mature specification of cold chain logistics system of agricultural products at present. In recent years with frequent food safety accidents and the improvement of food safety requirements, and the research of cold chain logistics environmental information real-time monitoring technology has gradually become the new hot spot.

There are a lot of domestic researches on cold chain logistics monitoring system, designed system has also achieved good effect, but there is also some disadvantages at the same time. First of all, acquisition device volume is way too large. The second is the lack of power monitoring acquisition node. Finally the cold-chain transport environment node communication performance study is less.

His article point to the disadvantages of present domestic research on cold chain logistics monitoring technology, design a transportation monitoring system based on the MMAS model for perishable foods independently, monitoring perishable food transportation at each node effectively. Through the interaction between each Agent collaboration of abnormal events and alarm and processing, and reduce traffic on wireless network overhead, and save energy, ensure the economic loss of perishable food transportation is minimal.

## PERISHABLE FOOD TRANSPORTATION MONITORING SIMULATION MODEL'S OVERALL STRUCTURE BASED ON MOBILE AGENT MODEL(MMAS)

### MMAS Simulation Model's Overall Structure

MMAS overall structure is as shown in the Figure.1

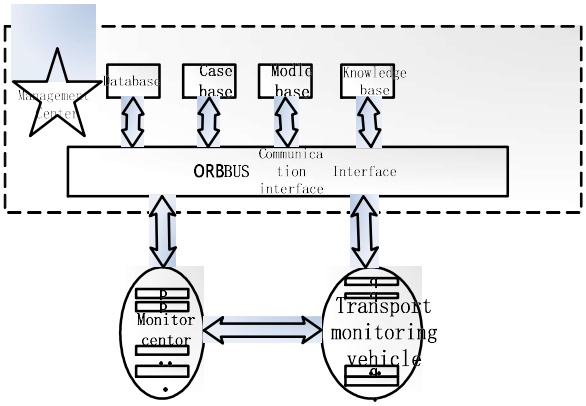


Figure.1 MMAS overall structure

In Figure.1, including (1) the perishable food monitoring event management module; (2) the monitoring center module. Here they are autonomous perishable food transportation monitoring for each member, and to form the corresponding module. Each module has its own internal database and modules which are realized their functions

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respectively, each module to contain their own monitoring data processing, transport management and simulation, etc.

**Design the Running Environment for MMAS Simulation Model**

In The actual situation of simulation model, determine the perishable food transportation monitoring system is a distributed application system, has a good performance of the distributed operation. Because each application module can be used as a stand-alone application, in a separate individual network running on your computer, so the model has good portability and scalability. To verify this, in this paper, the module configuration in three machines respectively, the operation of the implementation of the system model, as shown in the Figure.2.

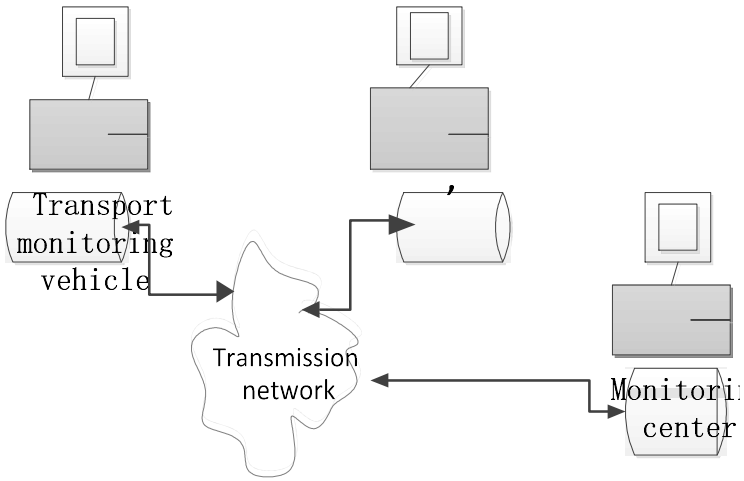


Figure 2. Network environment of MMAS simulation model operation

MMAS model simulation can be used to solve more problems of the perishable food transportation simulation object in the monitoring. In order to meet the requirements of computing scale, and adjust simulation scale conveniently, the simulation task can be decomposed to processors in a distributed environment in several computer processes, by the simulation of computer cooperation to complete the task.

**Management Center Agent Module Design**

Management center agent internal structure diagram is as shown in the Figure.3. It contains four specific functional Agent and information repository.

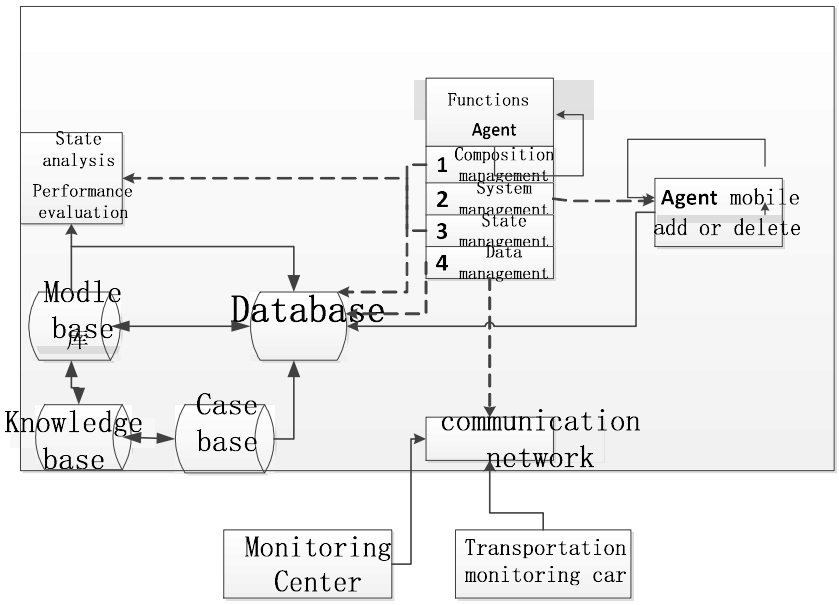


Figure 3. The internal structure of the management center Agent

MMAS model simulation can be used to solve more problems of the perishable food transportation simulation object in the monitoring. In order to meet the requirements of computing scale, and adjust simulation scale conveniently, the simulation task can be decomposed to processors in a distributed environment in several computer processes, by the

simulation of computer cooperation to complete the task.

1) Management Agent: According to the data stored in the database of all the nodes and the overall information of perishable food transportation monitoring, complete the perishable food transportation monitoring simulation system construction work, finished some basic settings for the whole of perishable food transportation monitoring system .
2) The Agent system management: According to the simulation, and the actual requirements, implement the mobile management of data nodes, increase, delete management, and other functions. Interdisciplinary (control, vision, mechanics, AI,IT ,EE,etc.)
3) State management Agent: Through the analysis of the state to monitor the entire state of perishable food transportation monitoring, complete management and performance evaluation task. The operating process is using the data of the database. In addition, it is also used in performance evaluation model library associated with each store in all kinds of knowledge.
4) The safety management Agent: Including mobile, communication of information security aspects of content, mainly used in the management of transportation monitoring safety of each Agent.
5) Database: Mainly used for all kinds of information data storage management center.
6) Model library: Usually include all kinds of model of the algorithm.
7) Knowledge base: Storing all kinds of knowledge.
8) Cases storage: The past various cases.

Through the above function of the effective operation and the necessary coordination mechanism, management center can effectively management the perishable food transportation monitoring system

**Perishable Food Monitoring Agent ModuleDesign**

The internal structure of perishable food transportation monitoring diagram: it is mainly composed of four specific functions of Agent and information repository, as shown in the Figure.4

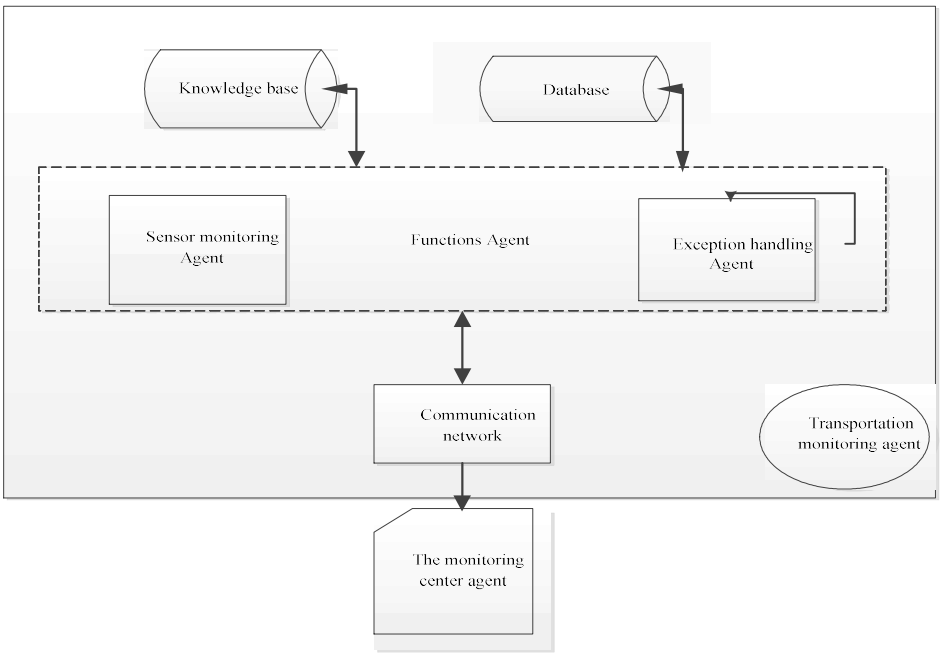


Figure 4. The internal structure of the perishable food transportation monitoring vehicle Agent

The function of the main Agent:

9) Sensor monitoring Agent: According to the data stored in the database of all the nodes and perishable food transportation monitoring the overall information, to complete the perishable food transportation monitoring simulation system construction work, and to do some basic settings.
10) The exception handling Agent: According to the simulation and the actual requirements, implement the mobile management of data nodes : increase, delete and other functions.
11) Database: Mainly used for the storage of the status of the perishable food truck monitoring system and for the information of each node and the use and maintenance of simulation system of information, etc.
12) Knowledge base: Used to store all kinds of knowledge and rules.

According to the features of ISMR, inspired by the metasynthesis, the ways and means of achieving comprehensive and integrated are concluded as follow.

**The Monitoring Center Agent Module Design**

Management center structure diagram: it is mainly composed of the function of a specific Agent and information repository, as shown in the Figure.5.

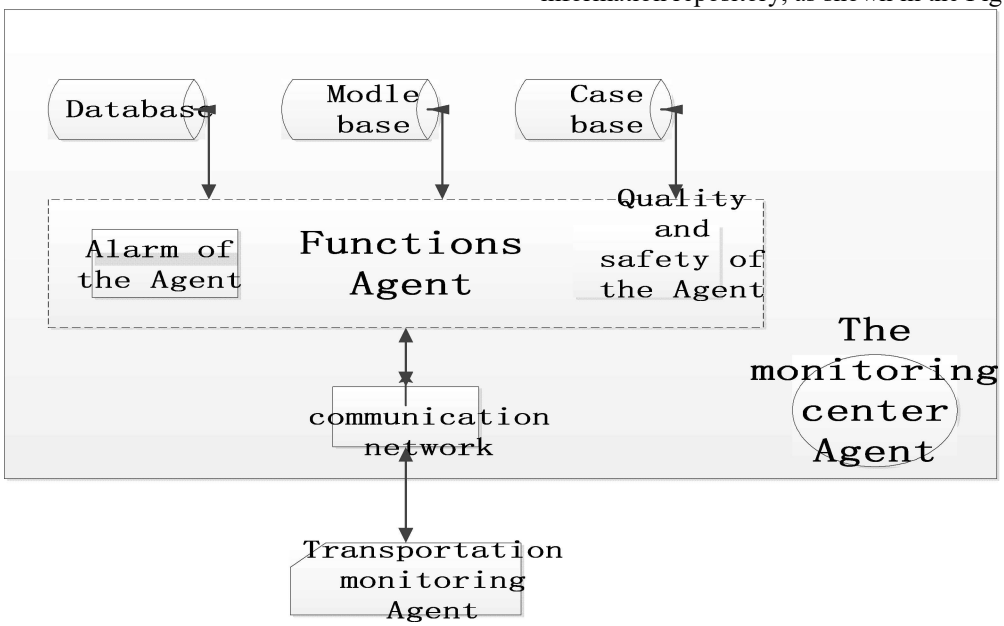


Figure 5. The internal structure of the monitoring center Agent

## COORDINATION MECHANISM DESIGN BASED ON THE MMAS PERISHABLE FOOD TRANSPORTATION

Perishable food transportation monitoring system of each link all have their own ability and the target, only by working together, can they provide users with reliable products and services. This chapter has designed a coordination mechanism based on the MMAS perishable food transportation safety management model, to monitor food each link, through collaboration between all the Agent found that may cause abnormal events of food safety problems, and then to call the police, to make the decision and the process.

This monitoring system designs the perishable food monitoring Agent, Agent management center, the monitoring center Agent, alarm Agent, Agent quality safety management, exception handling Agent, and the communication Agent. This seven kinds of Agent are divided into three categories: Management Agent which plays a role of coordination and controls them. Members Agent by transport vehicle monitoring Agent, alarm Agent, Agent quality safety management, exception handling; Achieve the function of the member function of the Agent is the Agent. Among them, the monitoring center Agent and vehicle monitoring Agent is static Agent, once generated will reside within the local host; Alarm Agent, Agent quality safety management, exception handling Agent is a dynamic Agent, they can produce, dynamic, according to their needs, to move or die; Communication Agent for mobile Agent, in the network needs to be constantly moving, collecting vehicle monitoring or monitoring.

Information management center of perishable foods can do judgment and processing. Each agent function of the input and the output are shown in Table 1.

Therefore, the whole simulation model of the structure is as shown in the Figure,6.

As is shown in theFigure.6, the module of the whole simulation model is made up of three layers. Among them, the first layer of this system is the management layer, which is mainly responsible for truck perishable food monitoring and the interaction process between the truck food monitoring and the management center, and located in the middle tier is the monitoring center, whose all functions are implemented by every function that is located at the bottom. Mobility of the monitoring center is mainly embodied in the fact that the management center can add, delete, and move the abnormal alarm, the quality and safety management and aberrant handling according to the actual demand. An alarm Agent sends abnormal information to quality and safety handling Agent, then abnormal information is packaged into a case, which is sent to the case store to be retrieved in order to obtain a solution to solve the abnormality. The monitoring Agent is always monitoring the whole process of transportation process of perishable food, so when an abnormal event occurs, the alarm Agent will be triggered and send the corresponding alarm to the monitor management center, the quality and safety management Agent will decide the schedule of exception handling, and after the exception handling Agent solves the abnormal case, it will send the

processing result to the quality and safety Agent. The course is as follows: (1)The transport sensor monitoring Agent monitors the temperature, humidity and the abnormalities of metamorphic spots appeared on the food's skin in the transporter via the temperature and humidity sensor and visual sensor; (2) the communication Agent informs the alarm agent; (3) The communication Agent will send the abnormal information to the quality and safety management Agent which belongs to the monitoring management center to make decisions. (4) The communication Agent informs the exception handling Agent to handle the exception and to send the handling result to the quality and safety Agent, the principle is the same as the step (1), it is the sensor monitoring Agent in the transport vehicle that monitors the product's (e.g. the one labeled as EPC) temperature and humidity, and the external changes of perishable food.

If the monitoring Agent finds abnormal events in the course of food transportation, for example, there are sick spots on the skin of food, then this event concerning food safety will be triggered, meanwhile, the alarm Agent will be triggered by the monitoring Agent ,then the quality and safety management Agent will be triggered by the alarm Agent, then the quality and safety management Agent makes the right decisions, finally the exception handling Agent deals with abnormal events to prevent the occurrence of food safety events, and convey the results to the quality and safety management Agent. As is shown in the Figure.7.

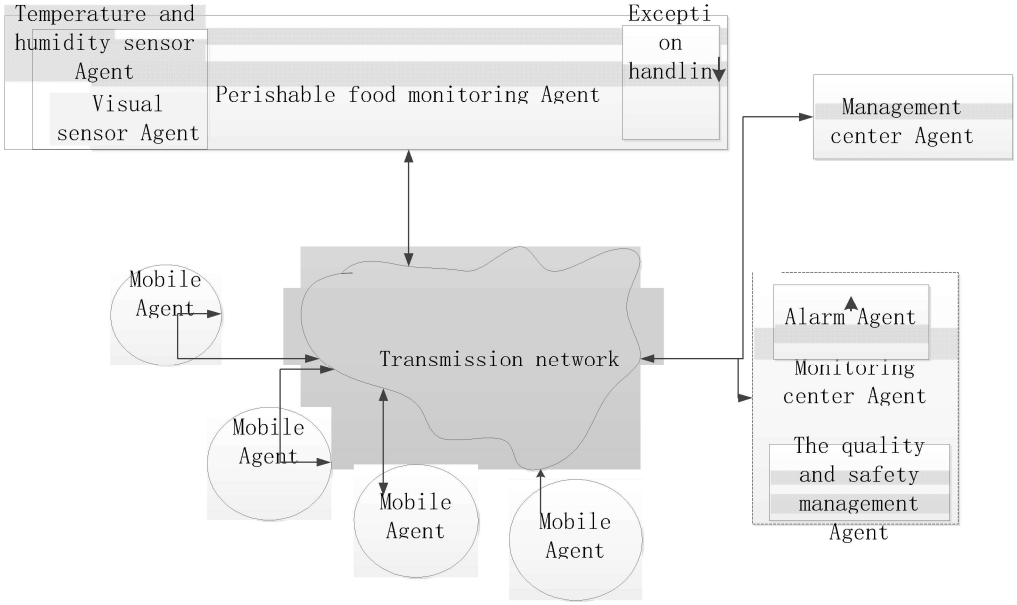


Figure 6. The coordination interaction between each agent simulation model based on the MMAS

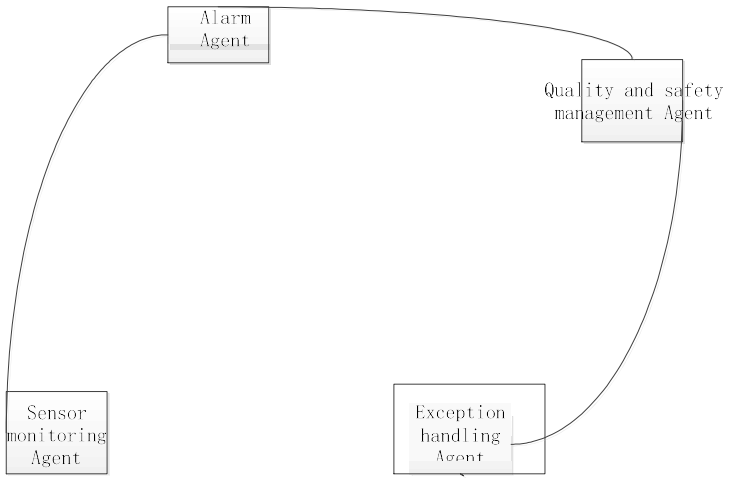


Figure 7. Agent monitoring process

The main part of the management centre is the quality and safety management Agent, it uses the case-based reasoning algorithm to retrieval and reuse, revision and retention the case. As long as the monitoring Agent founds new problems anomalies - target case, the quality and safety management Agent will description information to retrieve putted forward according to the target of the case, in order to

obtain the biggest source of the case similarity with the target case, thus get the target case of a solution, if this solution fails, just to adjust it, until succeed l. Quality safety management Agent has two main functions: one is to find the biggest similarity in putted forward the case to solve the abnormal situation, the second is to store the new cases. Case-based reasoning process is as shown in the Figure.8.

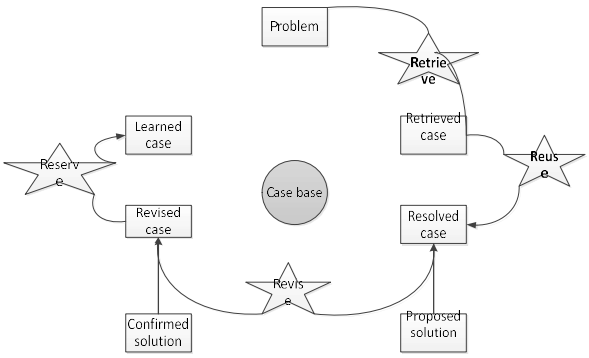


Figure 8. Case based reasoning process

In the quality and safety management Agent, the data term $x_i$ of each case has different weighting factor $w_i$ , which represents the extent that this character affects the quality and safety of the transport process of products. We first initialize the weighting factors of the data terms, and then the single layer neural network is adopted to weight training. The algorithms are implemented as follows.

13) Initializing the weighting factor $s_i$ and the threshold value $s_i$ .

$$\sum_{1}^{n} w_i = 1\left(0 \le w_i \le 1, i = 1,2,3,\cdots,n\right); \theta \in \left[-0.5, 0.5\right] \quad (1)$$

Activation. Input $x_1(p)$ , $x_2(p)$ ,..., $x_n(p)$ and the expected output $y_d(p)$ to activate the sensor. When $p = 1$ , compute the output of the activate function as :

$$y(p) = step\left(\sum_{1}^{n} w_i(p) x_i(p) - \theta\right) \quad (2)$$

Weighting factor training. Renew the weighting factor of the sensor as $w_i(p+1) = w_i(p) + \Delta w_i(p)$ where $\Delta w_i(p)$ is the correction for the weighting factor. The correction for the weighting factor is computed through the delta perceptron rules as in (3) and (4):

$$\Delta w_i(p) = \alpha \times x_i(p) \times e(p) \quad (3)$$

$$e(p) = y_d(p) - y(p) \quad (4)$$

Where $e(p)$ is the error function. If $e(p) > 0$ , the output $y(p)$ of the sensor should be increased; Otherwise, the output should be decreased. The contributed input for each sensor on the total input $x(p)$ is $x_i(p) \times w_i(p)$ . Therefore, the output $y(p)$ increases with the weighting factor $w_i(p)$ . $\alpha$ is a constant that denotes the learning rate/efficiency/speed. $y_d(p)$ is the expected output and $y(p)$ is the true output in the p-th iteration.

Iteration. $p \leftarrow p+1$ . Repeat step (2), until the above process converges. After the training process, we can judge whether an abnormal alarm occurs. If it does, query the similar case in the case data base. The more likely they belong to the same class, the more similarity they are. We use S to represent the similarity degree which is defined as follows: S=0 if a certain data term of two different recordings match, else S=1, as in (5) and (6).

$$x_i = \begin{cases} 0, \\ 1, \end{cases} \quad i = 1,2,\ldots,n \quad (5)$$

$$s = \sum_{1}^{n} w_i x_i \quad (6)$$

After the similarity degree between the case and the other cases in the case data base is calculated out, we choose the strategy or action, the case of which has a greatest similarity.

## TEH EMPITICAL RESEARCH

This chapter with a strawberry production base as an example, based on building MMAS strawberry transportation monitoring prototype system. This example extracts and transforms 1000 strawberry data, which makes each product data into sensor monitoring, abnormal alarm, quality and safety management, exception handling four stages, and each stage contains related events. We can take EPC (Electronic Product Code) Code 01001243 b0435cb000000000 products as an example, the four stages of partial data are shown in Table 2.

The experiments assumption the process of transporting strawberry, (1) the storage temperature is between -0.6℃and 0℃, It means abnormal if the temperature is more than 0℃ or is lower than -0.6. (2) The relative humidity should be between 90% to 95%, otherwise it means abnormal. (3)It means abnormal if the strawberry skin or the external form comes to disease spot. This experiment is in condition to whether it comes to exception and this experiment takes whether it handles the exception as a result. Conditions are shown in Table3

The experiment data is component of the sample data and test data. After training to the sample data by using single layer neural network, we can obtain a classification function:

$Y = 0.25x_1 + 0.25x_2 + 0.50x_3 - 0.50$ (Y represents output, and it is necessary to handle the exception, if Y⩾0, and it is not necessary to handle the exception if Y< 0)and its coefficients are on behalf of the weight of temperature, humidity, the size of disease spot; constant term 0.50 represents the threshold value. For example, when input is [1, 1, 0], which means the temperature and humidity is abnormal which means handling exception is needed. After training and testing, we obtain the source case. Conditions are shown in Table 3

After starting the system, transportation monitoring Agent and management center Agent all run in the background independently. The alarm Agent output the exception message. The quality and safety management Agent decides to make transportation products exception handling in transit. After handling the exception, handling Agent will return the result of handling exception in log. Taking perishable mechanical was damaged as an example. Monitoring Agent finds the product epidermis to be bad ,whose product EPC code is 01001236B0635CB000000000, Alarm Agent will send the exception message to the quality and safety management Agent and then the quality and safety management Agent will retrieve the case library to find the similar case and find a mechanical damage case whose product EPC code is 01011166D0629CA000000010 and, obtain a solution: whether the product need to sorting or not. At last, exception handling Agent handles the problem in depth. In order to avoid Agent handling the exception by experience, the system need to analyse the exception in depth. For example, if the strawberry epidermis comes to be bad, in order to provide useful information to other Agent, the size of disease spot should be returned.

Table 3. The results of decision table

| Condition | | | Result |
|---|---|---|---|
| Temperature exception | Humidity exception | Epidermis disease spot | Exception handling |
| True | True | True | True |
| True | False | True | True |
| False | True | True | True |
| True | True | False | True |
| False | False | True | True |
| False | True | False | True |
| True | False | False | True |
| False | False | False | False |

## CONCLUSION

In the present academic and corporate, for monitoring and control system of cold chain logistics transportation research has always been a hot spot. But the research about the temperature and humidity sensor, vision sensors together and sorting processing perishable food transportation monitoring system, is less both at home and abroad. Innovation in this article constructs the general model of transport monitoring system based on the MMAS perishable foods, and puts forward the innovative sorting processing system used for sorting problem of food. This paper mainly introduces the overall model based on the MMAS perishable food transportation monitoring system, designs the 7 class Agent as well as the coordination mechanism between them. And the case-based reasoning algorithm and neural network algorithm are in the quality and safety management Agent. Empirical results show that the model can automatically identify potential metamorphic perishable food transportation problems, and to handle the abnormal problem timely alarm and, prevent the happening of the food safety incidents effectively, to reduce economic loss in the transport of perishable food storage.

## ACKNOWLEDGMENT

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Table 1. The basic definition of Agent

| The Agent type | Management centre Agent | Perishable food monitoring Agent | Exception handling Agent | The monitoring centre Agent | The alarm Agent | The quality and safety management Agent | Communication Agent |
|---|---|---|---|---|---|---|---|
| Function | Monitor perishable food truck and the monitoring centre, and activate the corresponding Agent | Through the sensor to monitor whether the temperature and humidity is beyond the limit, food skin whether any disease spot; To report to the police Agent exception message | Adjust the temperature and humidity or sorting out the disease spot food within the critical value | Responsible for monitoring abnormal alarm, decision-making and exception handling scheme | Report to the quality and safety management Agent exception information | Responsible for the decision how to deal with abnormal information | Responsible for perishable food truck and monitoring management centre of communication |
| input | Application start-up instruction | Monitor truck status code | Application start-up instruction | The monitoring centre status code | abnormal information | Alarm exception information | Other Agent to send the request of the information |
| Action | Cycle scan transportation monitoring information table, check that the perishable food transportation monitoring vehicles and monitoring centre of the state interest, (1) if the transportation monitoring or monitoring centre of the state for free, than check whether there is a corresponding Agent in monitoring, if not than don't do any processing, stopped corresponding Agent if it is; (2) if the transportation monitoring or monitoring centre of the state is in use, in contrast to the situation in (1) to do processing. | Real-time access to transportation monitoring record of temperature and humidity, and compared with temperature and humidity threshold, when beyond a critical value, the output abnormal information; Real-time monitoring food epidermis, abnormal disease spot output information. | the solution of food anomalies | Real-time anomaly information interaction, if there is exception handling abnormal information, and accept the exception handling results as a new case. | Report exception information to quality safety Agent | According to the target case to case for largest case similarity, in order to obtain a solution to deal with the current exception | According to the request instructions, obtain information foremother Agent |
| Output | Perishable food transportation monitoring or monitoring centre of the state | abnormal information | Output processing result | Exception handling solutions | Abnormal information | Solution or a new case | Response information |

Table 2. Main information in different stages of the product

| product transportation | Product EPC code | Product category | Product name | Transportation car number | Required Delivery time | destination | weight | Cold storage temperature(℃) | Relative humidity(%RH) |
|---|---|---|---|---|---|---|---|---|---|
| 1The sensor monitoring | 01001263B0639CB000000000 | Perishable fruit | strawberry | 001 | 2015/1/28 | Beijing | 30kg | -0.6~0 | 90%~95% |
| 2Abnormal alarm | 01001263B0639CB000000000 | Perishable fruit | strawberry | 001 | Exception information | | | | |
| | | | | | The temperature:16℃ | | | | |
| 3The quality and safety management | 01001263B0639CB000000000 | Perishable fruit | Perishable fruit | 001 | Exception information sample comparison and judgment | | | | |
| | | | | | Adjust the temperature to the normal range：-0.6℃~0℃ | | | | |
| 4Exception handling | 01001263B0639CB000000000 | Perishable fruit | Perishable fruit | 001 | Exception handling | | | | |
| | | | | | Adjust the temperature to the normal range：-0.6℃~0℃ | | | | |

Table 4. The source case

| Sample code | Product EPC code | Product name | origin | destination | cold storage temperature（℃） | trigger | potential hazards | handling | relative humidity（%RH） |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 01001263B0639CB000000000 | strawberry | Nanning of Guangxi | Beijing | -0.6~0 | Mechanical damage | infecting other healthy strawberry | Sorting process | 90%~95% |
| 2 | 01001263B0639CB000000001 | strawberry | Shi bu town , An qiu city of Shandong province | Beijing | -0.6~0 | truck temperature exception | metamorphic | Adjust the temperature to the normal range | 90%~95% |
| 3 | 01001263B0639CB000000002 | strawberry | Huang chuan Town, Donghai County, Lianyungang city of Jiangsu province | Beijing | -0.6~0 | truck temperature exception | metamorphic | Adjust the humidity to the normal range | 90%~95% |
| ... | | | | | | | | | |
| n | | | | | | | | | |