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The Collection Method of Heterogeneous Smart Farm Data Based on Model Transformation Technique for Human Computer Friendly Learning

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Abstract. Recently, smart farm technology is in the spotlight as the solution of existing agricultural problems as spreading ICT convergence technology. For assisting expert farmers or guiding non-farmers, there is a need for a predicting method of growing and benefiting of crops as well as cultivating them through the cultivating method on AI/Big data approach. To do this, we absolutely need to collect a large amount of the right data to predict the growth of good or bad crops, and then consider how to gather the collected learning data. Therefore, we propose a data collection method based on metamodeling of Model Driven Architecture, which transforms heterogeneous data into a uniform learning data with model transformation rule. With this approach, we apply for easily customizing any prediction, and expect for even non-farmers to use any smart farm cultivation.

Keywords: Smart farm · Meta model · Model transformation · Heterogeneous data collection

1 Introduction

Recently, smart farm technology is in the spotlight as the solution of existing agricultural problems as spreading ICT convergence technology [1]. Additionally, there is a need for a predicting method of growing and benefiting of crops as well as cultivating them through the cultivating method on AI/Big data approach. To do this, we absolutely need to collect a large amount of the right data to predict the growth of crops. So, we are also considering how to gather the collected learning data.

We prepare first to build a smart farm environment to collect the learning data with the big data, and second to collect big data provided by external organizations such as *Korea Agriculture, Forestry and Fisheries Food Education Cultural Information Institute* [2] and *Korea Public Data Portal* [3] for their growth data of the cultivated crop. They provide their data through Open API to the public with each different format. To use their data, we need to transform their data with a data processing algorithm.

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We propose a data collection method based on metamodeling of Model Driven Architecture for heterogeneous data to transform a uniform learning data with model transformation rule. This provides very intuitive information presentation and model management [4]. More important thing is continuing adding other farm data formats without changing the program algorithm. We may apply for the integrated collection of heterogeneous big data.

2 Related Works

2.1 Meta Model-Based Model Transformation Method

Model to Model (M2M) transformation is a method of generating a target model from a source model using model transformation language. The components of this method are composed of Model, Meta-model, Transformation language, and Transformation engine as shown in Fig. 1 [5]. To perform M2M of Transformation Engine, the Meta-model of Source model and Meta-model of Target model must be defined. Meta-model is a schema that can read model information. Next, the Transformation Language should be defined. Transformation language refers to the meta-model and describes the rules for transforming the source model into the target model. The transformation language consists of information on adding, deleting, and modifying models. Transformation engine transforms the source model to the target model by executing the transformation language.

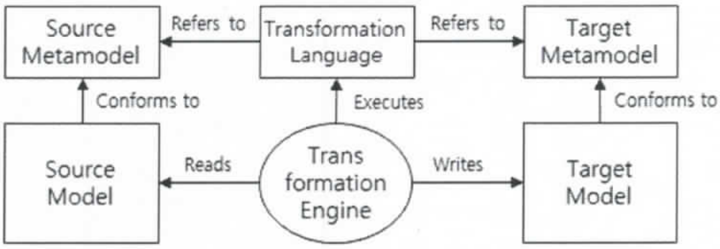

Fig. 1. Model to model translation mechanism

Eclipse Modeling Framework (EMF) [6] provides ecore model that can define meta-model. Model transformation can be performed using either a model transformation language (ATL [7], ETL [8], QVT-O [9], etc.). Since the metamodel complies with the OMG standard data file, XMI [10], optimal model transformation can be performed.

2.2 Big Data Collection Process for General Korean Smart Farm

A general Korean smart farm big data center provides big data through an API server. Users create a data collection server, and request and receive data from each center's API server through the data collection server. The detailed structure is shown in Fig. 2 below. Figure 2 shows the process of requesting and receiving data from two centers that provide smart farm big data in Korea.

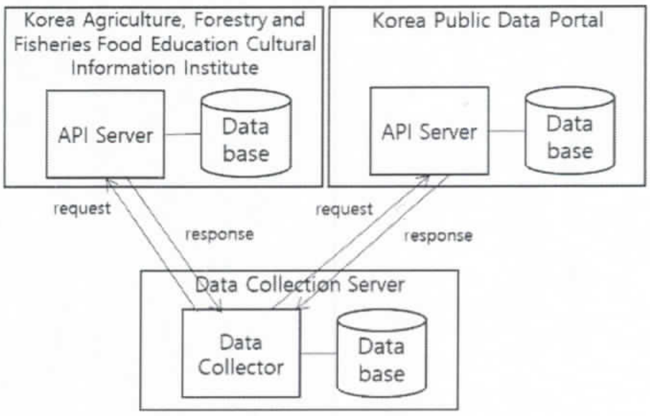

Fig. 2. Flow of obtaining data from smart farm big data server

Table 1. Structure of request packet used by Korea Public Data Portal

Category	Size	Sample	Description
serviceKey	100	%ED%95%9C%EA%B8%80	Authentication key
pageSize	15	10	Result count per page
pageNo	15	1	Number of pages
searchFrmhsCode	50	Testfarm01	Farm ID
searchMeasDt	10	2019010100	Information search date
returnType	10	xml	Response specific type

The structure of the request packet used in Korea Public Data Portal is shown in Table 1. The request packet needs user service key of and farm ID.

The sample of the request packet used in the Korea Public Data Portal is shown in Table 2. If the user connects to the server address, the API server outputs XML data.

Table 2. Sample of request packet used by Kore Public Data Portal

http://apis.data.go.kr/1390000/SmartFarmdata/envdatarqst?serviceKey=%ED%95%9C%EA%B8%80&searchFrmhsCode=TestFarm01&searchMeasDt=2019010100&returnType=xml

The part of the response packet used in Korea Public Data Portal is shown in Table 3.

Table 3. Part of response packet used by Kore Public Data Portal

Category	Size	Sample	Description
resultCode	2	00	Result code
[…] (omission)			
inTp	15	24.5	Internal temperature (‘C)
outTp	15	10.5	External temperature (‘C)
inHd	15	78.9	Internal humidity (%)
inCo2	15	434.0	Internal CO_2 (ppm)

The part of response packet sample used in Korea Public Data Portal is shown in Table 4.

Table 4. Part of response packet sample used by Kore Public Data Portal


```
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
-<response>
-<items>
-<item>
<inTp>24.5</inTp>
<inHd>78.9</inHd>
<inCo2>434.0</inCo2>
                    [...] (omission)
</item>
</items>
<numOfRows>10</numOfRows>
</response>
```


3 The Collection Method of Heterogeneous Smart Farm Data Based on Meta-model

We show our design of a smart farm system. In Fig. 3, we consist of smart farm data integration server, client server, and external organization. The integration server gathers sensor data from the client and external organizations trains the collected data and predicts crop production using the training data.

We propose the design of a Data Collector based on Meta-model (DCM) for Plant Growth Prediction System in the integration server. The DCM requests crop data to API Servers in heterogeneous external organizations and stores the received data in a database.

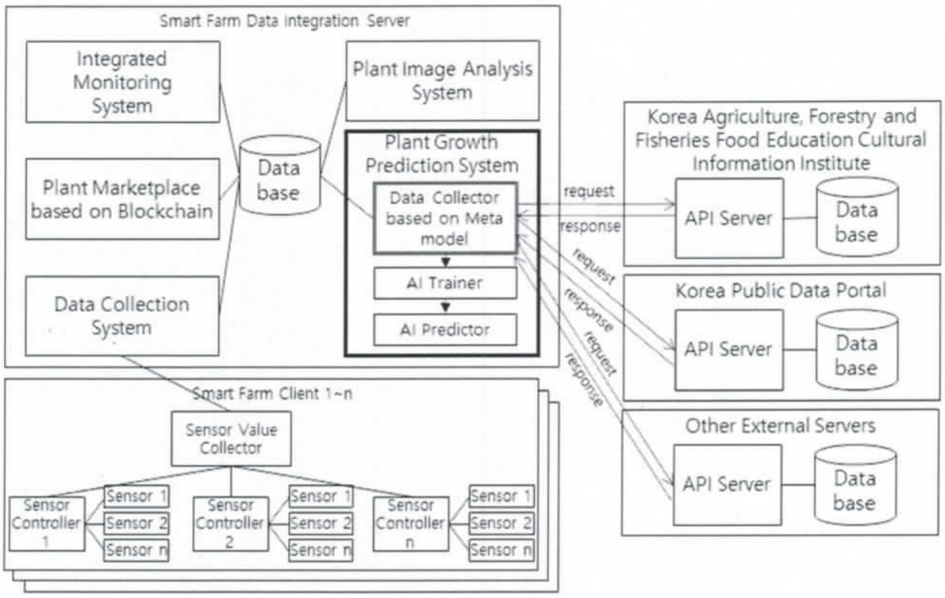

Fig. 3. The overall structure of a smart farm system

The DCM automatically generates a request and response model and the packet data from each model for each organization.

Figure 4 shows the automatic generation process of data request packet for heterogeneous external organizations. The DCM generates an integrated request model as a file. The transformation engine reads the integrated request model file, and automatically generates a data request model file for the Korea Public Data Portal. The structure of the model file is generated using information from the metamodel. Packet information of the automatically generated model is transmitted to the Korea Public Data Portal.

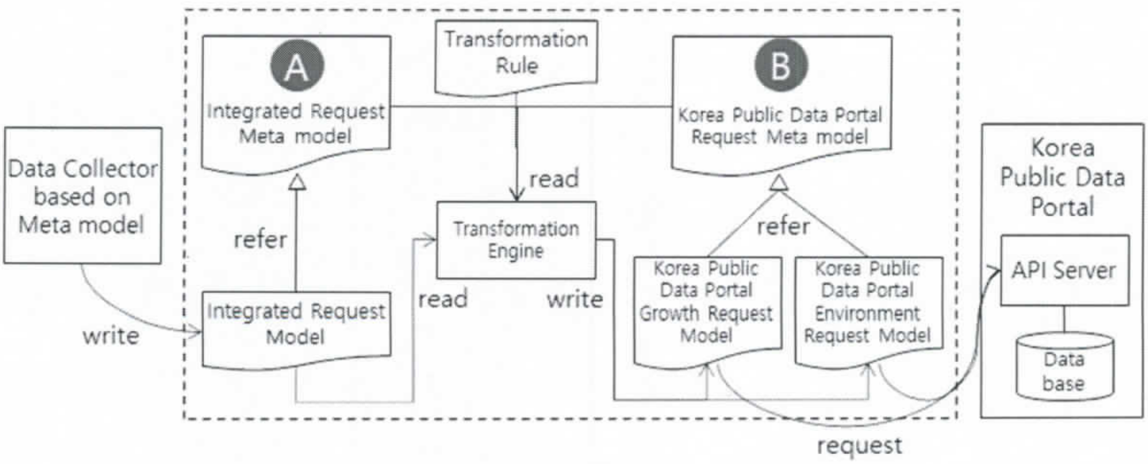

Fig. 4. Automatic request packet generation process with model transformation technique

Figure 5 shows the structure of the Integrated Request Meta-model. It consists of the address of the API server, environment request information, and growth request information. Environment and Growth present information using Request Data.

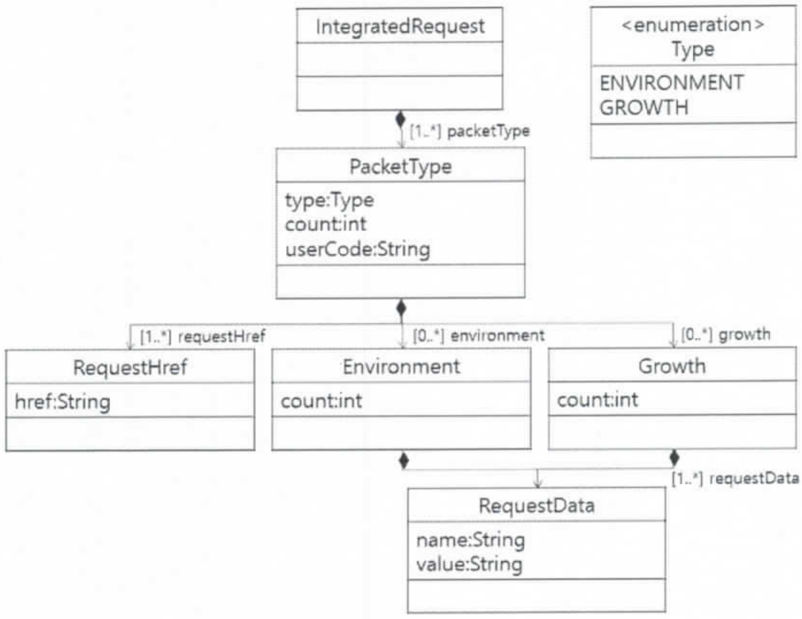

Fig. 5. Structure of Integrated Request Meta model (A)

Figure 6 shows the structure of the Korea Public Data Portal Request Meta model. The meta-model consists of the API server address of Korea Public Data Portal, environment request information for Korea Public Data Portal, and growth request information for Korea Public Data Portal.

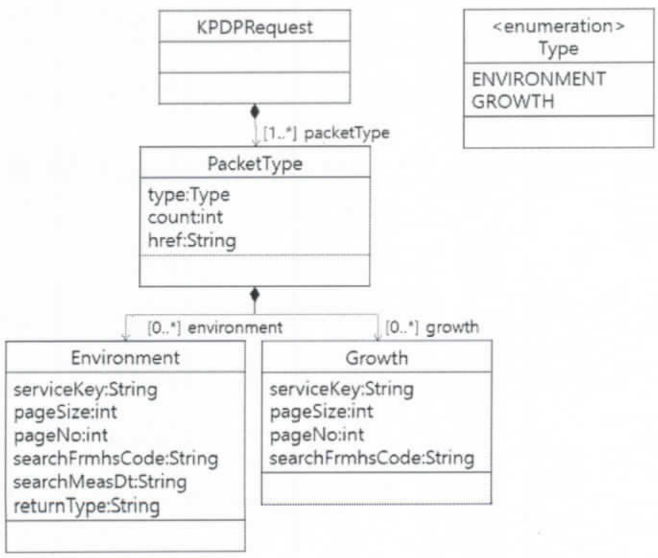

Fig. 6. Structure of Korea Public Data Portal Request Meta model (B)

Figure 7 is the transformation process between meta models using the transformation engine. Figure 7-(a) is the structure of the Integrated Request Meta-model. Figure 7-(b) is the structure of the Korea Public Data Portal Meta-model. Each model are expressed in the XMI code. The PacketType and RequestHref information of the Integrated Request Meta model is transformed to PacketType information of the Korea Public Data Portal Request Meta model. Environment information of the Integrated Request Meta-model is transformed into Environment information of Korea Public Data Portal Request Meta model. Growth information of the Integrated Request Meta-model is transformed into Growth information of the Korea Public Data Portal Request Meta model.

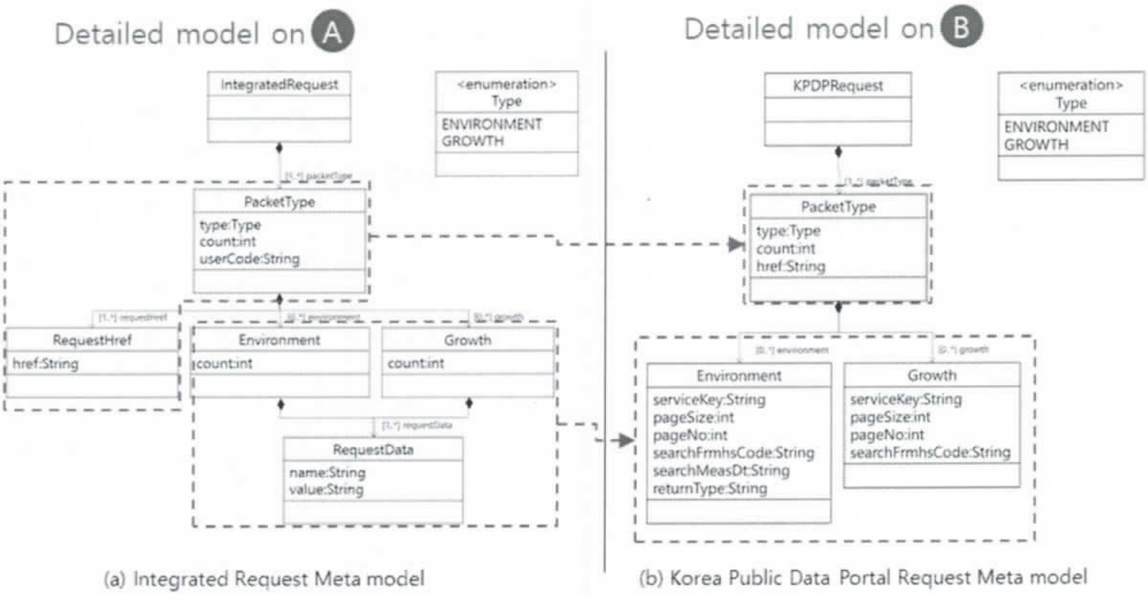

Fig. 7. The transformation rule between meta model A and B

Table 5 shows the XMI code of the Integrated Request Model.

Table 6 shows the XMI code of the Korea Public Data Portal Environment Request Model.

Table 5. XMI code of the Integrated Request Model

```
<?xml version="1.0" encoding="UTF-8"?>
<ir:IntegratedRequest xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:sed="http://integrat-
edrequest/1.0" name="Model">
   <PacketType type="ENVIRONMENT" count="1" us-
erCode="%ED%95%9C%EA%B8%80">
      <RequestHref href="http://apis.data.go.kr/1390000/SmartFarmdata"/>
      <Environment count="7">
         <RequestData name="hrefFolder" value="envdatarqst" />
         <RequestData name="serviceKey" value="%ED%95%9C%EA%B8%80" />
         <RequestData name="pageSize" value="" />
         <RequestData name="pageNo" value="" />
         <RequestData name="searchFrmhsCode" value="TestFarm01" />
         <RequestData name="searchMeasDt" value="2019010100" />
         <RequestData name="returnType" value="xml" />
      </Environment>
   </PacketType>
</ir:IntegratedRequest>
```

Table 6. XMI code of the Korea Public Data Portal Environment Request Model

```
<?xml version="1.0" encoding="UTF-8"?>
<req:KPDPRequest xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:sed="http://kpdpre-
quest/1.0" name="Model">
   <PacketType type="ENVIRONMENT" count="1"
href="http://apis.data.go.kr/1390000/SmartFarmdata/envdatarqst">
      <Envoronment
         serviceKey="%ED%95%9C%EA%B8%80"
         pageSize=""
         pageNo=""
         searchFrmhsCode="TestFarm01"
         searchMeasDt="2019010100"
         returnType="xml"
      />
   </PacketType>
</req:KPDPRequest>
```

Table 7 is a request packet generated from the Korea Public Data Portal Model. To receive public smart farm data, we transmit this request packet to Korea public data portal.

Table 7. The request packet generated from the Korea Public Data Portal Environment Request Model

http://apis.data.go.kr/1390000/SmartFarmdata/envdatarqst?serviceKey=%ED%95%9C%EA%B8%80&searchFrmhsCode=TestFarm01&searchMeasDt=2019010100&returnType=xml

If a new organization (new big data center) is added, the transformation rule file and the meta-model file for this new organization can be added as shown in Fig. 8.

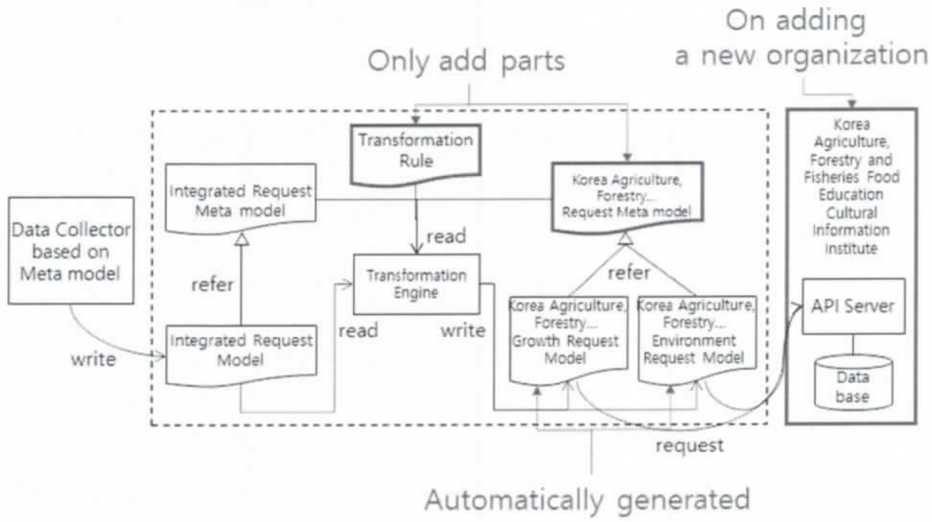

Fig. 8. The added files for adding new organization

Figure 9 shows the process of automatically transforming response packets received from heterogeneous external organizations into integrated response packets. The received packet is created as a response model file. The transformation engine reads the response model file of Korea Public Data Portal and automatically transforms the response model into an integrated response model file. The structure of the model file is

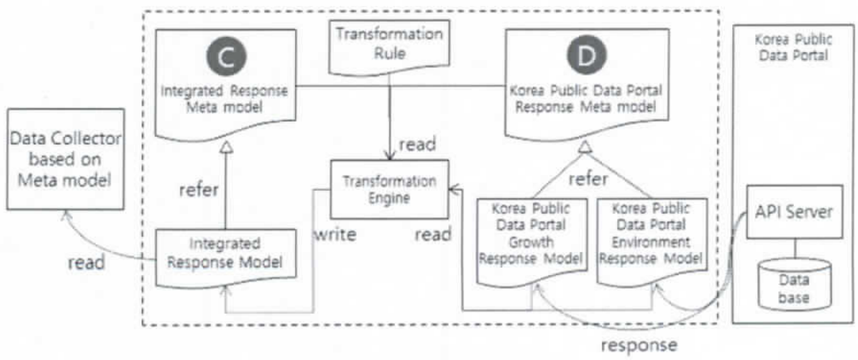

Fig. 9. Automatic response packet generation process with model transformation technique

created using information from the meta-model. The automatically generated integrated response model information is stored in the database.

Figure 10 shows the structure of the Integrated Response Meta model. Meta model consists the farm ID (userCode), environment response information, and growth response information. Environment and Growth presents information using ResponseData.

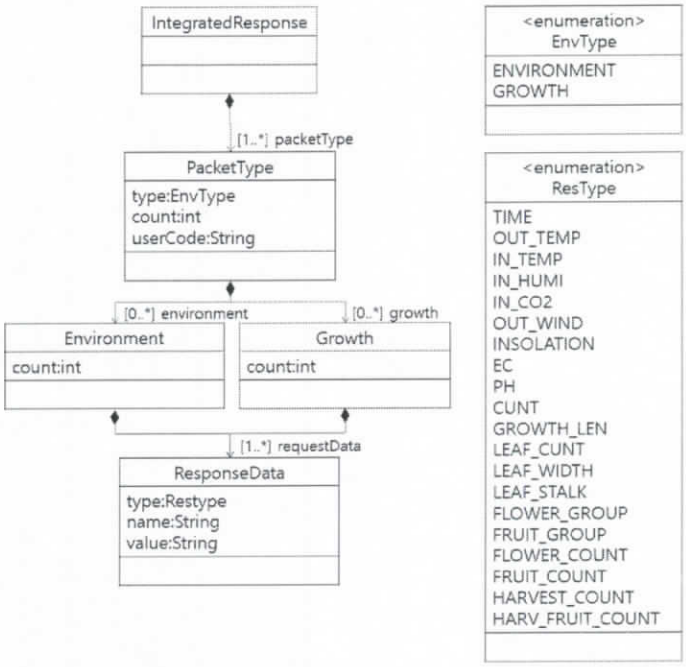

Fig. 10. Structure of Integrated Response Meta model (C)

Figure 11 shows the structure of the Korea Public Data Portal Response Meta model. The meta-model consists of the farm ID of Korea Public Data Portal, environment response information for Korea Public Data Portal, and growth response information for Korea Public Data Portal.

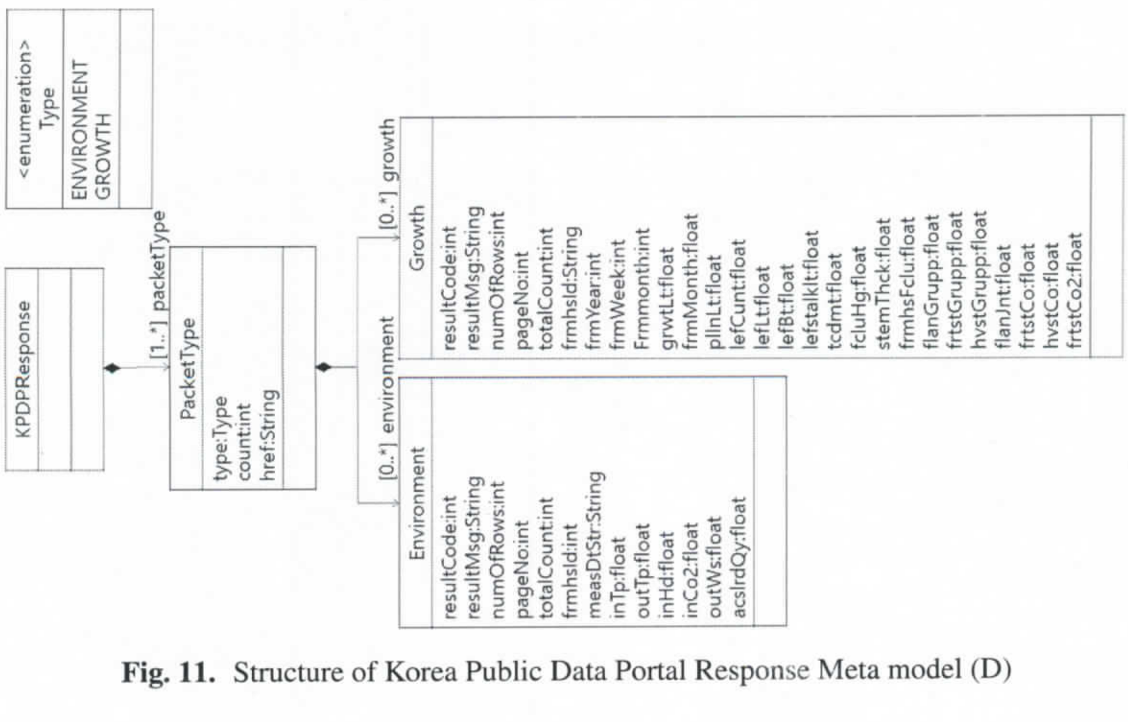

Fig. 11. Structure of Korea Public Data Portal Response Meta model (D)

Figure 12 is the transformation process between meta-models using the transformation engine. Figure 12-(c) is the structure of the Integrated Response Meta model. Figure 12-(d) is the structure of the Korea Public Data Portal Response Meta model. Each meta models are expressed in XMI code. The PacketType information of Korea Public Data Portal Response Meta model is transformed to PacketType information of the Integrated Response Meta model. Environment information of Korea Public Data Portal Response Meta model is transformed into Environment information of the Integrated Response Meta model. Growth information of Korea Public Data Portal Response Meta model is transformed into Growth information of the Integrated Response Meta model.

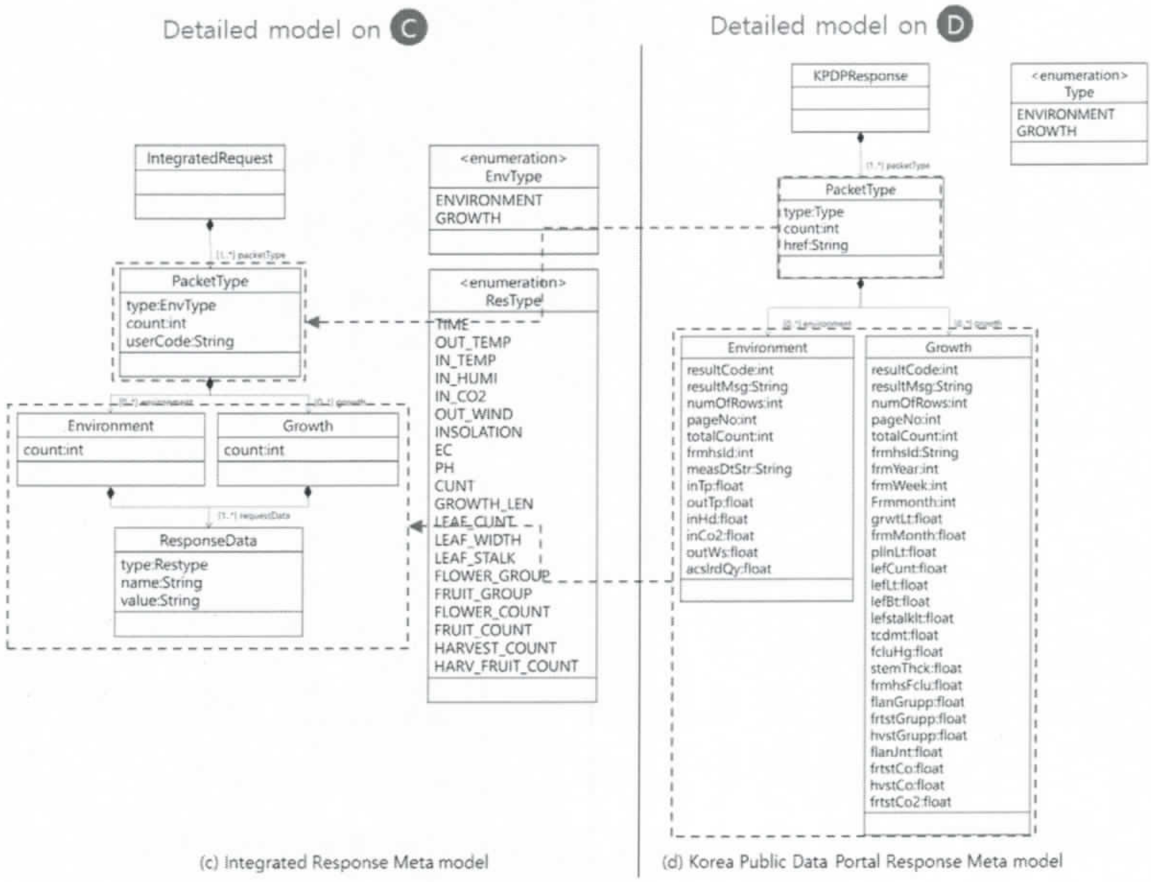

Fig. 12. The transformation rule between meta models (C, D)

Korea Public Data Portal Environment Response Model, Korea Public Data Portal Growth Response Model, and Integrated Response Model are expressed in XMI code. In this paper, the expression of the XMI code of these three models is omitted.

4 Data Collector Based on Meta Model

We implement DCM using Java. DCM functions consist of Continuous Data Requester, Meta model Translator for Request, Sender, DB Adapter, Meta model Translator for Response, and DB Adapter.

The detailed structure of DCM is shown in Fig. 13. Continuous Data Requester creates an Integrated Request Model to request the latest data every day and delivers it to the Meta model Translator for Request. Meta-model Translator for Request automatically transforms the received Integrated Request Model into a heterogeneous Request Model and delivers a transformed model to the Sender. Meta model Translator for Request includes Transformation Rule and Meta model for Korea Public Data Portal Model Transformation, Transformation Rule, and Meta model for Korea Agriculture, Forestry and Fisheries Food Education Cultural Information Institute. Sender automatically transforms heterogeneous Request Models into packets and delivers them to API Server. The receiver automatically transforms heterogeneous response packets received from API Server into heterogeneous Response Models and delivers them to Meta-model Translator for Response. Meta-model Translator for Response automatically transforms the received heterogeneous Response Model into Integrated Response Model and delivers transformed model to DB Adapter. Meta model Translator for Response includes Transformation Rule and Meta model for Korea Public Data Portal Model Transformation, Transformation Rule and Meta model for Korea Agriculture, Forestry, and Fisheries Food Education Cultural Information Institute. The DB Adapter stores the information of the received model to the MySQL.

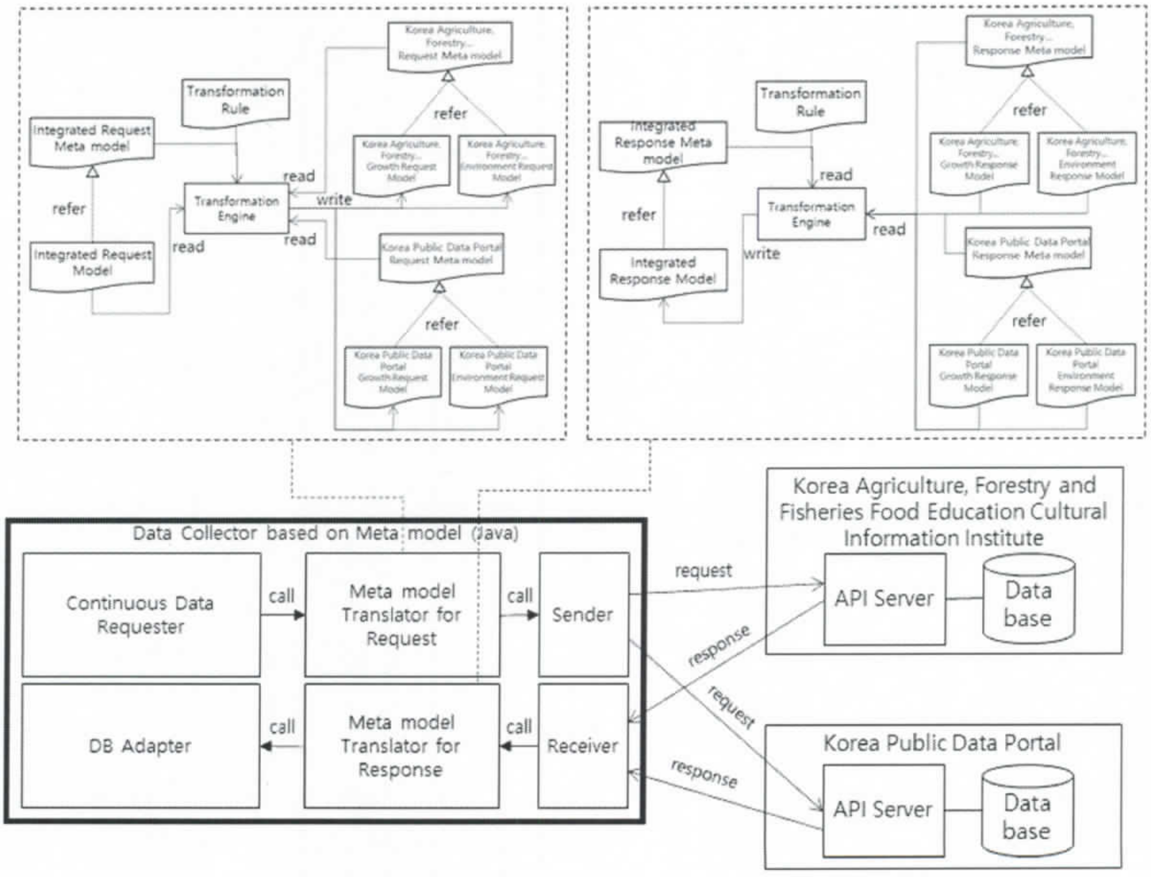

Fig. 13. Implemented Data Collector based on Meta model

5 Experiment Result

We use the implemented DCM to collect big data from two organizations. We correctly collect 403,920 data from the Korea Public Data Portal, and 2,694,936 data from Korea Agriculture, Forestry, and Fisheries Food Education Cultural Information Institute (Table 8).

Table 8. Number of data saved by Data Collector based on Meta model

	Korea Public Data Portal	Korea Agriculture, Forestry and Fisheries Food Education Cultural Information Institute
Number of normally stored data	403,920	2,694,936
Number of abnormally stored data	0	0

6 Conclusions

We propose a data collection method based on meta-model for collecting heterogeneous smart farm big data. We define the integrated request metamodel, the integrated response meta-model, the request meta-model of each organization, the response meta-model of each organization, and the transformation rule between those meta-models. The integrated request model is automatically transformed to the data request model of each organization. The data response model of each organization is automatically transformed to the integrated response model.

As a result, we automatically collect the big data of heterogeneous organizations, and provide for easily adding packets of other organizations. This method can be used as an automatic AI training data collection method for smart farm data prediction.

For mid-level farmers of domestic scale competing with global markets, the data collection technique we propose can contribute to enhance the system of the farm. This also suggests a new possibility for multiple farmers with different data systems to join forces with the social role and inclusive elements of technology to help local farmers survive. This not only serves as the basis for local farmers to survive competition from global markets, but it also suggests a new possibility to unite multiple farmers with different data systems. Therefore, it is hoped that this proposed technique can be the basis of major technologies in the future society as a new paradigm.

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