A Study on the Ontology Model for Preventing Livestock Disease Spread

Seokkyun Jeong[1], Hoseok Jeong[2] and Hyun Yoe[3]

[1,2,3]*Dept. of Information and Communication Engineering,*
Sunchon National University, Republic of Korea
{sk_jeong, hsjeong, yhyun}@sunchon.ac.kr

Abstract

The damage caused by malignant domestic animal infectious disease including AI and FMD has been on the rise throughout the world and in line with increasingly growing trade of livestock products, the need for early monitoring and epidemic prevention at early stage is more than important. This paper is intended to propose the ontology model which will detect the domestic animal infectious disease at early stage using context information and prevent the spread of disease. This study thus is aimed at designing the structure of situational awareness system to which ontology-based context model is applied in a bid to provide the service which will prevent the spreading of epidemic as well as apply through the experimental scenario.

Keywords: *Livestock, Context, Ontology*

1. Introduction

Situational awareness computing has been globally developed as strategic technology along with clouding computing, big data and Internet of the Things. Situational awareness computing linking the real space to virtual space is to informatize the real situation at virtual space thereby providing the user-centered intelligent service. This technology has been integrated into various areas and currently studied to apply to digital home and telematics. This paper is intended to apply situational awareness computing technology which has been used mainly for human to ontology model in a bid to prevent the spreading of livestock epidemic[1-3].

Domestic animal infectious disease is often occurred worldwide and spreading pace and damage by fatal livestock epidemic are very fast and huge. Korea suffered the huge economic damage amounting to hundreds of billions of won in 2000s caused by AI(Avian Influenza) and FMD(Foot and Mouth Disease) Particularly FMD occurred at Andong in November 2010 was spreaded all over the country, resulting in severe environmental problem by leachate generated from the buried carcass and social and economical loss[4-6]. Such a huge damage was attributable to spread by human at early stage when FMD had not been detected while the concerned authority failed to properly deal with the disease[7-12].

Thus in this study, ontology model to prevent the spread of livestock disease was designed to monitor the livestock and their feeding environment so as to detect the epidemic in timely manner and prevent the epidemic from spreading[13].

In Chapter 2, ontology model to prevent the spread of livestock disease was designed and in Chapter 3, potential risk and environment was explained through experimental scenario on spreading of domestic animal disease. And Chapter 4 includes the conclusion and the strategy for future study.

2. Design of the Proposed Ontology Model

2.1. Ontology Model Configuration

Ontology model proposed was as Figure 1 Besides low-level context model and high-level context model, upper context model between domain context model and domain context was used to incorporate various requirements to constrain the livestock disease from spreading [14-17].

Figure 2 shows 6 classes of upper ontology expressed using Protege 4.1[18] modeling tool to represent the concept in common. Spatial class was classified considering the spatial information inside and outside the farm and domestic animal class was classified depending on individual livestock information. Device class comprises the fixed device, mobile device and individual sensor. Time class is expressed by year/month/date/time.

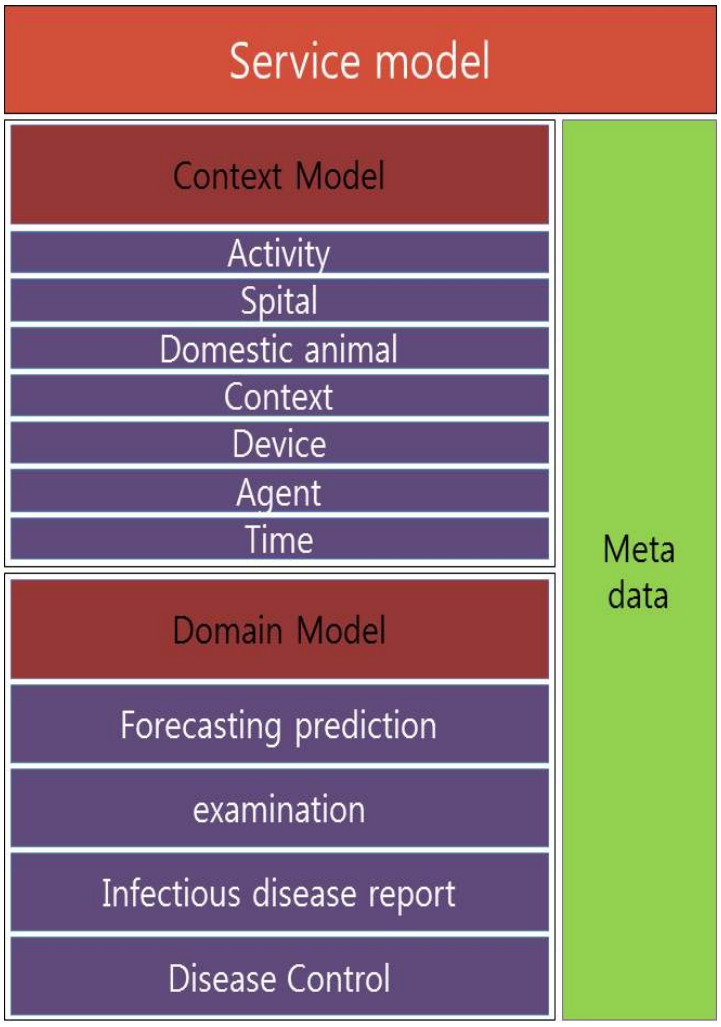

Figure 1. Ontology Model Configuration

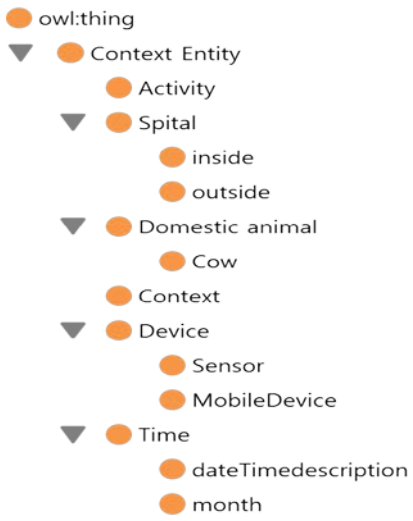

Figure 2. Upper Ontology Model

2.2. Ontology Model Realization

2.2.1. Spatial Ontology Model: Spatial ontology is expressed in context to determine the location of domestic animal and device. Location information in this paper is the factor to determine the current location of the domestic animal to have the inside and outside as child class. With the livestock farm which is the specific domain spatial information with inside as farm and outside as rangeland, it has detail spatial information required for each territory as properties. Figure 3 is the result from modeling spatial context data with ontology.

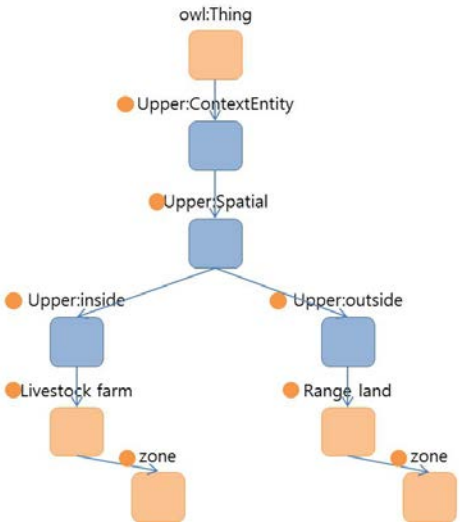

Figure 3. Spatial Ontology Model

2.2.2. Domestic Animal Ontology Model: Domestic animal ontology is the factor to deduce individual livestock and in this study, it's classified to have cow classified as child class. Figure 4 is the result from modeling Domestic animal context data with ontology.

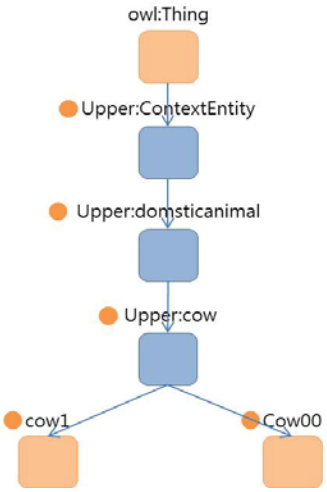

Figure 4. Domestic Animal Ontology Model

2.2.3. Activity Ontology Model: It's necessary to represent the context information considering the services depending on physical condition of domestic animals. Depending on context information, it's necessary to define what services are available and classify depending on characteristics of the services. In this study, context information on feeding and movement of domestic animal were expressed so as to have child class, eat and move. Figure 5 is the result from modeling activity with ontology.

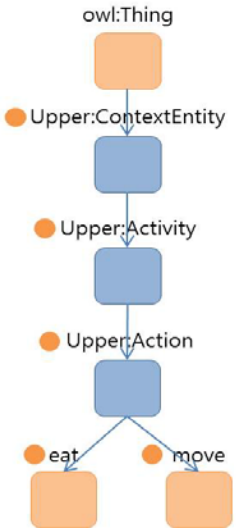

Figure 5. Activity Ontology Model

2.2.4. Device Ontology Model: To deduce the disease to be occurred from context information system, various information on farm is needed, which is achievable by expression of the sensors. In this study, it's designed by classifying them into sensor class to express the basic sensor systems and mobile device class to notify the person and concerned authorities of the disease occurred, Figure 6 shows the device ontology model to express the context information from the sensor.

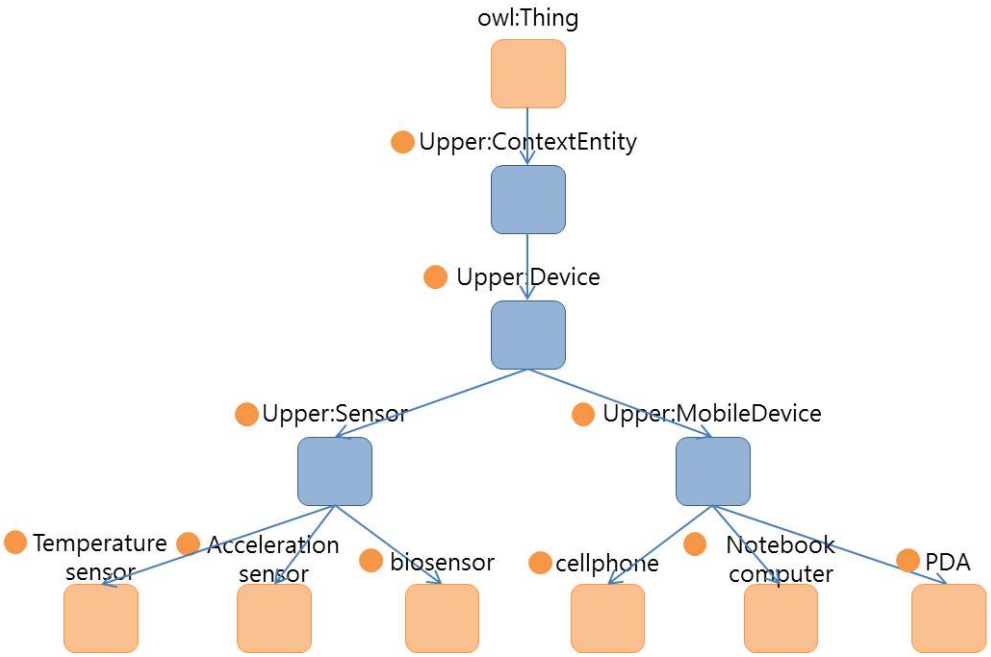

Figure 6. Device Ontology Model

2.2.5. Time Ontology Model: A time ontology mode has the structure with child class depending on time such as month and year. Figure 7 shows the result of modeling.

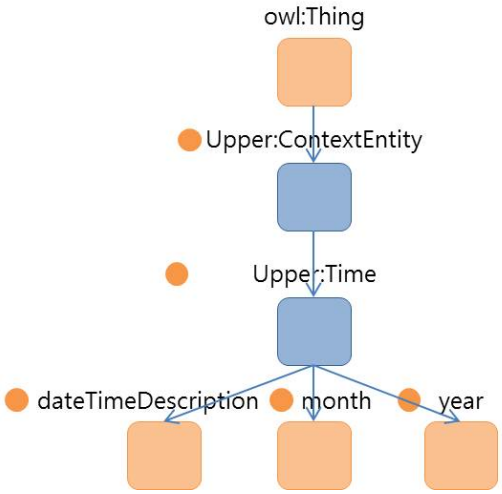

Figure 7. Time Ontology Model

2.1.6. Context Ontology Model: Context ontology defines the event information created depending on condition of livestock and farm and plays the role of creating the instance. It creates the instance by defining the context generated depending on body heat and movement of livestock and air condition at farm. Condition child class defines the properties of each livestock considering the body heat and movement of livestock, while environment child class expresses the air condition of the farm and rangeland. Figure 8 is the result from modeling context ontology.

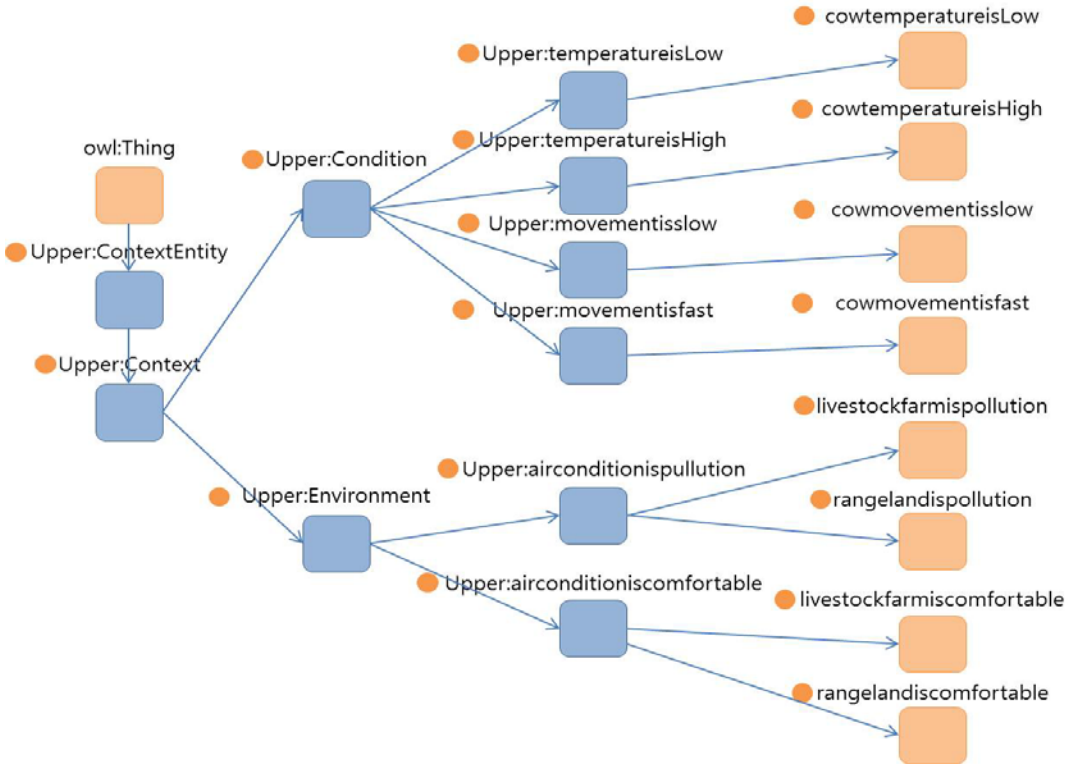

Figure 8. Context Ontology Model

3. Experimental Scenario

The followings are the experimental scenarios of ontology model proposed in this study to prevent the spread of domestic animal disease[19].

1. Temperature sensor and acceleration sensor to monitor the livestock are installed and air condition of the farm and rangeland is monitored by bio sensor.
2. When the body heat of the livestock is higher than reference value, the service to be provided includes the followings

- Temperature sensor on livestock checks the temperature rising time and temperature data hourly to analyze the likelihood of epidemic.
- When the temperature of the body rises together in the group, it searches the related services and notifies the concerned authorities of the data to prevent the epidemic from spreading.

3. When the movement of livestock is less than the standard, the services to be provided includes the followings.

- It monitors the movement of the livestock through acceleration sensor and analyzes the likelihood of epidemic by monitoring the movement of livestock.
- When the movement of the group is less than the standard, it searches the related services and notifies the concerned authorities of the data to prevent the epidemic from spreading.

4. When detecting the air-borne epidemic through bio sensor installed at farm and rangeland, it searches the related services to prevent the epidemic from spreading.

4. Conclusions

In this study, ontology model using context information was proposed to mitigate the damage by fatal domestic animal disease. Situational awareness system is designed to provide the users with useful information obtained using context information. The sensors installed inside and outside the farm and on animal are to detect the disease at early stage and notify the concerned authorities of the situation so as to prevent the epidemic from spreading. The epidemic is usually spreaded by the human or air and this study is intended to detect the disease in timely manner without intervention by the human so as to prevent the epidemic from spreading by human. The proposed ontology model will be further supplemented to provide the users in managing the livestock facilities with useful services.

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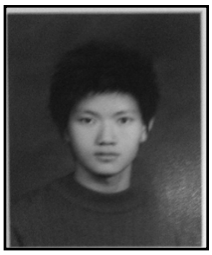
Authors



Seokkyun Jeong is a graduate school student of Sunchon National University. Seokkyun Jeong is also a researcher of u-agriculture IT Application Research Center and Agriculture IT Convergence Support Center at Sunchon National University too. Seokkyun Jeong's research focus is Wireless Sensor Networks and Cloud Computing.

Hoseok Jeong is a graduate school student of Sunchon National University. Hoseok Jeong is also a researcher of u-agriculture IT Application Research Center and Agriculture IT Convergence Support Center at Sunchon National University too. Ho-seok Jeong's research focus is Wireless Sensor Networks and Radio Frequency Identification.

Hyun Yoe is a professor in the department of Information and communication at Sunchon National University, South Korea. He received his M.S and Ph.D degree in Electronic Engineering from Soongsil University in 1987 and 1992, respectively. He has been a research staff in KT Research Center in 1987-1993 in Korea. He also had researched at Georgia Institute of Technology in 1997-1998 in U.S.A. He is a member of IEEE, KICS and KSII. Dr. Yoe's research focus is sensor networks and ubiquitous applications for agriculture. He has investigated issues in ubiquitous sensor networks and wireless networks. He has applied sensor networks to ubiquitous agriculture. He is in charge of uARC(ubiquitous Agriculture IT Application Research Center) and AITCSC(Agriculture IT Convergence Support Center) which is supported by MKE(Ministry of Knowledge Economy), Korea.