

Online Visualization of Urban Noise in Ubiquitous-city Middleware

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Abstract— In this paper, we propose the online visualization of Urban Noise as a part of Smart Ubiquitous Middleware (SmartUM). Since the middleware includes the visualization function, the applications in the u-city portal which want to use noise maps, don't need to include the processing mechanism to make noise map. This paper explains how the online visualization is done in cooperation with other functions of the middleware.

Keywords— Middleware, U-city, Noise map, Visualization, U-city Portal

I. INTRODUCTION

IT innovation has been prepared by Grid, Cloud Computing [1], World Wide Web and dramatic advances in tele-communications and electronics. Ubiquitous computing is another major IT trend to prepare IT innovation.

We have been developing Ubiquitous middleware and here in this paper, we would like to introduce some result of the noise map project as a part of our Ubiquitous middleware that is called SmartUM [2] (Smart Ubiquitous Middleware).

First of all, we define what noise map is. A noise map is that the sound level is represented with distribution existing in a given region, for a defined period. A noise map usually uses verified prediction-model. It computes values and distributions of sound with GIS (Geographic Information System) [3] according to sound source. Data that are gained from the noise map can be analysed as the influence of seasonal effects or time changes are considered. It visualizes noise level by using computer, contours and colors so we can easily catch the effect of the noise.

The structure of this paper is as follows. In section 2, we analyze the related work. In section 3, we introduce SmartUM. In section 4 we describe how the visualization of noise map is integrated with SmartUM. In section 5 we describe Experiment and Implementation. In section 6 we draw some conclusions and future work.

II. RELATED WORK

Ubiquitous computing is defined as a post-desktop model of human-computer interaction in which information processing has been thoroughly integrated into everyday objects and activity [4]. There have been vivid researches on

ubiquitous computing middleware. However, there is no ubiquitous middleware that provides online visualization.

Gaia [5] provides the user-oriented interfaces for physical spaces populated with network-enabled computing resources. The goal of Gaia realizes the active space that performs tasks easily through various resources to user. It utilizes components based on CORBA [6] and its service technology is Application Framework that is a Model-Presentation-Controller. Microsoft's EasyLiving [7] is focused on a smart space. Its middleware is called InConcert. It is related to service abstraction to divide device control, internal logic and user interface. Through mobile computers based on intelligent environment, its aim is that it creates the best comfort living space for user. Hewlett Packard's CoolTown [8] lets users use web from physical world. Its goal is that it provides users with a web presence environment. However, all of these don't offer users GIS. We introduce GIS in our middleware so it can provide noise map.

Environment engineers recently invented noise map with help of geographical information system and the noise map is about to be widely used. For example, the state of Rheinland-Pfalz in Germany has been servicing the noise map in public on the internet since 2008 as shown in figure 1 and England has been using the noise map focusing on evaluations on noise damages. There is no activity of including the noise map into the u-city middleware so far.

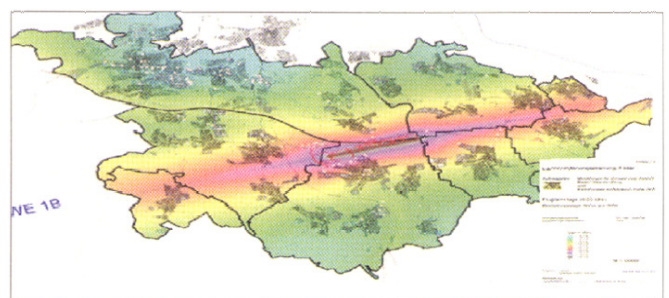


Figure 1. Noise Map of Rheinland-Pfalz

III. SMARTUM

In this section, we explain the internals of SmartUM focusing on the operation of the online visualization of urban noise. SmartUM shown in figure 2 provides the Common Device Interface Layer(CDIL) which manages the

USN(Ubiquitous Sensor Network) and sends the collected data to the CCL (Context-aware Computing Layer) so that CCL can make an intelligent decision. The CCL processes the data acquired through the sensor network and provides intelligent context. SmartUM uses an ontology-based intelligent inference engine and provides context-aware computing capability [9].

The GIS 2D/3D Visualization component in the Common Application Interface layer (CAIL) now processes the online visualization based on the information that is provided by the Ubiquitous Grid Core Computing Layer (UGCCL).

SmartUM has interface to the u-city portal [10], and the application in the portal can use the visualized noise map conveniently and easily.

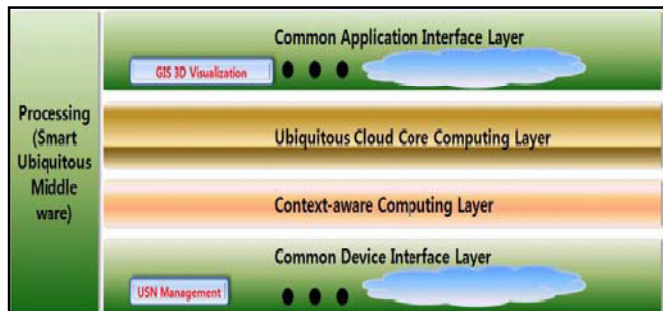


Figure 2. the Internals of SmartUM

IV. THE NOISE MAP PROCESSED BY SMARTUM

The 2D/3D GIS Visualization component processes a specific zone to visualize and User can see noise map on site using portal as shown in figure 3.

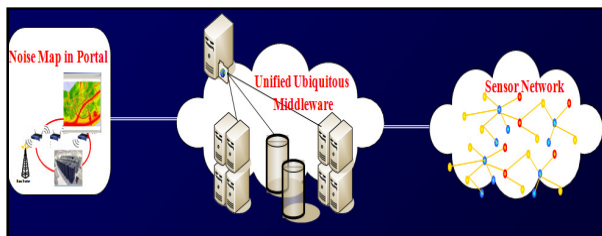


Figure 3. Sensor network to noise map in portal

A. THE STEPS OF MAKING NOISE MAP

The usual standalone steps to make noise map are as follows.

1. The object zone is selected and the analysis method is decided. The collected data and result depend on the analysis method.

2. GIS DATA are collected from the UGCCL. They are dimension data such as location and latitude, attribute data such as building, land, height and resident populations and sound source data such as the number of driving cars on the road, velocity and the noise level.

3. An on-the-spot survey is conducted to measure noise level and check the number of driving cars on the road and the proportion of small cars to heavy cars.

4. A fundamental noise map is modelled based on the survey of the data. Topogeography of the selected zone is made and the source sound after building and obstacles are set up.

5. The place where we want to analyse is selected and the noise value is computed with computer applications based on completed model.

6. The noise map that was generated by computation result is compared with the noise map that was carried out on-the-spot, in order to generate the final noise map.

B. THE NOISE MAP IN SMARTUM

The 2D/3D GIS Visualization component of SmartUM has less steps than the usual standalone case since the data are provided by UGCCL. The steps to visualize the noise map in SmartUM are shown in figure 4.

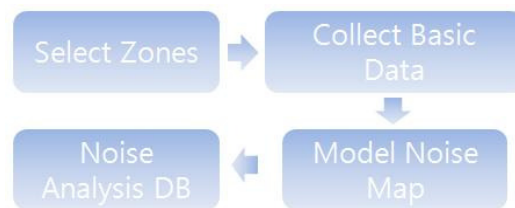


Figure 4. the Steps of making noise map in SmartUM

We select zones and it collects basic data explained in chapter 5. After collecting the data, SmartUM models noise map and it is analysed. After all, the map is completed and stored in the types of jpg.

If users want to see the completed noise map, it will be displayed on portal. It is uploaded on Google map using Arc GIS explorer application and it is deployed.

V. EXPERIMENT & IMPLEMENTATION

There are many applications supporting prediction-model such as B&K, DataKustik [11], SoudPLAN and so on. To realize the noise map in GIS 3D Visualization, We use SounPLAN 6.4ver because it provides a sound source computation with various prediction-model and RLS-90 equation that was proposed to expect the road traffic noise in Germany. The prediction-model of SounPLAN 6.4ver is shown in table 1.

Table 1. Prediction-model of SounPLAN 6.4ver

	Road Traffic Noise	Railway Noise	Aircraft Noise	Industry Noise
SoundPLAN	FHWA RD-77 RLS-90 CRTN	Schall03 OeAL-30 NPM CRN	AzB	ISO-9613 VDI 2714/2720 CONCAWE

As shown in the table, the prediction-model is dependent on a noise source. We focus noise source on the road traffic noise

so we use the prediction-model(SoundPLAN6.4ver) for modelling noise map.

RLS-90 uses prediction of point source array. It divides the model into 2 models, one is source model and the other is propagation model. The source model uses standard noise level at 4 height of 25meters distance point (it is called L25). The propagation model computes noise level by using sound transmission as shown in figure 5.

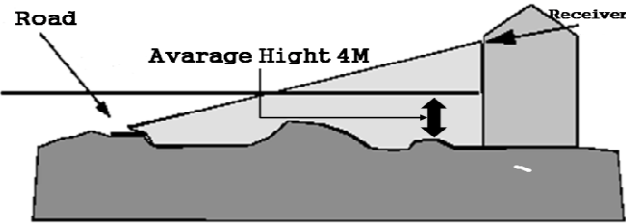


Figure 5. A computation of noise level

To compute noise level, the following information is needed.

1. The number of passing cars per 1hour and the proportion of small cars to heavy cars
2. Velocity information
3. The surface information of the road
4. Road gradient information
5. Multiple reflection information

We choose heavy cars as weight above 2.8 ton (That is standardized in RLS90) and mainstream as that the number of driving cars per 1hour is more than 800. RLS-90 considers sound diffusion, ground attenuation, sound insulation and reflection. Source model is defined as follows.

$$L_{m,E} = L_m(25, basic) + C_{Sp} + C_{Rs} + C_G + C_{Ref}$$

L_m means noise level: small car drives 100km/h on the road and heavy car drives 80km/h on the road. C_{Sp} means the velocity of cars; C_{Rs} means the kind of the surface of the road; C_G means the road gradient and C_{Ref} means the correction factor of multiple effects. The basic information is gathered and stored in CDIL of SmartUM.

CDIL uses noise analysis DB that stores information of noise level for storing the data and CAIL uses urban space model DB that stores location information of building. It consists of urban lots DB and building DB. They make relation tables and urban space model DB uses the relation table as shown in figure 6. Population DB that stores the populations of building are used to model noise map. The 2D/3D GIS Visualization component uses VRML [12] to visualize in 3D as shown in figure 7. Through the u-city portal, users now can see the 3D noise map as shown in figure 8.

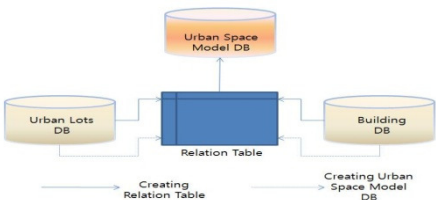


Figure 6. Creating Urban Space Model DB

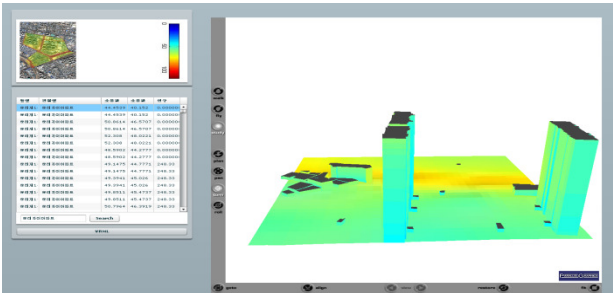


Figure 7. VRML to Visualize in 3D

As shown in figure 8, if you use specific zones, you can see noise level which has specific color according to noise level.



Figure 8. Visualized information in 3D through the u-city portal.

We also use ArcGis explorer to provide noise map. It can retrieve various attributes as shown in figure 9.

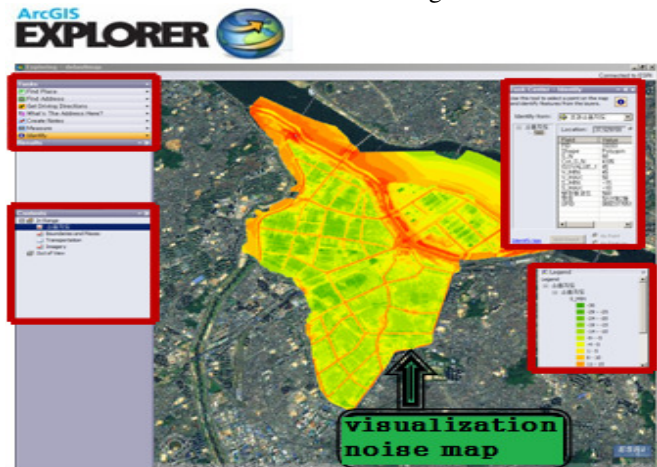


Figure 9. Visualized noise map using ArcGIS Explorer in 2D

VI. CONCLUSION

In this paper, we have explained how SmartUM generates noise map with GIS 3D Visualization component. Users don't need to know the details of making noise map if they use SmartUM. With SmartUM, it is very easy to analyze noise problems.

VII. ACKNOWLEDGMENT

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