GR-Media: Spatial Reference Model for Geo-Referenced Media (Work-in-progress paper)

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***Abstract*—Recently, the size of digital media contents is growing. Most of the media content is made to reflect the real world. In particular, media created by reflecting the location of the real world is called Geo-Referenced media. However, the media is divided into various types, such as photographs, videos, games and novels. So, it is complicated to make this media as a Geo-Referenced media. The purpose of this study is to define a model that provides location references of various media, and to provide a way to connect real-world and various Geo-Referenced media types. In this paper, media types include photography, painting, video, animation, comics, and novels.**

Keywords–Geo-Referenced Media; Spatial Reference Model.

I. INTRODUCTION

A variety of contents, such as images, multimedia, and novels directly or indirectly express and relate objects, places, and locations existing in the real world. For example, the village of Hobbiton, which appeared in The Lord of the Rings movie is shot in places of the Waikato town of Matamata in the real world. This place has become one of the places, which was visited with curiosity by people who received indirect experience through the movies. Such Geo-Referenced media is related to real-world through various type of media, and this association affects other fields like tourism industry and the content industry.

The model connecting the media and the real world is an important requirement for the utilization of contents and the diffusion of new industries. The problem of connecting the media and the real world is classified into three stages as shown in Figure 1:

1) How do you create a model that connects the media and the real world?
2) How do you author data by using authored reference models?
3) What services will you use for your data?

Therefore, in this paper, we propose a spatial reference model for constructing Geo-Referenced media for contents that are closely related to the real world for the first step. The proposed model needs to reflect the existing standard model that expresses indoor and outdoor space and place. In addition, we propose a model considering the reference method depending on the type of Geo-Referenced media.

This paper is organized as follows. In section II, we introduce related research and derive the specific requirements of the GR-Media model. Section III explains the types and characteristics of media. Section IV describes the media contents of the proposed model. Section V summarizes the research contents and discusses future research.

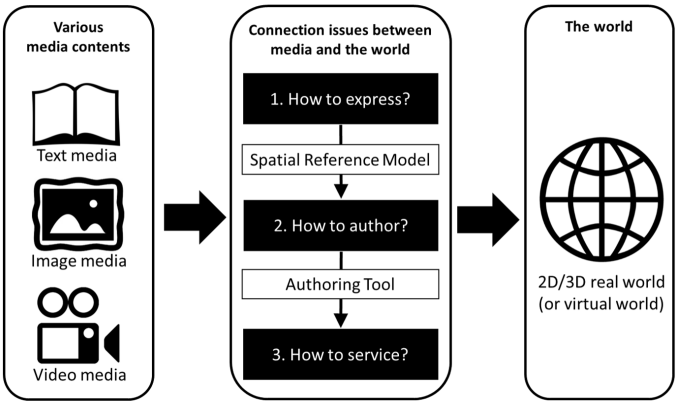
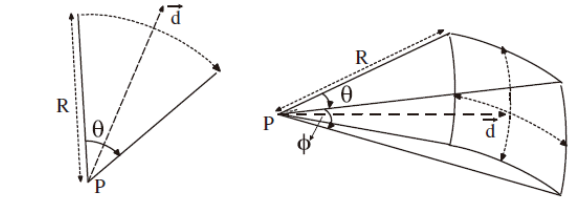


Figure 1. Problem definition for Geo-Reference media

II. RELATED WORK

A. Geo-Reference Media

This section introduces the research about combining multimedia and spatial reference information. First, MediaQ[1][2] is a service that makes easy to find media taken from outdoor space based on location. MediaQ manages the media based on the field-of-view (FoV) information shown in Figure 2.



P : camera location (<longitude,latitude>)
θ : viewable angle
d : camera direction vector
R: visible distance

P : camera location (<longitude,latitude,altitude>)
θ,ϕ: horizontal and vertical viewable angles
d : camera direction vector (in 3D)
R : visible distance

Figure 2. Illustration of camera field-of-view (FOV) (a) in 2D (b) in 3D

In addition, there have been studies to add spatial information to media, created in indoor space instead of outdoor

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space[3][4]. These studies use the same FoV as MediaQ's FoV, but present FoV reflecting the characteristics of the room. In order to manage the indoor location information of the media, the indoor network of the building and the location information of the media are connected.

However, all these studies manage information based on the information of the camera that generates the media. In other words, there is no consideration for the object taken by the camera has taken. However, many objects in the media are closely related to the real world. In order to match the media with the real world, a spatial reference model for objects in the media is needed.

B. Spatial Data and Spatial Reference Model

For the link between media and the real world, it is necessary to link the spatial reference model for media with the existing spatial data model and the spatial reference model. This section introduces representative indoor and outdoor spatial data model and coordinate reference system.

IndoorGML[5] is an international standard for the representation and exchange of indoor spatial information in the Open Geospatial Consortium (OGC), which includes a data model for representing indoor space. In IndoorGML, a cell space is defined as a unit space constituting an indoor space, and an indoor space is represented as a set of cell space. IndoorGML also has an indoor network graph. The node of this graph correspond to the cell space and is represented by a state. And the edge of this graph means connectivity between cell spaces and is expressed as a transition. In case of media generated indoors, connection with the real world can be expressed through matching with the indoor network. In this case, the type of indoor network is the connectivity graph as shown in Figure 3.

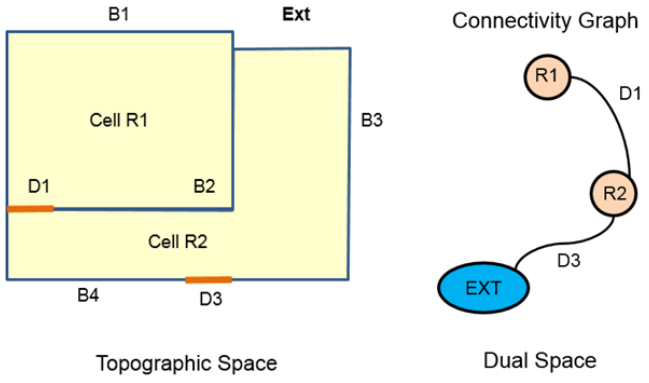

Figure 3. Example of connectivity graph in IndoorGML

CityGML[6] is an international standard established by OGC to represent urban models and includes data models for expressing road, building, tunnel, etc. There are various modules in the document, but ***_BoundarySurface*** most commonly used to express geometry. Therefore, in the case of media generated outdoors, the connection with the real world can be expressed by matching with the ***_BoundarySurface***.

ISO 19111[7] is a standard document describing a coordinate reference system, which has a model for the coordinate reference system as shown in Figure 4. The coordinate reference system consists of datum and coordinate system. The datum describes the relationship between the object and the coordinate system. The **SC_SingleCRS** has only one coordinate system. If more than one coordinate system is required, the **SC_CompoundCRS** can be used. Since there is a CRS already defined as shown in Figure 4, we define the necessary coordinate system to refer to the objects inside the media using the predefined CRS.

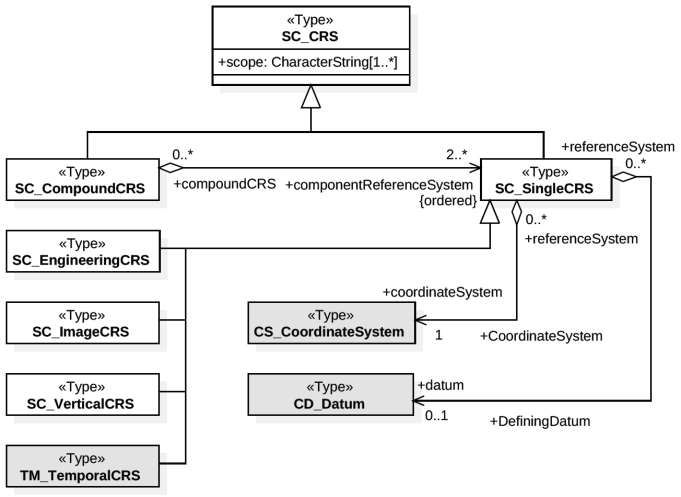

Figure 4. SC_CoordinateReferenceSystem package in ISO19111

As a result, the spatial reference model for Geo-Referenced meida needs to link IndoorGML for indoor media and CityGML for outdoor media. In addition, it is necessary to define the coordinate reference system for expressing the objects inside the media using ISO19111. Finally, we can create a spatial reference model for Geo-Referenced meida using classification according to the characteristics of the media.

III. Geo-Referenced Media Classification

In this paper, we design a spatial reference model for contents such as novel, painting, photography, video, movie, cartoon, and animation. The target contents are all digital media. Media is divided into text media, image media, and video media due to it's characteristics. Table I shows the contents classified according to the classified media types. Novel is classified as text media. Contents that are targeted to one image, such as painting or photographs, are classified as an image media. Cartoons are classified as multi-image media because they are having multiple images classified in cut units. Finally, content whose image changes over time, such as video, movie, and animation, is classified as a video media.

In media, objects that require spatial information are divided into two types. One is the camera object that create the media, and camera objects have FoV information and their presence is determined by the type of media. The other is an object inside the media. The objects inside the media have the following two kinds of information according to the types of the media.

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TABLE I. CLASSIFICATION OF CONTENT ACCORDING TO MEDIA TYPE

	Text media	*Image media*	*Multi-image media*	*Video media*
Content	Novel . . .	Painting Photography . . .	Cartoon . . .	Video Movie Animation . . .

- For text media:
  - The location of the object in the text
  - The spatial information of objects in the corresponding real world
- For image(or video) media:
  - Boundary geometry information for objects in images
  - The spatial information of objects in the corresponding real world

Finally, objects inside the media have two pieces of spatial information together: reference information about the media and spatial information of the real world. Therefore, a connection between two pieces of information is required.

IV. GEO-REFERENCED MEDIA MODEL

Based on the spatial information standard introduced in Section II and the classification according to the media characteristics defined in Section III, the GR-Media model as shown in Figure 5 was constructed.

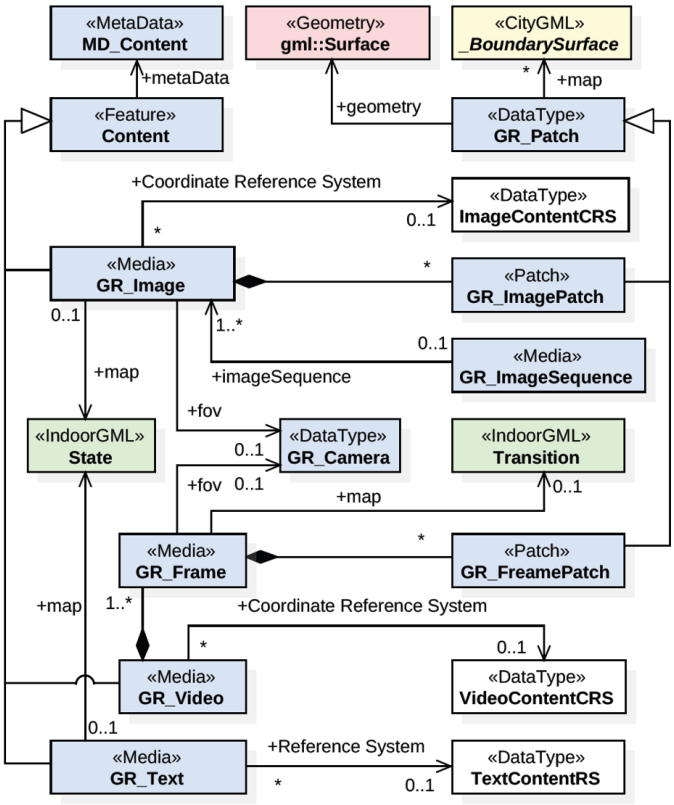

FIGURE 5. GEO-REFERENCED MEDIA MODEL

The characteristics of the GR-Media model are as follows.

All media inherit **Content** class. **Content** class has **MD_Content** class indicating metadata including reference space information. Media is divided into **GR_Image**, **GR_ImageSequence**, **GR_Video** and **GR_Text** class depending on the type.

GR_Image class may have **GR_ImagePatch** class for the representation of objects in an image and uses **ImageContentCRS** class as the coordinate reference system. **ImageContentCRS** basically use **SC_ImageCRS** class.

In the case of **GR_ImageSequence** class, it consists of a sequence of **GR_Image**. **GR_ImageSequence** is required for content with multiple images. For example, in the case of cartoons, it belongs to **GR_ImageSequence** because it is composed of several cut images.

In the case of **GR_Video** class, it is composed of several frame images(**GR_Frame** class). **GR_Frame** can have **GR_FramePatch** class for the representation of the objects in the frame image, and **VideoContentCRS** class is used as the coordinate reference system. **VideoContentCRS** uses **SC_ImageCRS** class to refer to an object in the frame image, and uses **TM_TemporalCRS** class to represent the time. That is, **SC_CompoundCRS** class with two coordinate reference systems is used.

In the case of **GR_Text** class, various types of media exist depending on contents, and there are various reference methods. Therefore, the reference model is designed to have only **TextContentRS** class to be extensible, and is not described in this model. In addition, **GR_Text** provided in this model assumes a text-only media.

GR_Camera class stores FoV information when media is created. Only media with one image are designed to have FoV.

Patches for representing objects inside each media inherit **GR_Patch** class. **GR_Patch** has the geometry of the object as Surface and is mapped to CityGMLś ***_BoundarySurface*** class.

In the case of media representing indoor space, media such as **GR_Image**, which do not have a temporal relationship between media, correspond to the **State** class of the IndoorGML. On the other hand, media such as **GR_Frame**, which have temporally continuous relationship with media, correspond to the **Transition** class of IndoorGML.

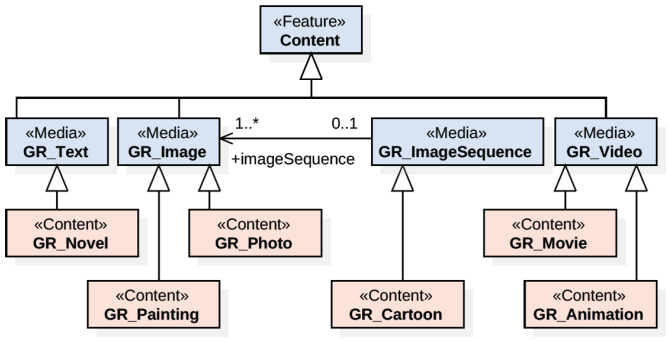

FIGURE 6. EXTENDED CONTENT MODEL

Figure 6 shows the extended model using the GR-media model for the content defined in Section III. First, text-based media, such as fiction inherits the **GR_text** class. Second, media consisting of a single image, such as paintings

and photographs, inherits the **GR_Image** class. Third, media composed of multiple images, such as cartoons, inherits the **GR_ImageSequence** class. Finally, for video media, such as movies, animations, the **GR_Video** class is inherited.

An example using the GR-Meida model is shown in Figure 7. **GR_Video** class has basic information about video (title, length, etc. of video). For example, Figure 7 depicts PSY's Gangnam Style music video. In this case, when the Trade tower appears in 32 seconds, information about the frame image is expressed by **GR_Frame** class. Then, make a polygon for the area corresponding to the Trade tower in the frame image, and express it using **GR_FramePatch** class. Finally, the 3D model of CityGML is mapped with the corresponding ***_BoundarySurface*** class to express the connection between the media and the real world.

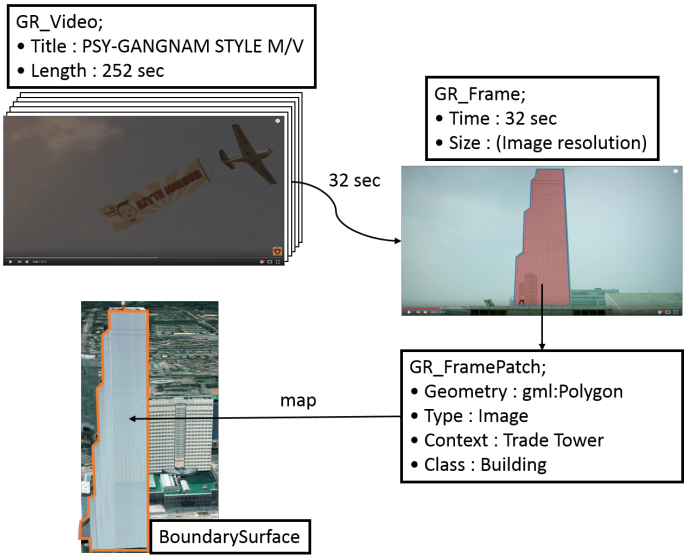

FIGURE 7. EXAMPLE OF GR_VIDEO

V. CONCLUSION

In this paper, we design a spatial reference model for connecting various types of digital media contents and real world.

However, there is a lack of consideration for content with complex situations. For example, it is difficult to use the proposed model in the case where a movie have information about the real world and the virtual world. Also, there is a limitation in covering media content like games, music, etc. In the future, we plan to design a model that considers more diverse content and matches with virtual worlds or multiple worlds.

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