DEVELOPING A METHOD TO GENERATE INDOORGML DATA FROM THE OMNI-DIRECTIONAL IMAGE

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ABSTRACT:

Recently, many applications for indoor space are developed. The most realistic way to service an indoor space application is on the omni-directional image so far. Due to limitations of positioning technology and indoor space modelling, however, indoor navigation service can't be implemented properly. In 2014, IndoorGML is approved as an OGC's standard. This is an indoor space data model which is for the indoor navigation service. Nevertheless, the IndoorGML is defined, there is no method to generate the IndoorGML data except manually. This paper is aimed to propose a method to generate the IndoorGML data semi-automatically from the omni-directional image. In this paper, image segmentation and classification method are adopted to generate the IndoorGML data. The edge detection method is used to extract the features from the image. After doing the edge detection method, image classification method with ROI is adopted to find the features that we want. The following step is to convert the extracted area to the point which is regarded as state and connect to shooting point's state. This is the IndoorGML data at the shooting point. It can be expanded to the floor's IndoorGML data by connecting the each shooting points after repeating the process. Also, IndoorGML data of building can be generated by connecting the floor's IndoorGML data. The proposed method is adopted at the testbed, and the IndoorGML data is generated. By using the generated IndoorGML data, it can be applied to the various applications for indoor space information service.

1. INTRODUCTION

1.1 Background and Objective

Indoor space is a new rising area of spatial information services. As people spend 80 percent of their time in indoor space, the needs of indoor spatial information service have grown rapidly (Li and Lee, 2013). However, applications are not various because there are limitations of indoor positioning technology and indoor space modelling. Especially, topological model is necessary to implement diverse services based on the spatial relationships in between indoor features, such as outdoor-indoor seamless routing service, emergency evacuation service, and so on.

In 2014, IndoorGML is approved as an OGC standard, which is the standard of the indoor space topological model for navigation service. IndoorGML is a topological data model to represent topological relationships among spatial features in indoor space, which does not contain geometry of indoor spatial objects. Due to the limitations of current 3D feature-based topological data models for micro-spatial applications, IndoorGML adopts a different approach for representing the topological relationships among 3D objects, which is called the Node-Relation Structure (NRS) (Lee *et al*, 2014). As the NRS approach, IndoorGML consists of two core elements, such as state and transition. State represents the space which we live as a point, such as room, hallway, balcony, elevator, and so on. Also, transition represents the spatial relationship between states as a line. Therefore, connectivity and adjacency can be expressed by transition (Lee *et al*, 2014). Nevertheless, concept of the topological model is defined by IndoorGML, there is no method to generate IndoorGML data except manually. It is necessary to implement the various services for indoor space. Therefore, this paper proposes the method to generate the IndoorGML data semi-automatically, especially based on the omni-directional image which is the most realistic way for indoor service.

1.2 Related Works

The omni-directional image is image or raster data set, and IndoorGML is vector data set. Therefore, concept of the proposed method is based on the research of the feature extraction from the image data. There is much research to extract features from image data (Ganchimeg and Turbat, 2014; Maselli, 2004; Mena, 2003; Na and Zang, 2011; Rau *et al*, 2015; Walia and Singh, 2014). One of the useful methods is edge detection. Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities (Umbaugh, 2010). Using edge detection technique, it can be identify or extracting features on the image. For examples, it is adopted to extract the road features from the satellite image or aerial photo. Also, building boundaries or footprint can be extracted by using edge detection technology. Image classification techniques is another good method to identify the specific area on the image, especially it is used in the remote sensing area very much. The most well-known example of this method is NDVI classification to extract the vegetation area from the image.

These methods are great to identify the features from the image on the purposes; there are few attempts to use these techniques to be adopted at the indoor space. It is a quite good method to be used at the indoor space if some conditions are fulfilled. Therefore, this paper proposes the method to generate the

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IndoorGML data from the omni-directional image based on the image segmentation or classification techniques.

2. A METHOD TO GENERATE THE INDOORGML DATA FROM THE OMNI-DIRECTIONAL IMAGE

Figure 1 shows the process of proposed method to generate IndoorGML data from the omni-directional image. In this process, 3 datasets are needed, such as the omni-directional images, shooting points and floor plan. Each omni-directional image has to be initially recorded in the same direction. Also, the position of shooting points can be identified on the floor plan. The number of shooting points can be changed as the subspacing method. In the floor plan, there is some information about the facilities in the indoor space such as size, position, so on. Therefore, using floor plan and shooting point's information, reference database can be generated. It is used for the information to identify which features are real that we want.

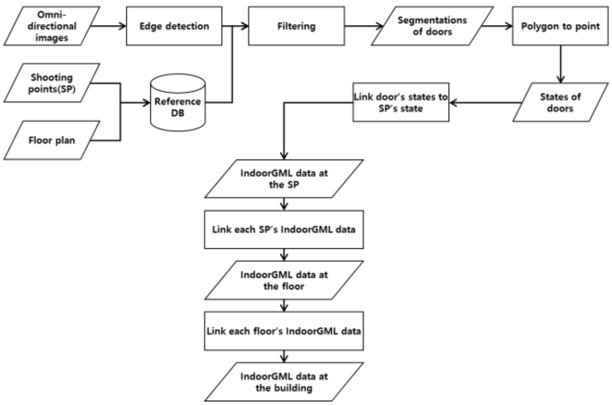

Figure 1. Flow chart of method

Figure 2. Adoption the edge detection on the omni-directional image (top: original, bottom: result)

The first step of the process is edge detection. It can find the edge through the omni-directional image and the features are generated by edges like Figure 2. After the edge detection step, various features can be detected; however, additional processes are needed to identify the features that we want as all features are not interests. To extract the exact features, the filtering step is followed.

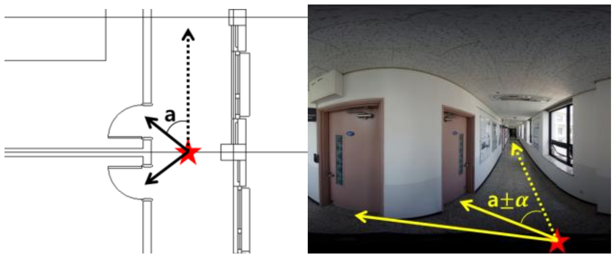

Figure 3. Finding a ROI on the image using shooting point and floor plan

In the filtering step, there are 2 specific methodologies which are region of interest (ROI) and image classification. ROI is a selected subset of samples within a dataset identified for a particular purpose (Brinkmann, 1999). Especially, in computer vision, the ROI defines the borders of an object under consideration. In this process, we can use ROI, using angle from the shooting point to doors, to narrow the area down where the door features are (Figure 3).

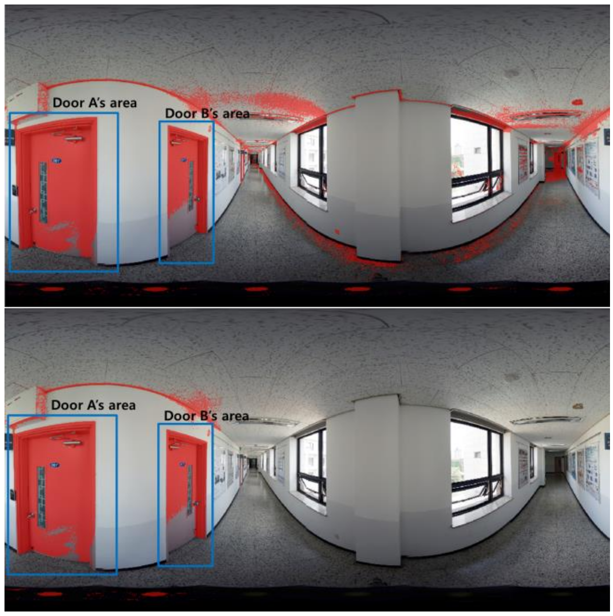

Figure 4. Image classification using the door's colour (top: without ROI, bottom: with ROI)

Also, image classification is used for finding real door features in the extracted features after edge detection step. In most of the indoor space, the door has own colour pattern, size, shape, and so on. It can be used to identify the real door features in the extracted features. In this method, the specific pattern of the door's colour can be used and size and shape which are from the reference database also can be used to find real door from the extracted features after the edge detection step. Figure 4 shows result of the filtering step depends on the using ROI.

After the filtering step, the segmentation of doors can be exported. In the next step, the segmentation of doors has to be converted into point which is same as state in IndoorGML because the segmentation of doors is the area of door. After these steps, connecting the states of doors and shooting point is performed. It makes the IndoorGML data at the shooting point.

By repeating the this process at the each shooting points, IndoorGML data for the each shooting points can be made and by linking all of shooting points, the IndoorGML data of floor can be generated. Also, this concept can be expanded to generate the IndoorGML data of building by floor level IndoorGML data. In this process, edge detection and filtering step is very important. There is much research and many methods of edge detection and image classification.

3. EXPERIMENT

To adopt the proposed method, 22 Omni-directional images are ready. Each image is taken at the same starting direction and same day. Also, the floor plan which is CAD format and 1/400 scale is prepared. The testbed is the sixth floor of 21century building, the University of Seoul. The result of the generating the IndoorGML data for the testbed is below Figure 5.

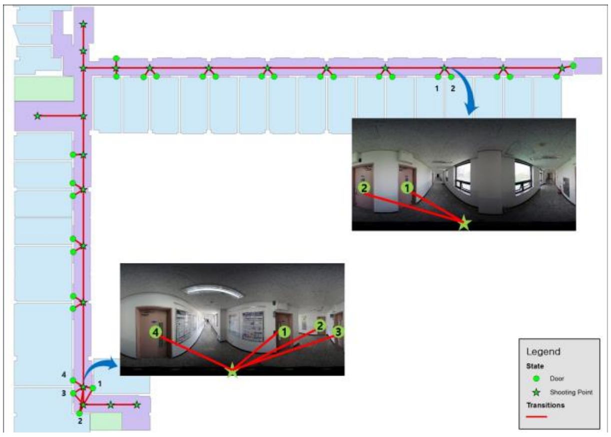

Figure 5. Generated IndoorGML data of testbed with floor plan

As the Figure 5, 51 states (22 shooting points, 29 doors) and 53 transitions are generated using proposed method. Each door is shown as a state and each states of door are linked to the state of shooting points. However, there is no state of the door of the elevator and restroom. In the case of the elevator doors, the colour pattern is different the comparing to the general doors of the testbed. Also, in the image classification step, the doors of the restroom can’t be identified since it is empty; therefore, to create the states at this site, it is necessary to check the result manually.

4. CONCLUSION

This paper proposes the method top generate IndoorGML data from the omni-directional image. In the proposed method, edge detection, ROI, image classification methods are adopted to find the interest feature. As the experiment for the testbed, the proposed method is demonstrated to be able to generate the IndoorGML data using the proposed method. The result of the experiment can be described by the spatial relationships of the testbeds.

In this method, there is no geometry considering. Geometry of extracted features is needed for the services. Therefore, future research has to be considered for how to contain the geometry information of extracted features.

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