A STUDY ON THE USER-INTUITIVE VISUALIZATION OF RAINFALL RADAR DATA USING GRAPHICS TECHNIQUES

Hyeoung-Wook Choi[1], Hyeon-Cheol Park[1], Jae-Woong Yun[1], Shin Kim[1], and Yun-Jae Choung[1]
[1]Institute of Spatial Information Technology Research, GEO C&I Co., Ltd., 1119-116 Bangchon-dong, Daegu, Republic of Korea,
Email: {hwchoi, hcpark , jwyun, skim, chyj}@geocni.com

KEY WORDS: Rainfall Radar, Radar Data Processing, Display, 3D GIS Matching

ABSTRACT: The sensing method, which uses the ground radar equipment, has been actively utilized in monitoring and predicting rainfall in the field of meteorology. The advanced countries are trying to minimize damage by installing small-sized x-band rainfall radar and performing real-time weather observation in areas where there are frequent damages due to sudden climate changes, such as local torrential rainfalls and tornadoes. An intuitive radar data visualization mashup service method, which uses graphics techniques, was suggested in this study for the effective utilization of radar data by the users. The suggested graphics-based visualization method reprocesses the rainfall data observed by the rainfall radar into the high-resolution raster-type data structure, such as 2D images or 3D volume layer data, so that the users can intuitively use the data. The reprocessed intuitive radar data observation data can be matched with 3D precision GIS maps or 2D Open Maps. The use of the suggested technique is expected to be of great help in the accurate understanding of climate situations and more effective tasks related to meteorological disasters by providing more precise data through radar data processing and precision GIS matching.

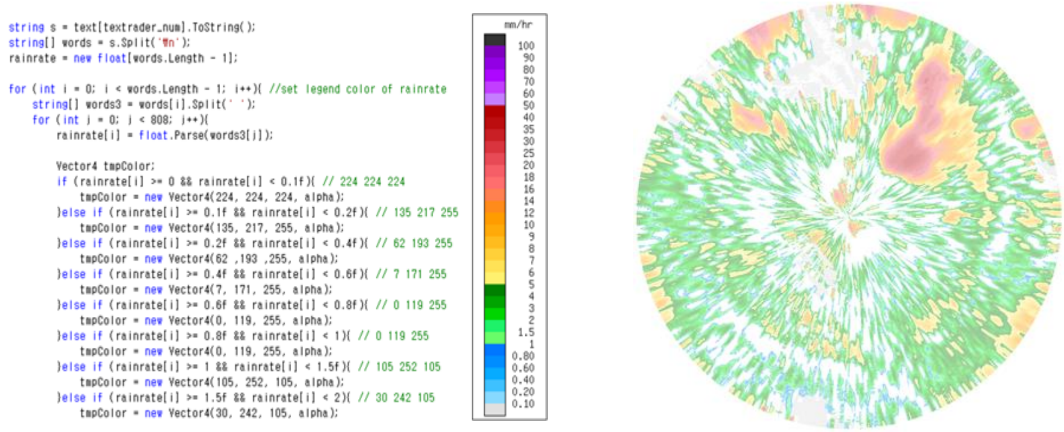
1. INTRODUCTION

In the past, observation data based on a ground station were typically used for the observation of rainfall. Such observation data are still valuable as the data of precipitation that actually falls onto the ground, and thus, they are necessary data in various fields. However, when a typhoon or torrential rainfall occurs, spatial distribution needs to be accurately known in order to predict the moving path of the rainfall distribution or the amount of rainfall. In this case, remote sensing data (e.g., radar data) can be effectively utilized (Park et al., 2007). Based on this advantage, radar equipment is actively being used for rainfall prediction. Advanced countries, such as Japan and the United States, have installed small-scale rainfall radar in order to predict local heavy rainfall that occurs frequently in the urban areas, and to minimize the relevant damage (Choi et al., 2015).
However, despite the use of developed remote sensing techniques, providing intuitive data for the users through the visualization of the high-resolution temporal and spatial data, which were obtained from the rainfall radar on a map by matching the data to spatial locations, is still insufficient (Jang et al., 2013). Therefore, in the current study, a method for providing more user-intuitive service was suggested by improving and upgrading the radar data visualization technique, based on the recently developed three-dimensional graphics techniques. It is thought that the suggested technique can be effectively used for providing and recognizing water disaster-related information through the visualization of the rainfall radar data.

2. GENERATION OF THREE-DIMENSIONAL VOLUME DATA FOR RADAR DATA

2.1. Two-dimensional image processing for the radar data

For the visual utilization of the data observed from the rainfall radar, it is essential to transform the initially generated grid-based text data into an image, and to perform a mashup with the geographic information that corresponds to the observation range. In this study, a two-dimensional image data was generated by parsing with the use of the C# script (Figure 1[a]). By applying the standard pseudo color after designating the pixel data, based on the X, Y coordinates, it was transformed into a two-dimensional image data, wherein a mashup with the geographic information can be performed (Figure 1[b]).



(a) Transformation code (b) Pseudo color transformation

Figure 1. Pseudo color transformation for the rainfall data

2.2. Coordinate setting for the two-dimensional image data

The rainfall data, which was observed from the rainfall radar, did not include the coordinates. As a result, it is typically expressed in a grid format centering on the location of the radar installation, according to the observation radius (Choi et al., 2015). However, in order to provide information in a format combined with the GIS data that can be recognized by a user, the coordinate setting for matching with the geographic information is essential. In the current study, grid unit data characteristics were used for the coordinate setting of the two-dimensional image data. In other words, the coordinates that corresponded to each grid location were extracted by calculating the observation radius, grid arrangement, and resolution centering on the coordinates of the radar installation location (Figure 2).

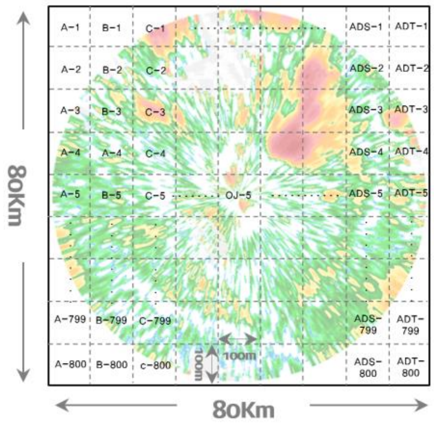


Figure 2. Coordinate extraction from the grid-based rainfall data

Table 1. Coordinate extraction results

Category	Coordinates (TM)	
	Latitude	Longitude
A-1	38.0688	126.3398
ADT-1	38.0688	127.1398
A-800	37.2688	126.3398
ADT-800	37.2688	127.1398
OJ-5	37.6688	126.7398

2.3. Implementation of a 3D raster model for the 2D radar data

For the three-dimensional modeling of the two-dimensional raster data, it is essential to generate vertical grids in a normal distribution format, based on the Z value. A virtual grid is the vertical division of a three-dimensional space, based on the data distribution, at regular intervals along the X, Y, and Z axes, and the graphic expression is generally represented by a mesh where the polygons have been combined.

In order to implement a three-dimensional raster model of the radar observation data, a triangular mesh that reflected the two-dimensional image structure was generated. A three-dimensional texture, which can be visually identified, was then generated by using the precipitation value that corresponded to each grid as the Z value. In addition, for noise elimination and generation of more visually intuitive data, the Gaussian smoothing filtering technique, based on mask processing, was applied (Figure 3).

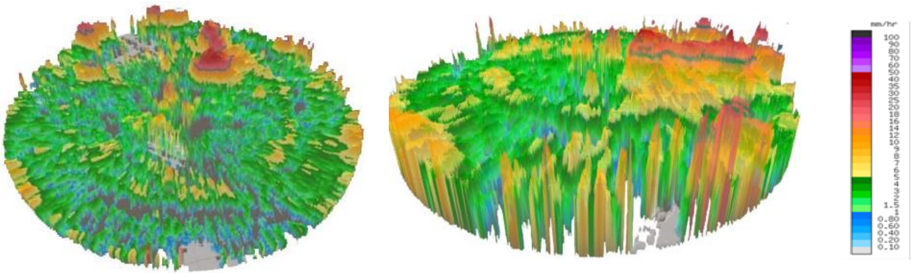


Figure 3. 3D Raster data transformation of the 2D image rainfall radar data

3. THREE-DIMENSIONAL RADAR DATA PRECISION MAP MATCHING AND VISUALIZATION

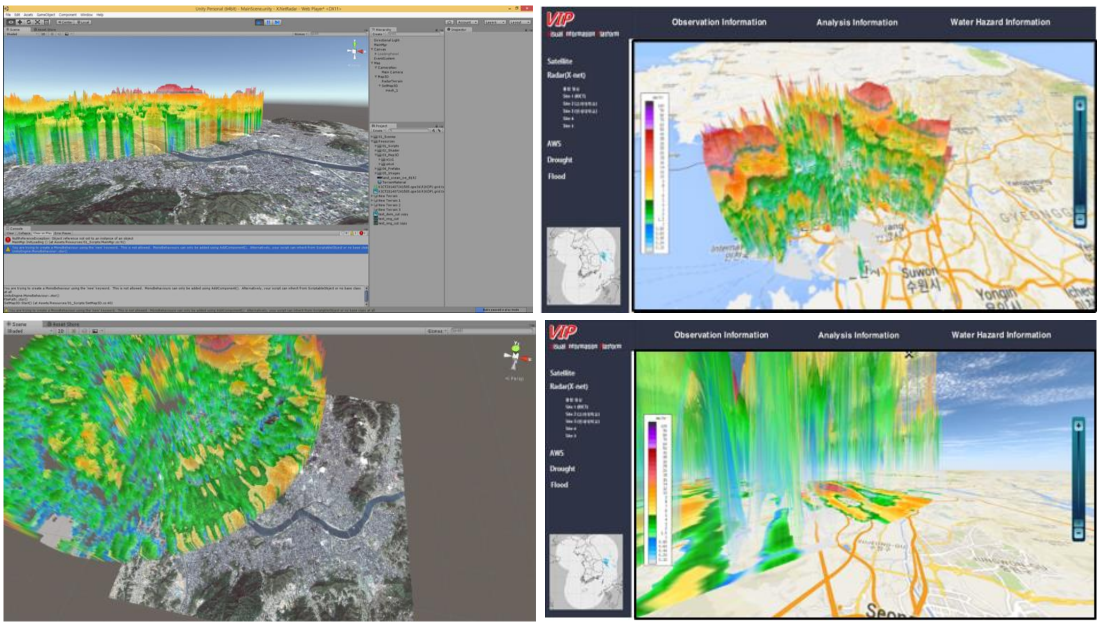
In this chapter, a service prototype, which can be visually provided for the users, was implemented through the real-time fusion of the geographic data and the three-dimensional radar time-series raster data, based on the pre-established GIS platform.

In order to provide the three-dimensional raster data to the users in an instantly responsive animation format, a real-time rendering technique is essential. The platform-independent Unity 3D was the tool used in the current study. In addition, the establishment of the prototype for user service consisted of a web page, including a 3D viewer, a web server for providing information, and a database for data storage (Table 2).

Table 2. Prototype development environment

Category	Tool
3D Program	Unity 3D
Language	C#
Editor	MS Visual Study, Mono Develop
3D Modeling	3DS MAX

Figure 4 shows the result obtained through the real-time rendering of the generated three-dimensional data, followed by the fusion with the GIS platform, for the purpose of providing such service to the users. As for the rainfall radar data expressed by the visualization technique, which was suggested in this study, it was easier to recognize the differences between the rainfall and the spatial distribution, depending on the region and altitude, as compared to the existing two-dimensional visualization.



(a) 3D data rendering and map matching (b) Developed prototype for user services

Figure 4. Results of the graphics-based three-dimensional radar information real-time rendering and map matching visualization

4. CONCLUSION

In this study, a method that provided graphics-based intuitive data for the effective presentation of the radar observation data was suggested. In this method, the precipitation data observed from meteorological radar was converted into two-dimensional image data, and the rendering of the data was then performed as a three-dimensional volume data, followed by the mashup on the pre-established three-dimensional GIS platform. Based on the suggested technique, a service prototype combined with the three-dimensional GIS platform was established, and it could be used effectively for rainfall monitoring (Figure 4[b]).

Data visualization enables non-experts to easily access data and understand the analysis result, which improves the value of the data in terms of utilization. From this point of view, the visual information expressed by the suggested technique would enable the general users to recognize the situation more easily; therefore, this could be an effective tool for providing water disaster-related information.

5. ACKNOWLEDGMENTS

This research was supported by a grant (16AWMP-B079625-03) from the Water Management Research Program funded by the Ministry of Land, Infrastructure, and Transport of the Korean government.

6. REFERENCES

- Choi, H.W., S.M. Kang., K.J. Kim., D.Y. Kim and Y.J. Choung., 2015. Development of the Visualization Prototype of Radar Rainfall Data Using the Unity 3D Engine. Journal of the Korean Association of Geographic Information Studies, 18(4), pp.131-144
- Jang, B.J., S.H. Lee., S.H. Lee., K.S. Moon., V. Chandrasekar and K.R. Kwon., 2013. A Visualization Method of High Definition Water Radar Information for Various GIS Platforms. Journal of Korea Multimedia Society. 16(11):1239-1249
- Park J.H., B.S. Kang., G.S. Lee and E.R. Lee. 2007. Flood Runoff Analysis using Radar Rainfall and Vflo Model for Namgang Dam Watershed. Journal of the Korean Association of Geographic Information Studies. 10(3):13-21