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Four-Dimensional cadastre modeling with UML Diagram

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Abstract

In addition to the third dimension in the cadastre, the need for temporal information about the past is also increasing. Changes may occur in real estate, both legally and geometrically, over time. It is of great importance in terms of four-dimensional cadastre that these changes can be monitored instantly in the four-dimensional environment together with the vertical dimension. In this study, a four-dimensional cadastre design was made using the UML modeling language, which is a visual modeling language. In this design, along with the horizontal and vertical positions of the real estates, the fourth dimension, which shows the temporal changes, and the value element, which is thought to be the fifth dimension of the cadastre in the future, are partially included. In addition, in this study, using the UML modeling language, the zoning status of the immovables, the lines passing under and above the immovable, the type of changes that occurred in the immovables, the time and explanation of the change were included and their relations with each other were examined.

1. Introduction

Due to the two-dimensional cadastral systems in the world, the legal status of the three-dimensional rights and restrictions that are the subject of ownership above or below the land cannot be determined. The need for three-dimensional information, especially in cities that develop in a vertical direction, increases its importance day by day (Ayazlı & Batuk, 2007).

In our country, temporal Land Registry and Cadastre data are needed intensively. Land Registry and Cadastre data are constantly changing over time as a result of practices such as subdivision, development plan implementation, sales, donations, and mortgages. (Cömert & Alkan, 2004).

In addition to the vertical dimension, the need for temporal knowledge of the past is also increasing. Changes may occur in real estate, both legally and geometrically, over time. It is of great importance in terms of four-dimensional cadastre that these changes can be monitored instantly in the four-dimensional environment together with the vertical dimension.

One of the reasons for the need for four-dimensional cadastral information is that a historical record is required for a particular property. Time always plays an important role in cadastral systems. (Van Oosterom, Ploeger, Stoter, Thompson, & Lemmen, 2006).

Although there have been great changes in the Turkish cadastre in recent years, the problems for the transition to the three-dimensional cadastre have not been solved. The third dimension was neglected in the cadastral renewal studies in Turkey, only the elevation of the land was measured. Infrastructure facilities were not measured and not associated with the cadastre. Therefore, the renovation works were incomplete and insufficient. With the developments in technology and studies in spatial information systems, the need for a four-dimensional cadastre has become a necessity (Nacar, 2021).

Due to the fact that cadastre is a living phenomenon, the importance of the fourth dimension, the time factor, is increasing (Çay et al., 2007).

2. Method

In this study, the four-dimensional cadastral design was modeled with the UML modeling language.

UML, which is the abbreviation of "Unified Modeling Language", can be translated into Turkish as "Unified Modeling Language". Rather than being a programming

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language, UML is a collection of methods that define and describe how business systems can be modeled. A good modeling in the analysis and design phase prevents many problems that may arise in the software phase. UML is more suitable for object-oriented programming languages. A software prepared with UML is both less costly, more effective and longer lasting. The birth of UML can be considered as one of the biggest developments in the software industry in recent years. (Uymaz, 2007).

Class Area
Structure and Attribute Area
Behavior and Methods Area

Figure 1. Structure of UML

As shown in Figure 1, UML consists of three different areas: the class area, the structure and attribute area, and the behavior and methods area. Among these fields, the class field is the field where the names of the classes are written. The structure and attribute area are the area where the elements of the class and their descriptors are located. The behavior and methods area are the area where the methods of the class elements are located.

Here the relationships between classes are specified. These relationships can be one-to-one, one-to-many, etc. may form. Figure 2 shows the UML diagram of the second dimension of the cadastre. Here, the immovable's ID number, block and parcel number, point number, slice meridian, coordinate values, datum and projection variables and data types of these variables are shown.

2D
-Id: Int -Block: Int -Parcel: Int -Point number: Int -Y : Double -X: Double -Datum: String -Projection: String -Slice Meridian: Int
-List ( ) : void -Save ( ) : void -Delete ( ) : void -Update ( ) : void -Clean ( ) : void

Figure 2. UML representation of 2D

Figure 3 shows the UML diagram of the third dimension of the cadastre. Here, immovable's ID number, the block and parcel number, the average elevation of the parcel, the registration object type, the elevation of the registered object, the elevation difference and the explanation variables and the data types of these variables are shown. In addition, the relationship of 3D with the registered object type is also shown.

Figure 4 shows the UML diagram of the fourth dimension of the cadastre. Here, immovable's ID number, the block and parcel number, the change type, the change time and the description variables and the data types of these variables are shown. Also, the relationship of 4D with the type of change is shown.

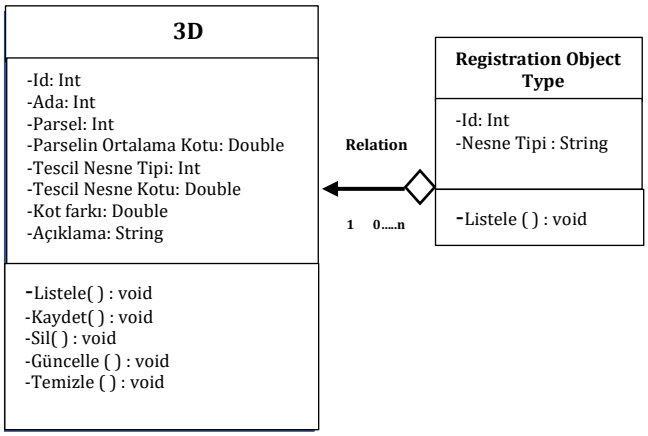

Figure 3. UML representation of 3D

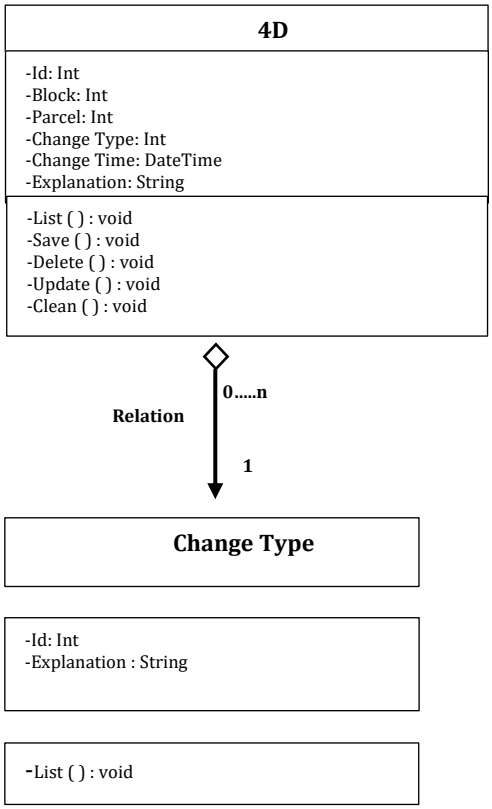

Figure 4. UML representation of 4D

Figure 5 shows the UML diagram of the zoning status of the immovable. Here, immovable's ID number, the block and parcel number, current zoning plan, plan function, approval date, scale, floor area ration (TAKS) and floor area coefficient (KAKS), building height, number of floors, construction layout, front, side and back garden distances variables and data types of these variables shown.

Figure 6 shows the UML diagram about the general information of the immovable. In the general information class, immovable's ID number, province, district, neighborhood/village, location, address, block, parcel number, title deed area, owner, father's name, qualification, numerator and denominator amount variables and the data types of these variables are shown.

In addition, the relations of the general information class with the province and district classes are shown.

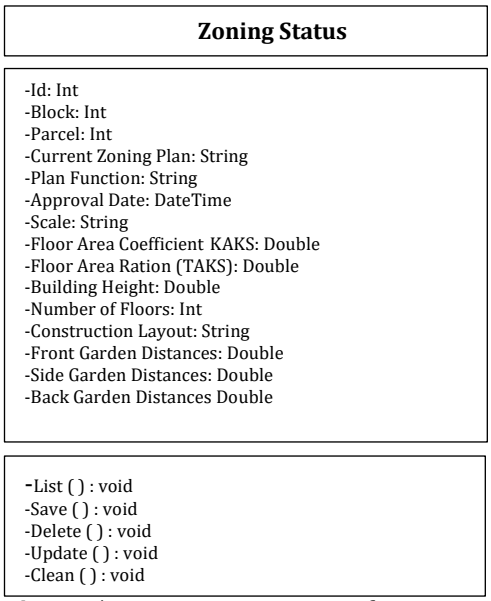

Figure 5. UML representation of zoning status

In Figure 7, the interface design of the desktop application that is desired to be made according to this UML diagram is shown. In this design, by entering the province, district, neighborhood/village, block and parcel information of the immovable whose information is desired to be accessed, the 2D, 3D, 4D and 5D buttons of that immovable appear on the screen. If two-dimensional information of the immovable is desired to be accessed, the 2D button should be pressed, if three-dimensional information is desired to be accessed, the 3D button, if four-dimensional information is desired to be accessed, the 4D button should be pressed, and if five-dimensional information is desired, the 5D button should be pressed. Here, the two-dimensional information of the immovable is meant by its horizontal coordinates, projection and datum information, ownership and share information. What is meant by the three-dimensional information of the immovable is the lines passing under and over the immovable and displaying the vertical coordinates of these lines as well as the horizontal coordinates of these lines. What is meant by the four-dimensional information of the immovable is the chronological display of the changes that have occurred in the immovable over time. What is meant by the five-dimensional information of the immovable is the value of the immovable.

In Figure 8, the third-dimensional interface design of the desktop application that is required to be written according to this UML diagram is shown. Here, after pressing the 3D button, the registration object types that pass under and over the immovable appear. The elevation differences of the selected registration object type according to the parcel can be accessed here. The main registration object types here are drinking water, rain water, sewage, natural gas, energy transmission lines, bridges, viaducts, drilling, buildings, etc.

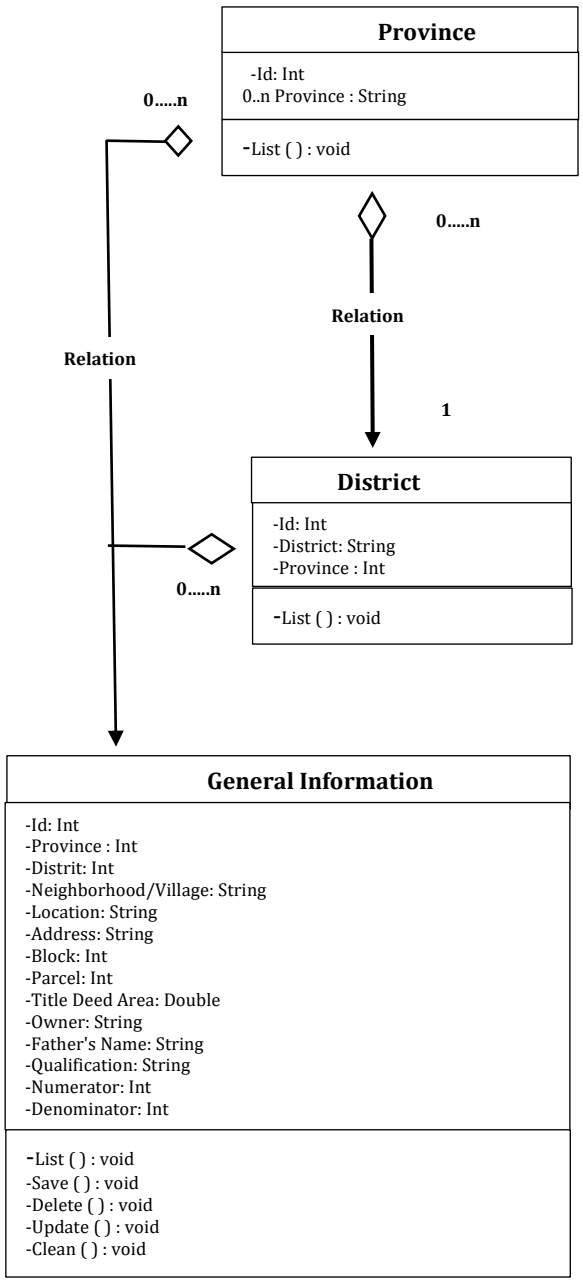

Figure 6. UML representation of general information

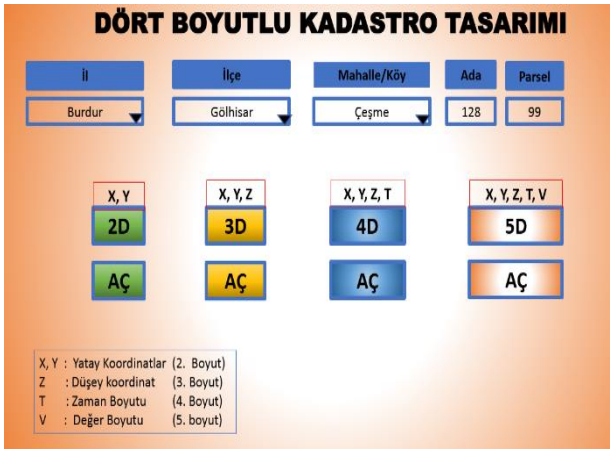

Figure 7. Interface design of the home page

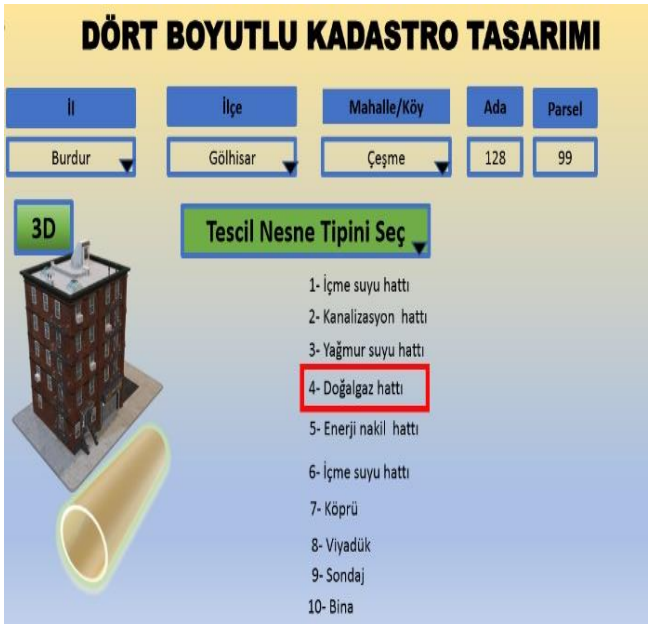

Figure 8. Interface of the third dimension

In Figure 9, the interface design of the fourth dimension of the desktop application that is desired to be made according to this UML diagram is shown. Here, after pressing the 4D button, the geometric and legal changes that occurred in the immovable over time are listed chronologically. Here, changes in the geometric sense are changes such as subdivision, amalgamation, renuniation for road, development plan implementation, expropriation. Changes in the legal sense, on the other hand, are changes such as liens and mortgages that do not change the geometric shape of the parcel.

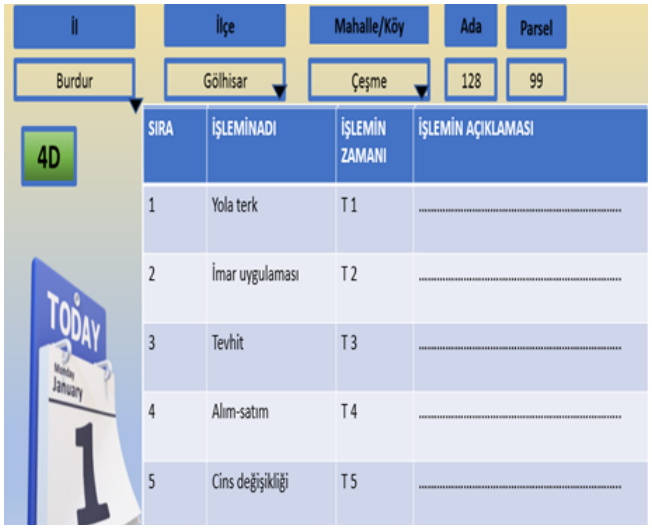

Figure 9. The interface of the fourth dimension

3. Results

As a result, it has been seen that the UML diagram is suitable in four-dimensional cadastral design, the UML diagram can be used easily with any programming language, and the UML diagram can be easily understood by every user regardless of the program language. Since many public institutions and organizations in Türkiye need historical temporal data of immovables, such a design is needed.

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