

# **3D MODELING OF THE ÇUKURSARAY (THE HOLLOW PALACE), ISTANBUL - TURKEY AND ITS APPLICATION FOR CAMPUS INFORMATION SYSTEM**

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## **Abstract**

*In the recent years, 3D modeling is becoming more popular and is being used more widely from computer games to medicine. The demand for 3D spatial data and 3D modeling is changing traditional Geomatics Engineering applications from 2D to 3D representations. The increasing usage of spatial data in Geomatics Engineering has resulted in intense use of digital maps and 3D models along with it. Visualization objects and using 3D models in engineering applications increase the spatial reality and make the processing of spatial data more efficient. Because, a 3D model represents objects more realistic than a graphic based object. The introduction of 3D models has fostered new expectations in different fields such as online mapping services, navigation systems. Furthermore, 3D modeling is becoming an important tool for monitoring and preserving cultural heritage. In this study, it is aimed to develop a three dimensional (3D) virtual model of the Çukursaray (the Hollow Palace), Istanbul-Turkey and to integrate this model into the campus information system. The Çukursaray which was built by the Ottoman Empire is a historical building in the central campus of Yildiz Technical University (YTU). This study is also a part of Yildiz Technical University Campus Information System. Campus Information Systems are used by many universities for different aims. In general, the system includes information about academic and administrative units and staff, topographical and natural features and land use on the campus. Databases, maps, spatial and attribute datas, analyses and queries are used to build a campus information system. Nowadays, a web-based campus information system became an effective tool for end-users to access spatial and non-spatial data about campuses interactively and rapidly. It enables users to access current and visual information about the campus over the web. In this study, Autodesk® 3ds Max® software was used to create 3D model and ESRI ArcGIS was used as geographical information systems software.*

## **1. INTRODUCTION**

In the recent years, 3D modeling is becoming more popular and is being used more widely from computer games to medicine. The demand for 3D spatial data and 3D modeling is changing traditional Geomatics Engineering applications from 2D to 3D representations. Because, three dimensional (3D) graphics and visualization techniques represent objects more realistic than graphic based objects. The increasing usage of 3D modeling and visualization has resulted in intensive use of 3D models in different applications such as industrial design, architecture, manufacturing, Geographical Information Systems (GIS) and etc. Furthermore, 3D modeling is becoming an important tool for monitoring and preserving cultural heritage.

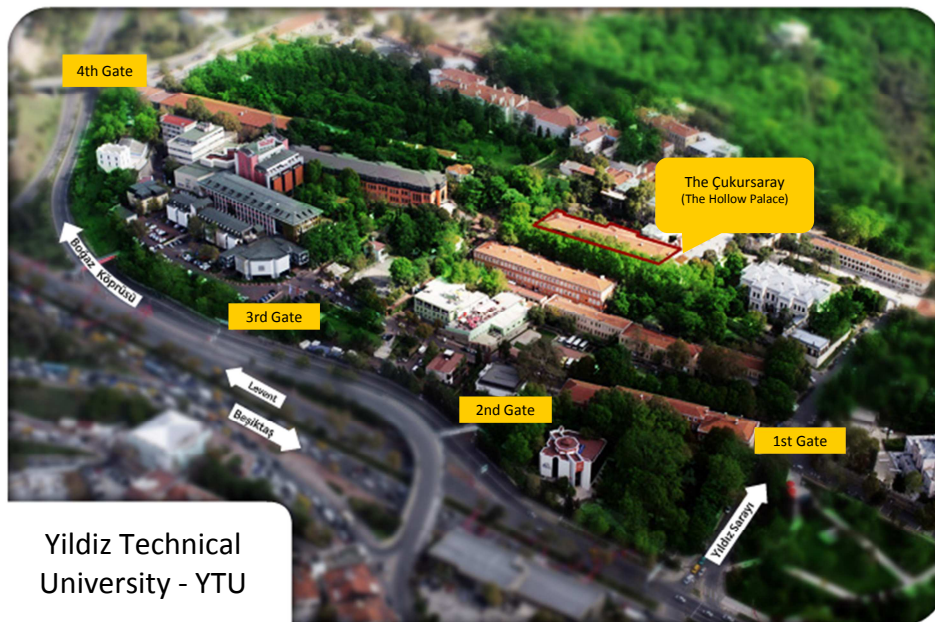
3D modeling is the process of developing a mathematical and geometrical representation of any three-dimensional object (Sengupta, 2011). The role of the 3D modeling and visualization in the field of cultural heritage is recognized as an important conservation, protection, analysis, development and management tool. The Çukursaray is an architectural heritage building with its historical value. Its history is dating back to

1877. It is located in the Yildiz Campus which is the central campus of Yildiz Technical University (YTU), Beşiktaş, Istanbul, Turkey (Figure 1). It is also one of the historical and important buildings of the Yildiz Palace which is the fourth permanent residence of Ottoman Sultans. Known today as the Çukursaray (the Hollow Palace) is the biggest building of Yildiz Palace after the Şale Pavilion. It was built as a residence for single or widowed sultans in the era of Abdülhamit II (1876-1909). A limited intervention was made in 1937 to transform it into a boarding house; however it mostly retains its architectural characteristics and today it is used as the Institutes Building by YTU (Özkan, Karadağ, & Kurmel, 2008). Therefore, this study is important to preserve this cultural heritage and to transmit it to future generations.

Firstly, necessity of the 3D modeling in cultural heritage and aims of this study are presented. Then, methodology and the application of this study are presented. Finally, problems encountered and results are presented.



**Figure 1:** Overview of the Yildiz Campus



**Figure 2:** An Overview of the Yildiz Campus and the Çukursaray

## **2. NECESSITY OF THE 3D MODELING IN CULTURAL HERITAGE AND AIMS OF THIS STUDY**

Preservation of cultural heritage of a community is essential to its identity and its transmission to future generations (Vernieri & Soibelzon, 2009). Some prevention methods have been introduced for the preservation of cultural heritages such as buildings, monuments, structures, sites. These are based on basic principles and methodologies which are developed by experts from different areas.

Documentation of the cultural heritage is one of the main steps of cultural heritage conservation and restoration. 3D models give clear and detailed information of existing situation of the objects. They can be used for comparing the existing situation with the future situation after restoration or previous situation after a disaster.

The main aim of this study is the need of the 3D models to produce more realistic and detailed environment for preservation of cultural heritage. Furthermore, this study is a part of the Yildiz Technical University Campus Information System project. This brings up the need of 3D models in a realistic campus information system. Using 3D models and visualization objects in GIS applications provides users an interactive visual exploration of 3D digital environment of a campus. In addition, using them increases the spatial reality and makes the processing of spatial data more efficient. GIS is a combination of hardware, software, data and people. GIS became more important since it is used as a visual and analytical tool. The introduction of 3D models in GIS has fostered new expectations in different fields such as online mapping services and navigation systems. Because it helps the users to understand spatial information and supports decision making process.

With the use of the Internet as an effective tool, GIS has gained new features and web-based GIS applications have been developed. A web-based GIS has a wide variety of applications. It allows users to access and analyze spatial data over the web. It means that the end-user does not need an expensive and complex GIS program. An easy and cheap web browser is used to access the system. It also has a dynamic structure so it is more efficient than a static map. Today, a web-based campus information system is used to access spatial and non-spatial data about campuses interactively and rapidly. A campus information system includes information about academic and administrative staff, topographical and natural features and land use on the campus. This system also enables users to query, analyze, share or transform the data.

### **2.1 Methodology**

In this study, 3D modeling of the Çukursaray and its application for campus information system consist of following steps:

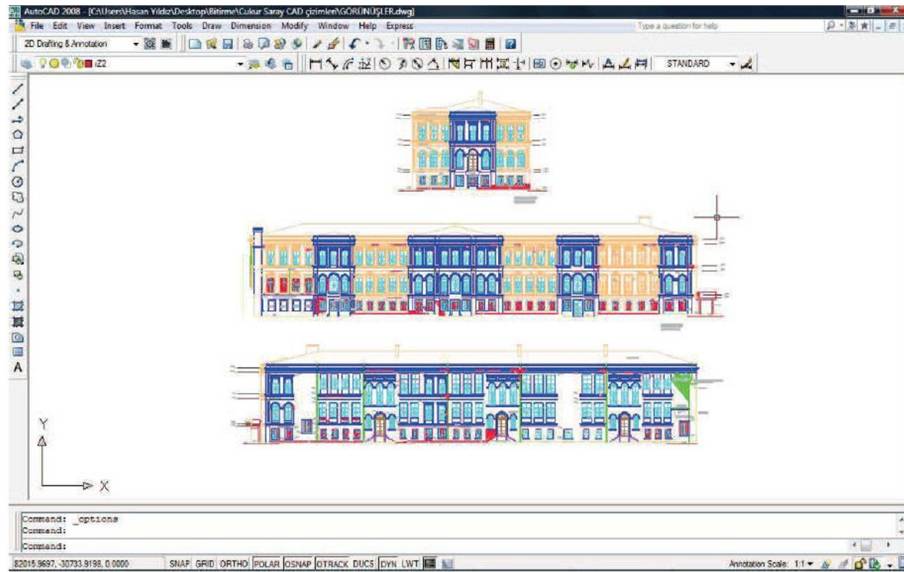
- Data acquisition
- Generation of a 3D model
- Visualization of the 3D model
- Importation of the 3D model into GIS.

Detailed information about these works is presented in the following section.

## **3. APPLICATION**

In this study, a 3D model of the Çukursaray is created. The first step of the study was getting the CAD drawings of the building from YTU Directorate of Construction & Technical Works.

Actual drawing of the Çukursaray was created by using “boundary” command via AutoCAD (Figure 3). The objects which have line features were transformed into polyline or polygon features. The 2D base model was created very detailed and accurately. Each side of the building (east, west and north sides) was created separately (Figure 5, 6, 7).

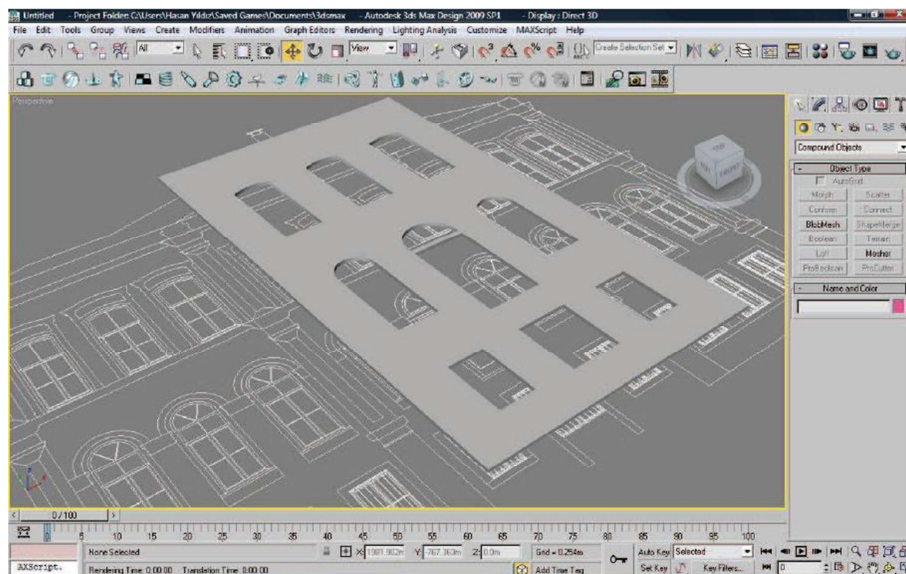


**Figure 3: CAD Drawings**

We tried to reflect the Çukursaray's architectural characteristics while drawing the 2D base model. Because it is a historical building and it has several decorations objects on it. Also, each side of the building is different from the others.

The second step was importing the 2D base model into Autodesk 3ds Max which is a modeling, animation and rendering software. 3ds Max's "import" function provides users to import several different file types into the 3ds Max.

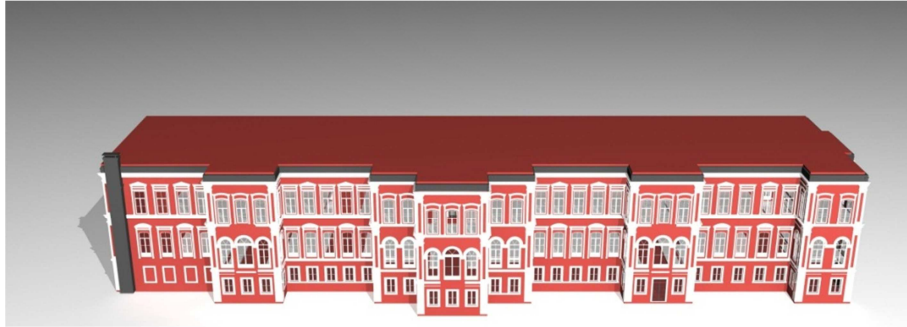
Each side of the building was imported into 3ds Max workspace separately (Figure 4). The design of the 3rd dimension was the next step in the design of the 3D model. "Extrude" command was used for setting the height of the objects. Also, "ProBoolean" command was used to create windows and doors. After the design of all sides, they were combined.



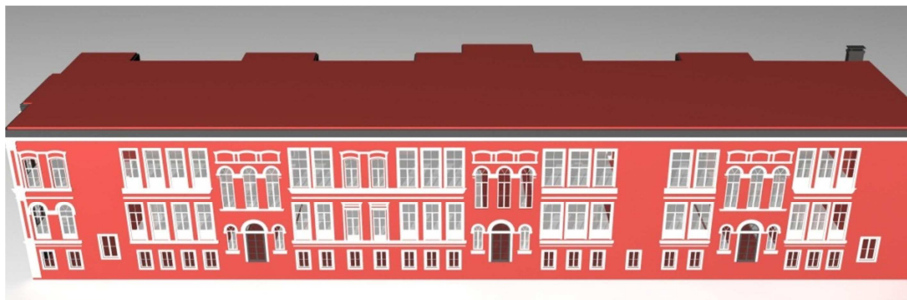
**Figure 4: Screenshot of Autodesk 3ds Max**



Setting the materials and the rendering were the next step in 3ds Max. Material editor was used to select the most suitable material and the color for the objects to create the most realistic representation.



**Figure 5 :** 3D Model of the Cukursaray (East Side)



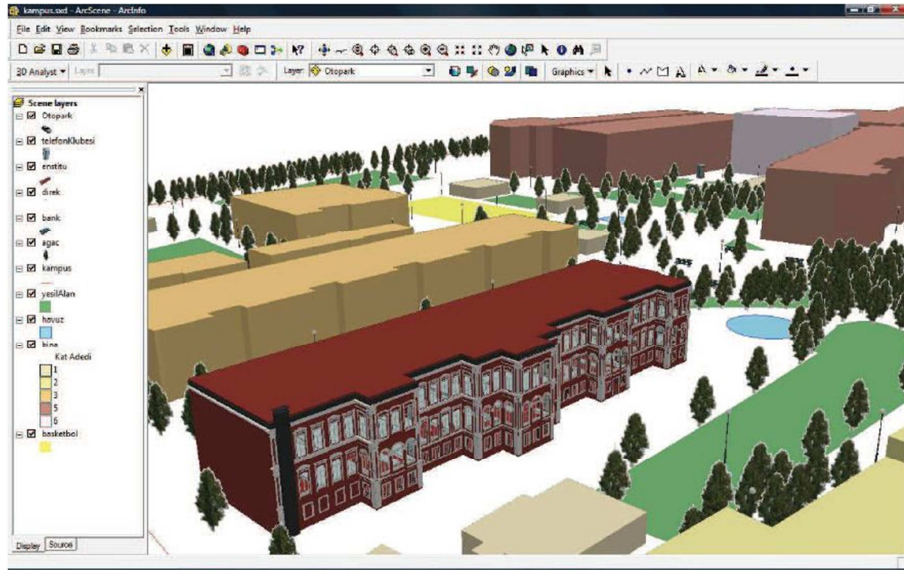
**Figure 6 :** 3D Model of the Cukursaray (West Side)



**Figure 7 :** 3D Model of the Cukursaray (North Side)

The next step was importing 3D model into ArcScene after completing the 3D design of the Çukursaray. By using ArcCatalog, a personal geodatabase and a feature dataset were created. A land use map of the Yildiz Campus was obtained in DWG format and it was imported into feature dataset to create layers by “*import*” command. Different layers were created for different objects in the campus and attributes of the objects were added.

The layers such as buildings, institute, tree and etc. were added to a new ArcScene file. For using 3D model in ArcGIS a “*3ds file*” was created in via 3ds Max. Then, the 3D model of the Çukursaray was imported into ArcScene or ArcGlobe as a “*3D Mark Symbol*” for a point which represents the location of the Çukursaray. Another option to import a 3ds file into ArcGIS is using ArcToolbox module and “*Import 3D Files*” command. We used the first option because it provides to change rotation, size or angle parameters. Also the 3rd dimension of the other buildings in the campus was created by using their number of floor and 3D symbols such as trees, cars were used to increase reality (Figure 8).

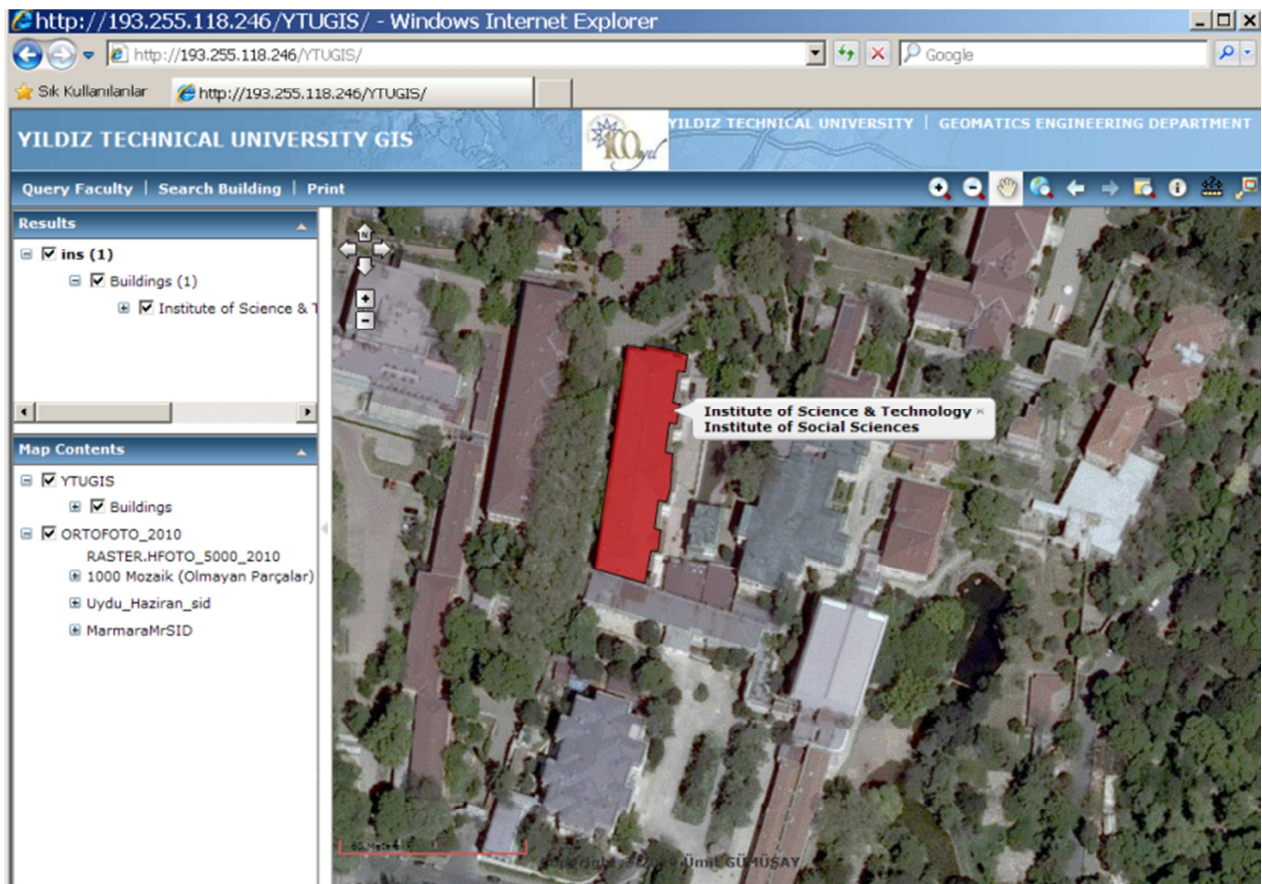


**Figure 8 :** Screenshot of the ArcScene

Finally, campus information system was served through the ArcGIS Server. Any user in any part of the world can access the YTU Campus Information System directly using the link below:

<http://193.255.118.246/YTUGIS/>

When the web address above is followed, Yildiz Technical University's vector map and raster orthophoto map appear on the screen as shown in Figure 9. It is possible to search buildings and faculties.



**Figure 9 :** Overview of the Yildiz Campus Information System

#### 4. PROBLEMS ENCOUNTERED AND RESULTS

Cultural heritage is affected by natural effects. Also, it is threatened by recovery and reconstruction works. As a result, restoration works may be required. Measured drawings which show the original state of the structure are used for restoration works for many years. Today, information technologies are used instead of traditional methods to get more precise data and to save time. Therefore, 3D modeling and visualization are important tools in the field of cultural heritage. They can be used in the area of documentation of cultural heritage and planning of cultural heritage restorations. They also provide comparing the existing situation with the future situation after restoration works. It was achieved to develop a three dimensional (3D) virtual model of the Çukursaray (the Hollow Palace) and interactive visualization of the model via computer. One of the aims of this study is to integrate the 3D model into our Campus Information System. We have published our information system via ArcGIS Server and tried to integrate the model into it. But, ArcGIS Server does not support *3D Web Applications*. So, we have just achieved to publish the 2D base model of the Çukursaray via YTU Campus Information System. It can be accessed by using a web browser.

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