

Digital Elevation Model Based on Aerial Image for 3D Building

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Abstract: *In city planning managing, the third dimension is becoming a necessity. Using 3D GIS modeling offers a flexible interactive system while providing one of the best visual interpretations of data which supports planning and decision processes for city planners. As a result, 3D GIS model expresses terrain features in an intuitive way which enhances the management and analysis of a proposed project through 3D visualization. This paper discusses the concept of 3D GIS modeling techniques using a simple procedure to generate a high resolution ortho imagery model (real 3D GIS model) which will show the effectiveness of this approach. The 3D GIS model provides access to mapping data to support planning, design and data management. Intelligent GIS models and GIS tools help community planning and apply regional and discipline-specific standards. Integration of GIS spatial data with aerial image helps to improve quality, productivity and asset management. The following study built 3D GIS map and all utility information for high resolution ortho image as an example. The primary objective is to improve data management (e.g., maps, plans, usage of facilities and services) and to develop methods using 3D spatial analysis for specific applications at the university. In this work, we discuss the construction of a digital elevation model based on aerial image stereo pairs using matching method and the use of this DEM for 3D city planning. We used aerial photographs with high accuracy (1/4000) covering the study area acquired in 2015 and additional cartographic data from usgs. 3D land use zoning allowed building volumes, usage, and density. They are the main tools defining the image of a city and bring into focus the model of best practice of the rehabilitation and conservation of the historic Medina.*

Keywords: 3D GIS model; ArcScene; Database; High Resolution orthoimage

1. Introduction

In the past, multiple software tools were required for viewing parcels, streets, addresses, sewers, Streetlights and other elements of a work site. Nowadays, the GIS (geographic information system) is the most active technology in Geographic Science and Earth Science. With the development of computer and network software and hardware, GIS allows users to visualize, analyze and manage spatial data that is geographically referenced. One of the powerful features of GIS is the ability to overlay spatial datasets such as infrastructure locations, street widths, building footprints and tree locations allowing users to visualize and understand the relationships between data. The ability of GIS to display and analyze spatial data makes it an effective tool for physical planning (e.g., land use, infrastructure and transportation planning). In many interactive computer graphics applications, maps in 3D (three dimensions) are central to enabling the exploration, presentation and manipulation of geographical data. 3D maps are used by GIS specialists as tools for presentation of spatial data to non-experts. Recently, the geo informatics systems, 3D computer graphics and 3D GIS have been emerged with reality. Most of the 3D GIS applications tend to focus on visualization such as walk-through animations or scenic simulations. The 3D data model is regarded as a tool to express the 3D objects in reality. Three dimensional models consisting of the geometry and texture of urban surfaces could aid applications such as urban planning and heritage conservation. A standard technique used to create large-scale city models automatically or semi-automatically is to apply stereo vision on aerial or satellite imagery. 3D city models are digital representations of the Earth's surface and related objects belonging to urban areas (like cities, factories, buildings etc.). Several disciplines like urban

planning, architecture, telecommunication, tourism, environmental protection.

The 3D city model generate from this aerial image can be used in many applications. To visualize the city for various purposes (tourism, virtual tours, etc.),

- In urban planning,
- In navigation systems,
- In intelligent transportation systems,
- In urban risk modeling;
- In architectural visualization;
- In telecoms – positioning of mobile phone transmitters;
- In flood risk mapping.

2. Literature Review

3D map is one of the main topics in the GIS (geographic information system). There are many research efforts in the area of developing 3D maps. Brooks and Whalley [3] presented a unique GIS that, seamlessly integrates 2D and 3D views from the same spatial data. Multiple layers of information are continuously transformed between the 2D and 3D modes under the control of the user, directly over a base-terrain. Although 2D/3D hybrid or combination displays, is now widely used in medical applications such as tomography, they have not been explored to any great extent in GIS applications. Many existing commercial 3D GIS systems have 2D views they are typically isolated from the 3D view that they are presented in a separate window. Brooks and Whalley [3] introduced a 2D/3D hybrid GIS that allows the user to view the 2D data in direct relation to the 3D view within the same perspective. The conclusion of this research has developed a unique 2D/3D hybrid GIS with multiple navigational tools. Swanson [5] studied and

addressed the 3D visualization and analysis of geographic data, as she stated The introduction of 3D graphics into architecture, engineering and molecular biology has fostered new expectations in those fields. There certainly appears a need for visualization in nearly every subfield of geography as well. For example, it could prove a very persuasive tool in the hands of city planners, urban designers and traffic engineers. Possibly even, they could use it to bring abstract project variables like visual impact analysis into the cost-benefit equation. The potential is definitely there to do a lot more interesting perspective views of remotely sensed data.

Shehata and Koshak [6] constructed a 3D model to understand and analyze the locations, types and sizes of the possible natural risks in Mina (near Makkah, Saudi Arabia). This is a city of tents that accommodates around two million pilgrims during the season of Hajj (Islamic pilgrimage). The 3D GIS can be used to analyze slopes and investigate water drafting paths and the locations of possible falling rocks. The paper provides illustrations of possible areas of risk, using 2D and 3D visualizations and offers recommendations to avoid future environmental hazards. The paper also shows areas that are prime locations for future development and assesses their safety hazard. They have built a 3D GIS model of Mina [6].

Ohigash et al. [7] proposed a mechanism to migrate a 2D legacy system with its GUI (graphical user interface) into a 3D environment. This mechanism is based on a special coordinate transformation for both the texture mapping and the event dispatching. It enables them to use a 3D terrain model with a shadow copy of a 2D legacy GIS. As for legacy geographic simulators and legacy databases without any GUI they provide them with their proxy objects. These proxy objects can interoperate with each other, and also with the shadow copy of a 2D legacy GIS through their slot connections. As a result, their approach enables them to dynamically integrate multiple independent legacy simulators and/or legacy databases with a 2D legacy GIS simply through the composition of their 3D display objects. In conclusion, they developed a framework for the ad hoc integration of legacy geographic simulators, legacy databases, the integrated visualization of their results and a 2D legacy GIS system [7]. and sharing AutoCAD Map 3D and Autodesk Map Guide technology drive efficiency and effectiveness by making it easier to work on the data within desktop applications and over the Web. Powered by FDO(feature data objects), these foundation technologies allow users to access data directly and seamlessly in a variety of formats and data storage systems, the AutoCAD Map 3D and Autodesk Map Guide technology illustrate how the AutoCAD Map 3D and Autodesk Map Kalil and Braswell [8], used AutoCAD Map 3D and Autodesk Map Guide Enterprise as their foundation technology, Autodesk offers a complete solution that helps organizations to realize efficiencies and optimize the value of geospatial data. AutoCAD Map 3D provides the desktop backbone that supports the data creation, editing and management. The Autodesk Map Guide Enterprise delivers powerful, easy to use online maps and related information for a development

environment which then leverages the advantages of open source technology, including low cost of ownership and easier integration with diverse databases. In conclusion, AutoCAD Map 3D and Autodesk Map Guide Enterprise provide organizations with a robust foundation for all activities that depend on geospatial data. From data creation and editing to management Guide Enterprise drive the seamless creation, editing, management and sharing of data [8].

Additionally, the open geospatial viewers (e.g. Google Earth, Virtual Earth, etc.) increase the demand on 3D city models (Remondino et al., 2006). 3D building and its update require the development of automatic methods for acquisition of Digital Surface Models (DSM) (Toutin and Gray, 2000). Digital photogrammetry, both airborne and spatial, is an efficient modern technique for DSM acquisition as a base for 3D building. A digital surface model represents the elevation associated with the surface of the earth including topography and all natural or human-made features located on the surface of the earth. There is a variety of DSM source data available for developed areas and the suitability of these available data depends on the project specifications. In remote regions around the World, where little or no source data are available, the DSM can be produced automatically from stereo satellite scenes, from satellite sensors such as IKONOS, SPOT-5 and Terra-ASTER (Baltasavias and Stallmann, 1993; Gruen et al., 2007; Jacobsen, 2004).

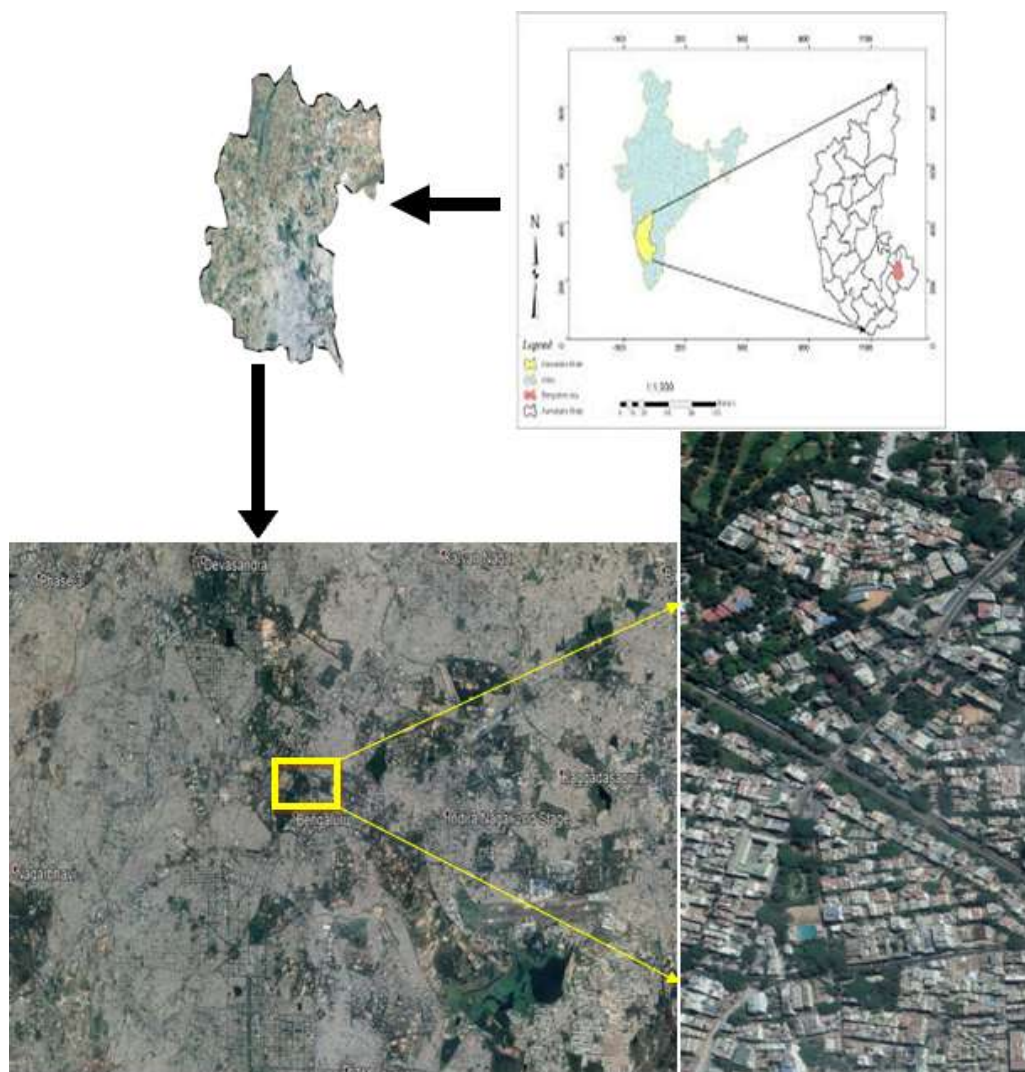
3. Material and Method

Study Region and Used Test Data

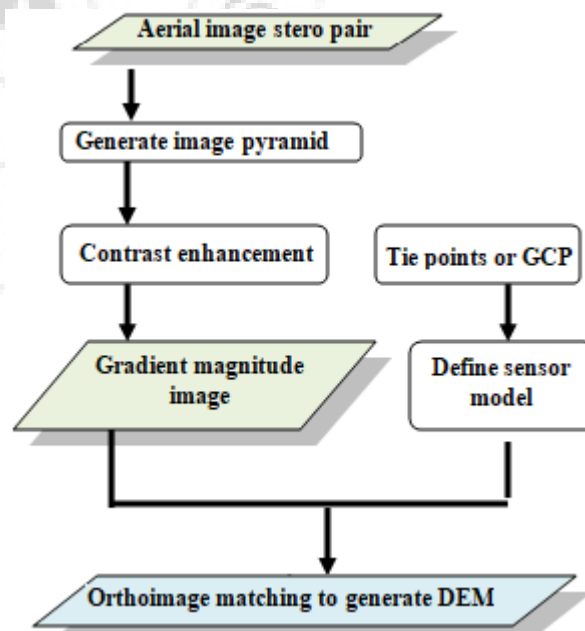
Bangalore, capital city of Karnataka is the sixth largest metropolis in the country and a nerve center for the various cultural, social and religious activities, contributing to the growth of the city. Bangalore district is situated in the heart of the South-Deccan plateau in peninsular India to the South-Eastern corner of Karnataka State between the latitudinal parallels of 12°39' N & 13°18' N and longitudinal meridians of 77°22' E & 77°52' E at an altitude of about 3000ft. above sea level covering an area of 2,190 sq. kms. The temperature varies from a minimum of 14°C to a maximum of 33°C and Rainfall (Actual) of about 1060 mm. The pleasant weather has the warmest months from March to May, coldest months from December to January, rainy - southwest monsoon from June to September and rainy - northeast monsoon from November to December.

Bangalore has a total of 198 wards spread across the 4 taluks namely, Bangalore North, Bangalore South, Bangalore East and Anekal. It is also categorised into zones namely, Byatarayanapura Zone, Dasarahalli Zone, Rajarajeshwarinagar Zone, South Core Zone, West Core Zone, East Core Zone, Bommanahalli Zone and Mahadevapura Zone

The present study area is located in Bangalore South Taluk and belongs to Bommanahalli Zone



Geo-referencing operation concerns the sensor orientation that include the determination of the exterior orientation along the flight trajectory of each flight strip and the resampling of the scanner data into the object coordinate system. With the help of some control points the GPS/IMU-model can be shifted and rotated for correcting the datum definition. This model is defined for each flight strip and with control and ties points and transformed into the object coordinate system.



Geo-Referencing Images

Before the image analysis can be performed, the camera data have to be geometrically rectified (Geo-referenced) with respect to a map projection system. Geo-referencing operation concerns the sensor orientation that include the determination of the exterior orientation along the flight

trajectory of each flight strip and the resampling of the scanner data into the object coordinate system (Ecker et al., 1993). With the help of some control points the GPS/IMU-model can be shifted and rotated for correcting the datum definition. This model is defined for each flight strip and with control and ties points and transformed into the object coordinate system.

Ground Point Coordinate Determination

This method generally contains three basic steps:

Set up sensor mathematical model to reflect the relationship between points on the ground and pixels on the image, do image matching to get a disparity map, and finally calculate each point's altitude. In this study, we can use the procedure of DEM generation developed. This process can be broken down into the following steps:

The point measurement tool is designed to collect Ground Control Points (GCPs) and tie points that are common to two images so that the images can be correlated. In the case of IKONOS imagery, the RPC file that comes with the images contains valuable information that lessens the need to collect large numbers of control points. In this step we can see how choosing GCPs and generating automatic tie points can considerably improve the results of the orthorectification.

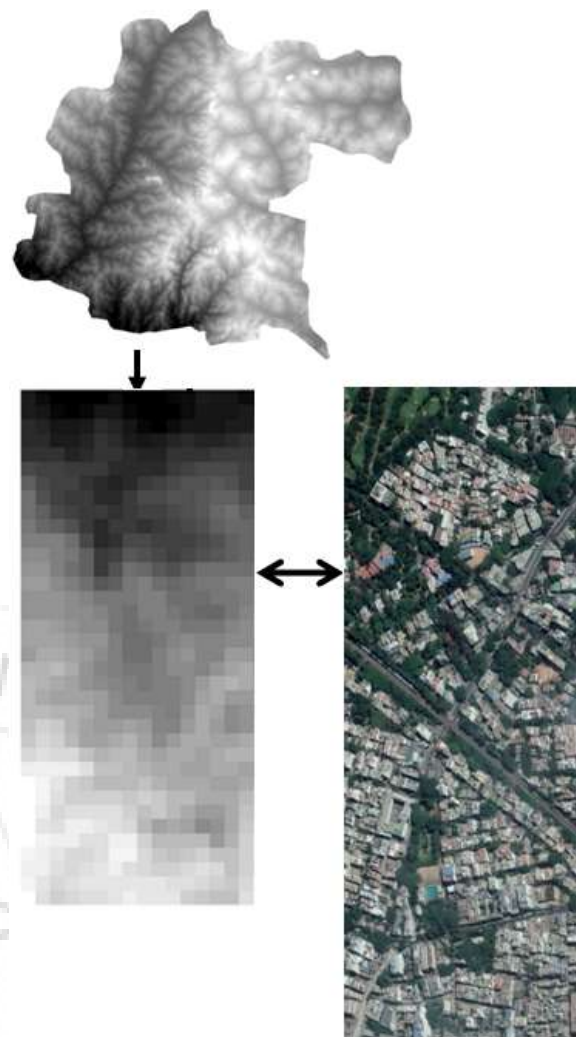
Digital Image Matching for DEM

Ground points appearing within the overlap portion of the left and right images associated with a DEM are identified. This is referred to as digital image matching. The resulting output consists of the image location of ground points appearing within a DEM. (DEM images are downloaded from USGS or GLOVIS)

DEM Construction with Aerial Image

The automatically extracted and calculated mass points are used as a basis for constructing a DEM. DEMs are constructed differently depending on the specified DEM output type.

Digital Elevation Models (DEMs) are a type of raster GIS layer. Raster GIS represents the world as a regular arrangement of locations. In a DEM, each cell has a value corresponding to its elevation. The fact that locations are arranged regularly permits the raster GIS to infer many interesting associations among locations: Which cells are upstream from other cells? Which locations are visible from a given point? Where are the steep slopes? One of the most powerful applications of DEMs is adding synthetic hillshading to maps so that the map reader may see the relationship between terrain and other things you may be mapping



Explore your Elevation Raster

The U.S. Geological Survey National Elevation Dataset is an example of a continuous surface raster. The term Raster denotes a means of describing a condition as a matrix of congruent rectangular cells. In the world of imagery, these cells are called pixels. In a continuous value raster the cell values are decimal values. It's possible also to have integer rasters and true-color imagery that represents reflected light in channels, like Red, Green and Blue and sometimes Infrared. I've just scratched the surface of raster data formats here.

Explore Your Raster using ArcMap10.5

- Use the Add Data button to add your national elevation dataset raster, image from the source folder.
- Use the Identify Tool to click on a cell. Note the Pixel Value and the Stretch Value.
- The Pixel Value represents the elevation of the cell that you clicked, in Meters above Mean Sea Level. The cell values in most cases were determined by interpolating points collected with stereo photogrammetry.
- The Stretch value is a number between 0 and 255. The stretch can be manipulated with the symbolization properties of the layer. Try different symbolization methods.
- zoom to a scale and a location where you can clearly see the shape of a cell. Note that in a projected data frame, the cells are not square. You could use the measure tool to see their dimension. It is about 9 by 7 meters. With a

resolution like this you would not expect this representation of elevation to represent features in the landscape that are less than 30 meters in extent (a three-by-three cell neighborhood.) Why not?

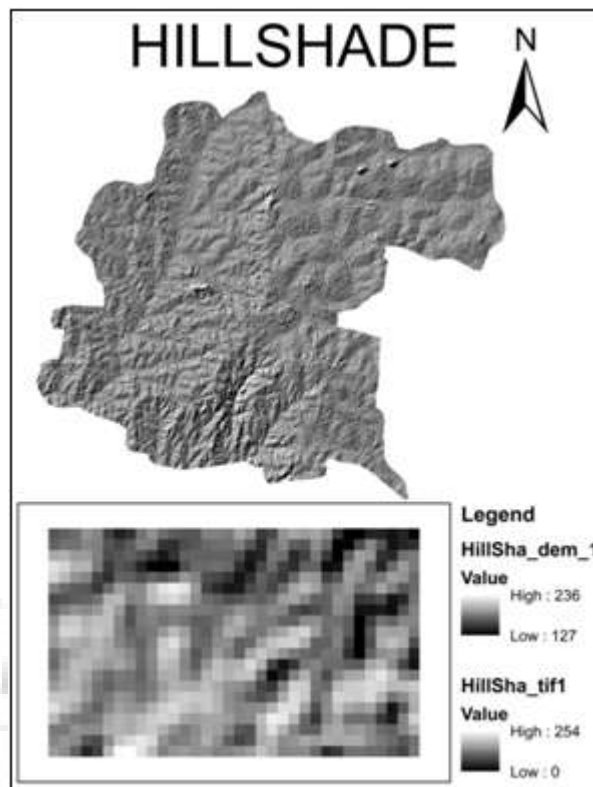
- Take a look at the Source properties of the raster. Take a look at the spatial referencing system of the raster. It is GCS, NAD83. This means that the inherent units used to encode the location and the shape of cells is simply Decimal Degrees. This explains why the description of the Cell Size in the source properties is such a very small number -- because 9 meters is a very small portion of a decimal degree (approximately 100 kilometers at the equator.) This mismatch in scale between the X,Y units and the Z units (meters) will be a problem we have to deal with later.

Creating Shaded Relief

We will begin by transforming our elevation raster to a shaded relief map and an aspect layer using wizards from the ArcGIS Geoprocessing Toolbox. You will see how to use the individual wizards in the toolbox. At the end of this document, you will see how geoprocessing tools can be chained together to create custom tools that will let us create custom wizards to automate useful tasks

Transforming Elevation to Hillshade and Aspect: These two tasks will allow us to introduce the toolbox and a few simple wizards. The input raster for each of these procedures should be projected as described above.

Hillshade with GCS: The hillshade tool shades slopes based on their steepness and direction. This requires that the X, Y and Z (elevation) coordinates are all in scale. If you create a hillshade on a raster whose XY coordinates are GCS (latitude and longitude) your Z values will be drastically out of scale with X and Y and will create an effect of an extremely steep, ragged jagged landscape. Your hillshade will look like this screenshot. If your hillshade looks like that, then you need to make sure you have set your geoprocessing environment.



Create Hillshade and Aspect Rasters with ArcMap10.5

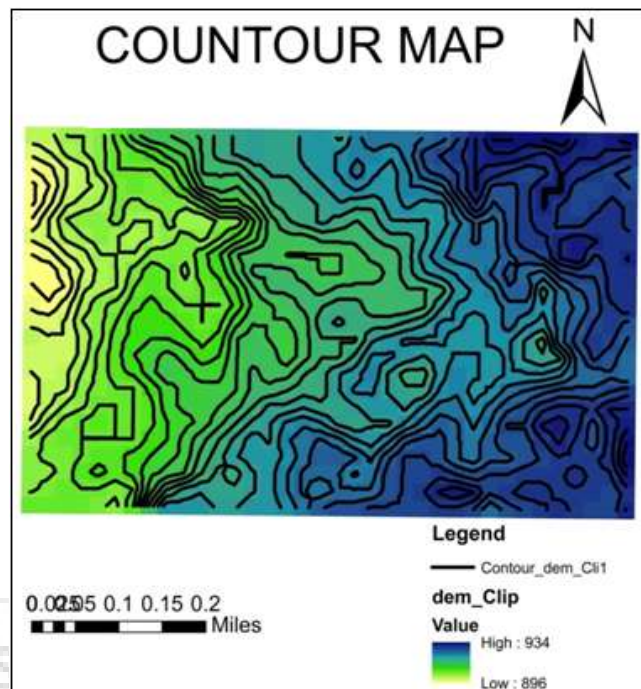
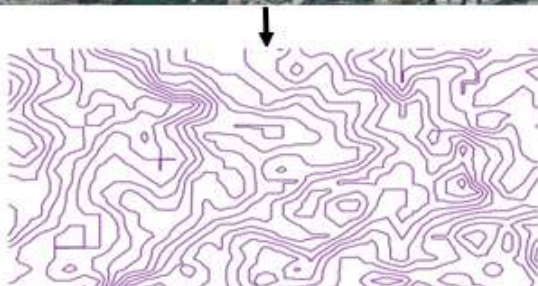
- 1) Make sure you have the Spatial Analyst and 3d Analyst extensions enabled in **Tools->Extensions**
- 2) Open the Toolbox Panel in ArcMap by clicking the little red toolbox icon raster.
- 3) You can find the Hillshade and other surface tools in the **Spatial Analyst** toolbox within the **Surface** toolset.
- 4) Open the **Hillshade** tool.
- 5) Click the **Show Help** button at the bottom of this geoprocessing dialog.
- 6) Click in any of the input boxes and note the context sensitive help.
- 7) Click the More Help link at the bottom of the Help panel to see more information about the parameters of this tool. You can also click More information about how Hillshade works" on this page to see a more conceptual discussion.
- 8) In the **Output Raster** blank use the browse button to find a location in your project folder and give your output raster a name with a **.img** suffix.
- 9) Proceed to create a hillshade raster.
- 10) Take a look at the Display properties of the raster. See that its stretch type is set to Minimum Maximum. You can play with different stretch methods to see what they do. The object is to be able to integrate the hillshading into your map's background so that you can see it.

Making Contours

The next set of steps covers the creation of contours. The "Create Contours" tool in the surface toolbox makes it straightforward to choose a contour interval and to scale the vertical units using a Z-Factor. These contours can also be exported to CAD. The references and processing steps listed below cover the basic tools for creating contours. For a more nuanced approach, take a look at the **DEM to DXF Contours** tool described in the next section.

Create and Label Contours

- 1) Find the **Contour** tool in the tool panel under **Spatial Analyst Tools > Surface** tool set.
- 2) Open the help panel on the wizard, and mouse over the different fields.
- 3) Click the **Help** button at the lower right to look at the entire help document.
- 4) It may take some experimentation to choose a contour interval that reveals the lay of the land without creating inscrutable bunches of contours.
- 5) If you want to change the Z units to feet, use a Z-Factor of 3.28.
- 6) Once you have created a new contour feature class, open the Attribute Table of your new contour layer. Note that each contour is a polyline and has an attribute named **Contour** that holds the elevation for each.
- 7) You can label the contours with the label properties of the layer. Make sure that you choose the correct attribute to label your contours.
- 8) It is conventional to associate contours with the line that they are labeling by making the labels a similar color as the line and aligning the label with the line. Alignment of labels is accomplished with the **Placement Properties** options in the Label Properties dialog for your layer.
- 9) To keep the contour label from conflicting with the line, you can alter the label properties to create a halo under each label. To find the halo mask properties, go to the **Label Properties** for your contour layer, choose **Symbol**, then **Edit Symbol** then set your options under the **Mask** tab. It is best to choose a color that is similar to the hue and value of the general background of your map.
- 10) Finally, if you want to show a lot of contours, say every Meter, You can help your users by creating a layer of **index contours**, say every five meters. Your index contours can be darker and labeled while the one meter contours are not.



Reproject and Reformat your Elevation Model

The terrain rasters from USGS are encoded using a plain Geographic Coordinate System GCS, which means that the X and Y units are decimal degrees of Latitude and Longitude. The Z units are Meters above Sea Level. That means that a unit of X is over 100,000 times the earth distance as a unit of Y. GCS also means that unless you are on the equator the cells are substantially different from square. These coordinate system issues can make a difference when modeling certain relationships like Slope and Hillshading. When you need to get the X,Y, and Z units of your terrain model into sync, then you need to reproject it.

About Resampling: When a raster dataset is projected from a plain geographic coordinate system to a projected one, the size and shape of the cells is transformed. You can think of Resampling as creating a new grid of cells and assigning values to the new cells based on the values of the old cells. The default method (Nearest Neighbor Resampling) simply assigns a value to the new cell based on the value of the cell in the old raster that is nearest to the center of the new one. This is the right thing to do with rasters whose values represent categories. For rasters that represent a continuous surface the Nearest Neighbor method can create stair-stepped variations. For continuous value rasters, like elevation models, the Cubic resampling method is best.

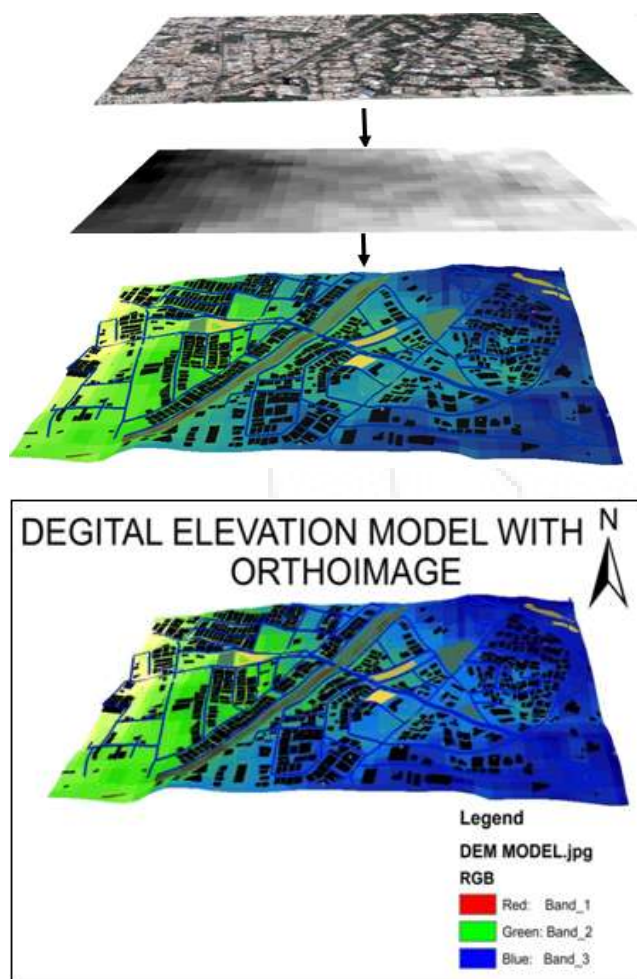
Dem Extraction Matching with Orthoimage

In this step, we set the DSM extraction properties, we check the advanced extraction properties and we generate and view the DSM from aerial image stereo pairs. In the end we check the Contour Map. The quality of DSM products are measured by how accurate the elevation is at each pixel and how accurately the morphology is presented. Several factors are important for the quality of DSM derived products:

- Terrain roughness
- Sampling density (elevation data collection method)
- Grid resolution or pixel size

- Interpolation analysis
- Vertical resolution
- Terrain analysis

In order to check the geometric accuracy of the obtained results, building heights and points on the ground have been measured manually. These measurements have been compared with the generated height models. We selected points in the center of the building tops and on the ground at a sufficient distance from the facades. The root mean square (RMS) difference between the manually measured heights and the automatic results turned out to be ± 22 cm. In general it can thus be stated, that for the height accuracy is in the range of two pixels GSD. This value includes not only the matching accuracy, but also the accuracy of manual measurement



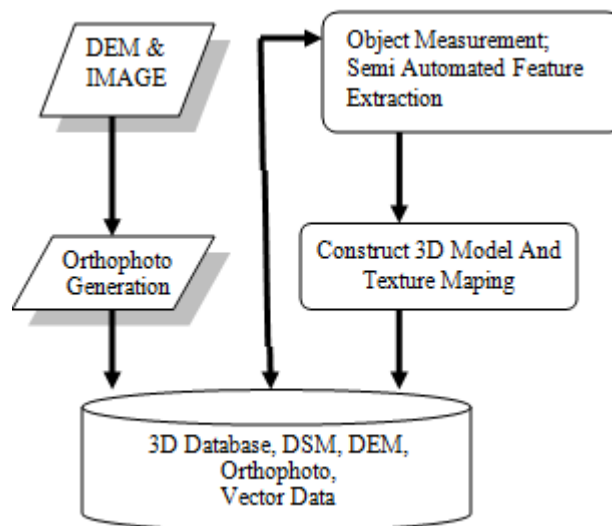
3D Modelling

Beginning a 3D Modeling Project in ArcGIS

In an earlier construction on Digital Elevation Model, we got some experience with GIS data sources that represent the elevation of the terrain. This will take this a step further. We will look at a few additional types of data that let us represent the form of places in three dimensions, or at least two-and-a-half dimensions!

We are going to start with a large city-wide repository of data representing terrain, buildings and the materiality of the ground. From this we will clip out a smaller dataset that we

can play with in 3D without over-burdening a modest computer. Our clipped dataset is going to include: A Terrain Model, A Ground-Plan Image, Buildings, and a Clipping Frame. At the end of the tutorial we create a 3D model from these that we can play with and generate renderings from a tool called ArcScene. The 3D datasets that we extract from GIS may also be exported to other tools, such as SketchUp, Google Earth, AutoCAD, Rinceros, and others.



Save a Georeferenced Groundplan Image

As we have explained above, one element of our site model will be an image of the groundplan for our site and its context. This image will represent the roads, water, land and open spaces within the area covered by our clipping frame. The image will also include the outline of the frame. This will make it very easy to register the image as with other layers as we export them to other tools.

Before we get into exporting the images we should think about resolution. We don't want the images to have more resolution than we need, because this will create unnecessary problems in every thing we do subsequently.

Export a Groundplan Image

- 1) Zoom out to your context frame and measure its width in meters.
- 2) For the context image, you don't necessarily need a very high-resolution image. A good resolution for your context image may be about a half-meter per pixel, which is good enough to see distinguish buildings, roads, cars, etc.
- 3) Thinking about it another way, many programs like AutoCAD and Sketchup will choke if you try to drape a texture with more than, say 4000 x 3000 pixels... So if your context image is more than 4 kilometers wide, think about that.
- 4) Arrange your map display to include the model clipping frame.
- 5) Think about the sort of graphical hierarchy thou would want in a reference image that will be draped on an aerial photo in your model. You may want to use other overlays with transparency to colorize the photograph or to include details for some other GIS layer that you have.

- 6) Choose **File>Export Map** to export a jpeg image. You can use the options for the export jpg dialog to set the quality to about 95% which will substantially shrink the file size.
- 7) In the Export Map Dialog, you should check the option to **Save World File**, which will save some georeferencing information for the image.
- 8) Use **Bookmarks > Create** to save a bookmark for the current map extent



Export a Clip of your Elevation Raster and Groundplan Image

Our Elevation Raster from US Geological Survey uses Decimal Degrees of Latitude and Longitude as its geographic referencing system. This is problematic, since the Elevation units are in Meters. I've reprojected this raster to Massachusetts State Plane Mainland Meters. You will find this raster in the USGS group layer. Because we want to make a nice compact 3d model, we will export a clip of the elevation model using the same extent that we used to export the groundplan image. Note that if you want your terrain dataset clipped exactly to your model frame you can use the clip raster tool from the **Data Management Tools > Raster > Raster Processing** toolset.

Clipping a Raster

- 1) Return to the bookmark for your model extent if necessary
- 2) Right-click your digital elevation model, **ned_third_sec_masp_mtr.img** and choose **Data > Export Data**
- 3) Make sure to change the option in the upper left to export the extent of the data frame.
- 4) For **Location** choose your data folder.
- 5) Save your clipped elevation model as a tiff or an Imagine Image format.

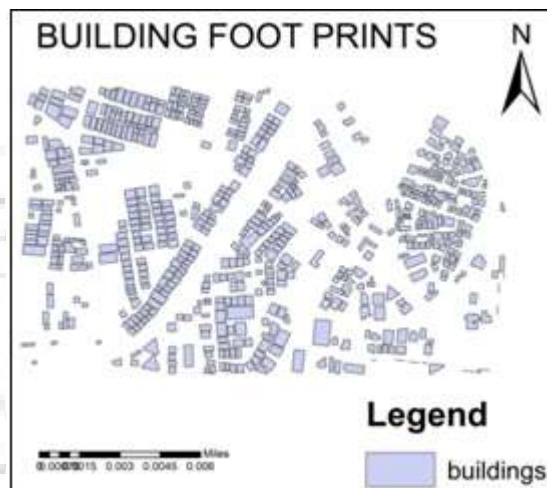
Make a Clipped Shapefile of your Model's Buildings

Finally, we will select and save the buildings that occur within our model study area. Then we have everything we need to make a nice compact 3d model of our site! Like above, there are a few ways of doing this. If you want your buildings clipped neatly to the edge of your frame use

the **Clip** tool; from the **Analysis/Overlay** toolset. Or if you just want a quick and dirty selection, you can right-click the buildings layer and choose **Data/Export Data** and set all of the options appropriately to export the buildings within the current display.

Export your Buildings to a New Shape File

- 1) If necessary, return to the bookmark you saved for your model frame.
- 2) Right-click your buildings layer and choose **Data > Export Data**
- 3) Make sure that you change your export option to export the features within the view extent. Save your buildings as a shapefile in your data folder.



Portraying Your Model in ArcScene

ArcScene is very similar to ArcMap, except it has some additional features for visualizing and navigating data in 3D. The following notes will provide links to documentation that will provide necessary details about how to add your data, adjust the display properties and to navigate your model in 3D. The following links may help to jog your memory after an in-class demonstration

Set Up your ArcScene Model

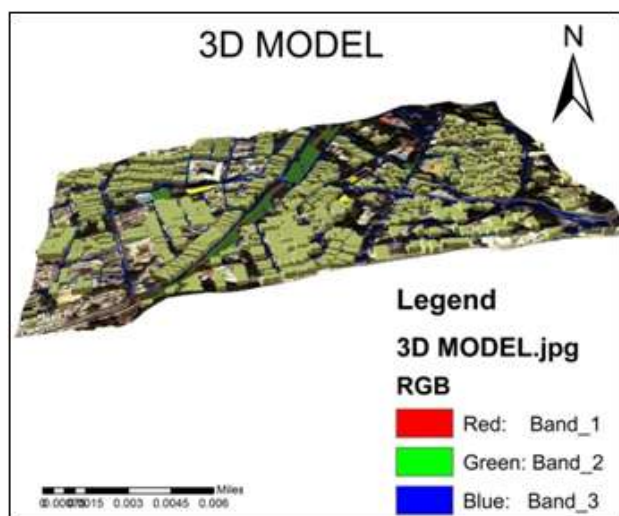
- 1) Start ArcScene. Set your ArcScene Document Properties to **Use relative Pathnames**.
- 2) Add your clipped DEM and your buildings and your groundplan.
- 3) Fix its Symbolology properties of your groundplan, setting **Stretch** to none as discussed above.
- 4) Set the **Base Heights** property of your ground plan to **Float on an Elevation Surface** provided by your DEM.
- 5) Set the **Extrusion Property** of your Buildings Layer to extrude each building to the height indicated by the field **Abs_Ht_Mtr**.
- 6) Inspect the model to see if it makes sense

Navigating in ArcScene and Saving a View

Now that you have a 3D model you will want to try flying around and saving some images that you can use to describe aspects of your site. See the references below for hints on navigating in your ArcScene model

Create a Birds-Eye View Image

- 1) Navigate your model until you find a view that shows what you want.
- 2) Choose **File > Export Scene > 2d** to export an image of your model.
- 3) Note that arcscene offers a special box for adjusting the resolution of your exported image **in the View Size box at the bottom left corner of the export image dialog.**



Processing of 3D Model

4. Result and Discussion

3D Building

Many GIS problems can only be solved in 3D, particularly in the area of urban development, with capabilities for generating high-quality 3D building using the same GIS data.

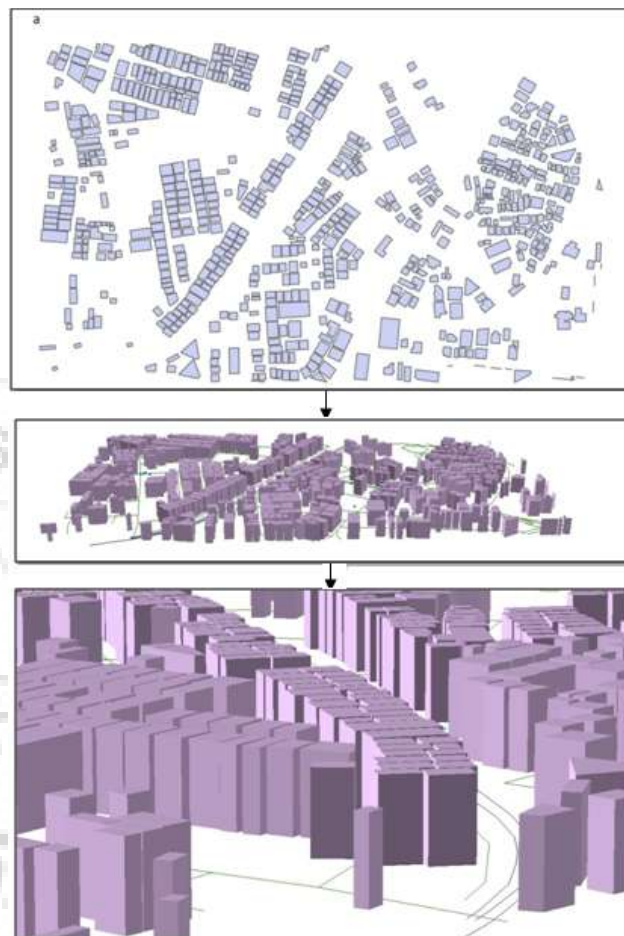
Modeling objects for 3D descriptions of the real world have been useful for many urban applications such as planning, construction and representation of the urban sceneries. Buildings, roads, trees and terrain are considered as the most important objects in producing a 3D city model particularly for the creation of virtual environments. 3D city model is basically a computerized model or digital model of a city. This work considers important stages involved in creation of 3D city models, which includes reconstruction of buildings, landscape and urban settings that are relevant in urban and environmental planning. The platform used in the creation of a virtual 3D city model has been provided by the GIS environment and assisted by ArcScene; a 3D modeling software. The emphasis is placed on the use of aerial and terrestrial photographic techniques and the existing topographical map data.

In this work, to generate the 3D model, we followed several steps:

- Geodatabase/2D Information.
- 3D Streets, Blocks, and Parcels (import or creation).
- 3D Extrusion, Roof Generation, and Street Furniture.
- Texturing and Facade Creation.
- Finished 3D City and Updation in the Geodatabase.

ArcScene software delivers a full suite of tools to aggregate geospatial data, layout and edit street networks, generate and modify buildings. The essential tasks performed are:

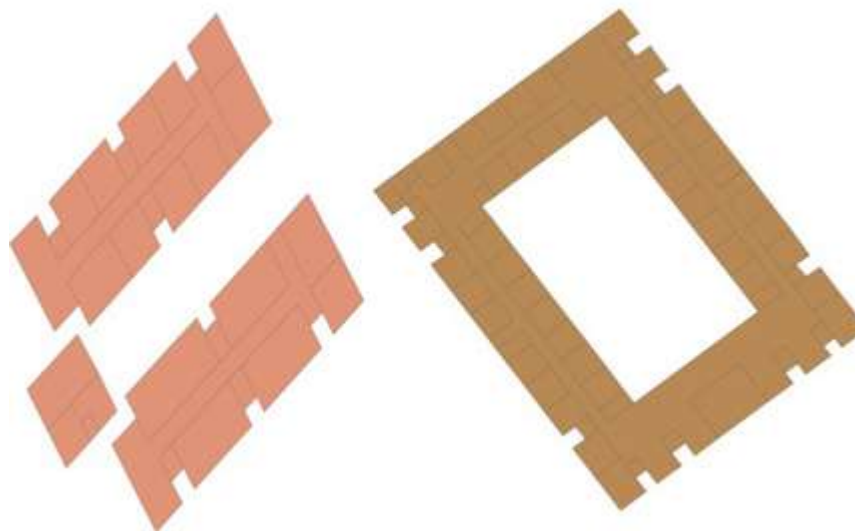
- Turn the 2D feature into 3D based on an elevation surface.
- Create 3D urban scenes based on standard GIS data.
- Semi-automatic and manual extraction of 3D features



Architectural aspect using 3d model

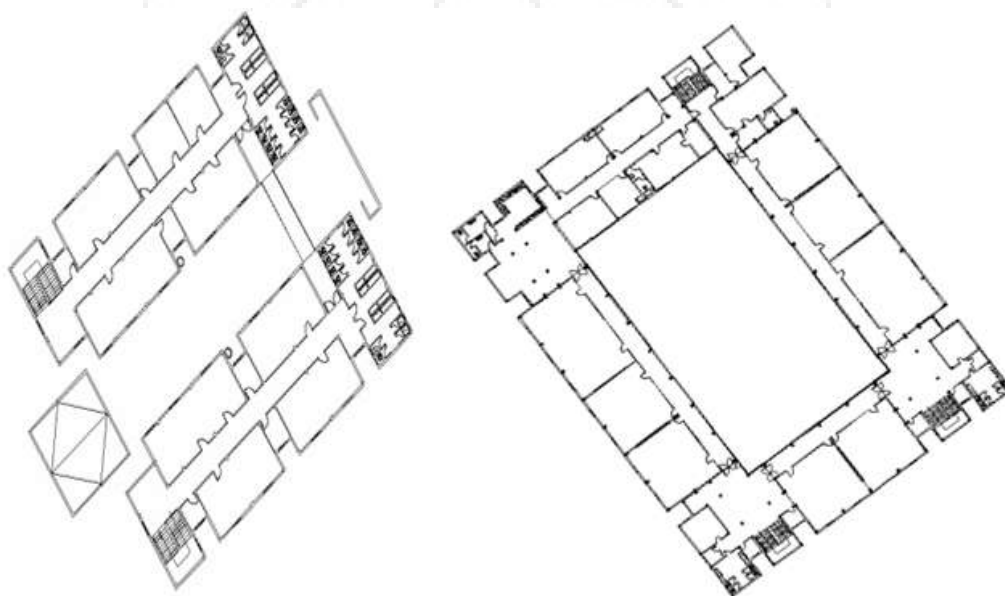
The objects have building features were transformed into polygon features and line features were transformed into polyline features such as roads networks and other utilities layers. The 2D base model was created very accurate and detailed. The GIS Data Modeling is an important step to define all required geospatial databases, including vector and raster classes and their relationship classes based on the defined objectives of project. This will draft what is required and missing to build the required GIS data model

3D-map database employed in the application is a database product distributed at the university. This database involves the characteristics. The geospatial data in the contemporary GIS are organized in one of many geo databases also called GIS or spatial databases. Commonly, geo database is an object-relational database designed to store, query, and manipulate geometry and coordinate data type as the other standard (attribute) database data types. The geometry and coordinate data type represents the shape and the location of an object in the physical world.

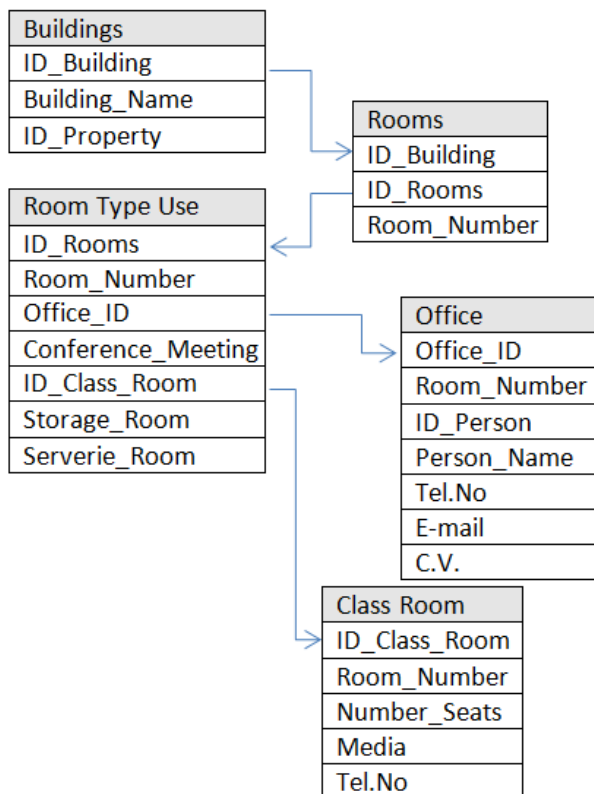


A simple prototype campus geo database was designed as a subset of the facility management data model. an example of common geo-database schema about main building container including spatial and attribute data in tables, feature classes, etc. and its relationships is given. The primary tables buildings ID and buildings name. The

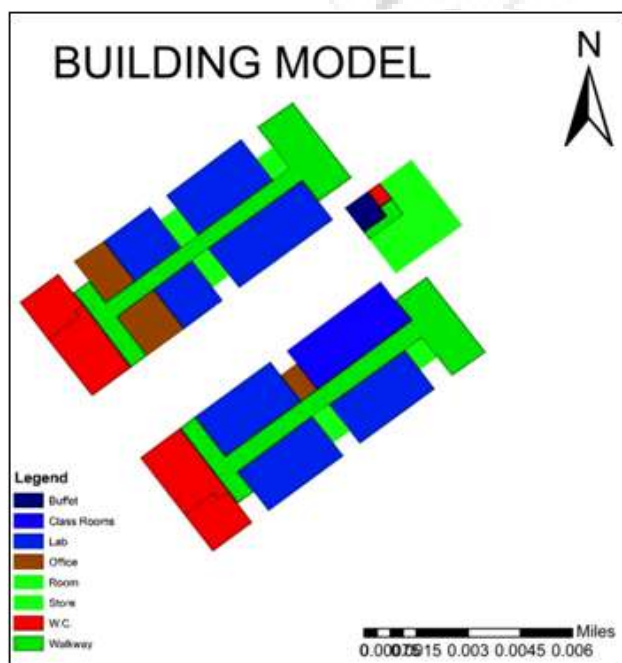
secondary tables are code classifiers of properties, rooms, room types, number and room ID. Then all spatial databases are joined to create layers in GIS environment in order to build the relational database and built the 3D model using the ArcScene from the ArcGIS software



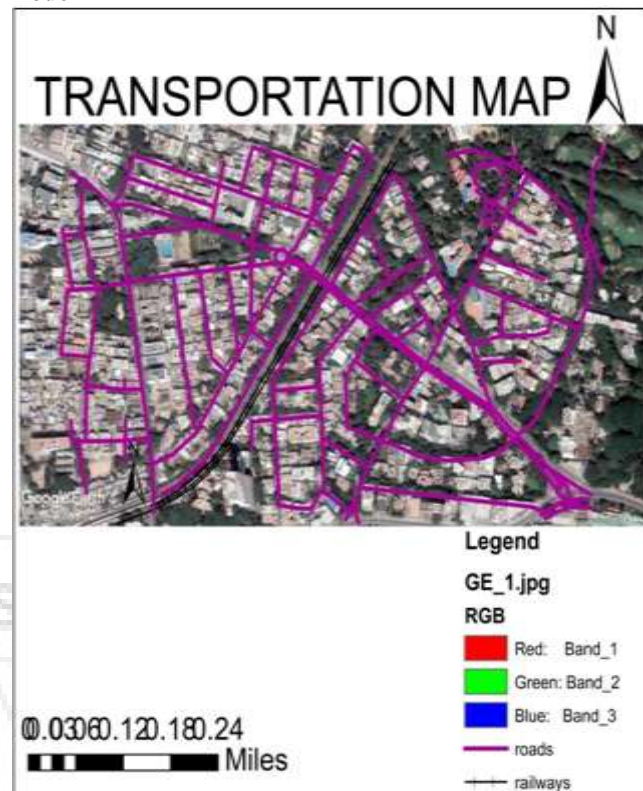
(AutoCAD files drawing added to deed of division for two types of buildings)



The next step was to build the 3D model into ArcScene after completing the 3D design of the university campus using ArcCatalog. A personal geo-database and a feature dataset were created. The layers such as buildings, roads, tree, etc. were added to a new ArcScene file. For using 3D model in ArcGIS, also the 3D 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. Similar to 2D view, users can view different types of building's campus planning information in the view (Fig. 12), and the 3D green space view. The various layers are displayed on the 3D building model using ArcScene.



Extraction of Transportation Map From Given 3D Model



5. Conclusion

This paper investigates the necessity of detailed surface representation in order to generate a feasible platform for the detailed simulation of urban modeling. In this first step of the project, we generated a digital surface model based on aerial image stereo pairs using the matching method. Methods to generate the 3D city structures have been investigated and possible solutions are tested and discussed. Features and 3D models extracted from these data can provide benefits in various GIS applications, where the building is necessary. For example, 3D surface objects extracted from aerial photographs can represent a significant layer of GIS databases for the simulation of natural disasters, telecommunications planning (i.e., positioning of antennas). 3D land use zoning allowed building volumes, usage, and density. They are the main tools defining the image of a city and brings into focus the model of best practice of the rehabilitation

3D GIS provide urban designers and planners with a useful tool for modeling and analysis. The 3D GIS application was developed in order to evaluate urban space efficiently and to provide information about urban planning to local communities. This application enables users to visualize complicated urban planning information in the 3D way, to evaluate the allowable capacity of the block and to simulate building plans. With visualization and analysis capability, 3D GIS is considered a powerful tool to solve various issues which modern cities confront.

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