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Introduction

3D Visualization is an area of research that meshes both design and technology. The study area for this project is in the California State University Long Beach (CSULB) campus located City of Long Beach (Figures 1 and 2). The University has the third largest campus of the 23 Universities in the California State Universities. The purpose of this applied research project was to build a 3D map to visualize this campus. An open source GIS software, QGIS, was used to carry out this project. The QGIS qgis2threejs plug-in played a vital role in modeling the campus. A 3D model developed with QGIS is easy to access and can serve as an effective medium for communicating spatial information about the campus over the internet. The interactivity of the web map helps the users view the campus building information in real time. Since QGIS is free, it makes it easy for a GIS expert to present the result of the project on the web for free and without licensing limitations.



Figure 1. 2D map of the CSULB study area

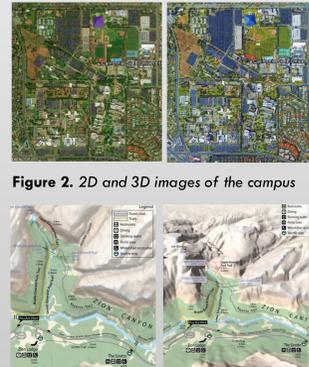


Figure 2. 2D and 3D images of the campus



Figure 3. 2D and 3D Map trail maps

Data and Data Sources

Data Acquisition:

The data required for modeling the CSULB campus in 3D was readily available and easy to access. The most important datasets for visualizing the campus were the DEM and imagery for the terrain surface part of the model and building shapes and heights from the campus basemap for the built environment portion of the model (Table 1).

Data Storage and Management:

An open source GIS software was used build the map, there were no proprietary issues. Most of the data had to be organized within a project folder and saved as either individual file rasters or as shapefiles. This organization scheme made it easy to manage the data while working on the QGIS software.

Table 1. List of data and data sources used in the project

Dataset	Source
Campus DEM	LARIAC 1 via CSULB
Campus Basemap	Geography Dept.
Campus Aerial Imagery	LARIAC 3 via Geography Dept.
Campus Height Above Terrain Raster	LARIAC 1 via CSULB

Methodology

To visualize our area of interest, the data was first refined. From the various attributes on the campus basemap, the building features were identified and extracted as a separate shapefile. Once the buildings were saved in a separate dataset, the features of QGIS were explored and the building symbology was defined. The next step was to devise a method for extracting the heights of each of the building polygon features. For the building heights to be precise, a methodology, that would extract the median heights from the pixel values, was required. However the due to some failed results, it was only possible to extract the mean heights.

The first step in this process was to clip the raster to get the pixels that are under each of the building polygons. Next, the pixels in this clipped raster had to be converted to point features. This way, the attribute table would record the height of every point. Once the raster is converted into points, the new point layer's attribute table was spatially joined to the building shapefile. The parameters for this join were set, such that, the mean height of the pixels that intersected each building polygon was joined to the building shapefile attribute table. Lastly, these mean heights were entered in the BLD_HT_FT ("building height in feet") field of the building shapefile using the field calculator. The final step on acquiring all the data required for visualization and dissemination involved an 8 step process (Figure 4).

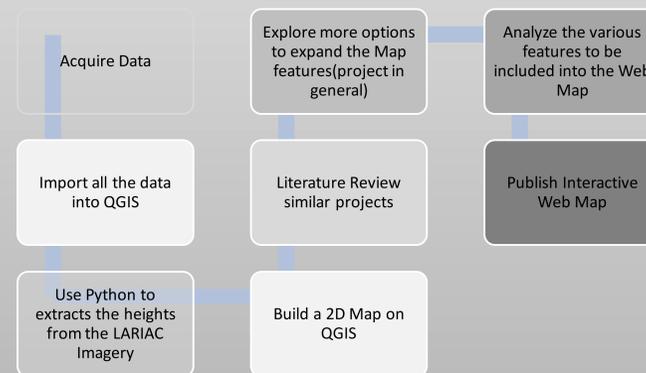


Figure 4. Methodology followed for the project

Timeline

The initial tasks of the project that involved acquiring data was done prior to June 8. The timeline below shows the weekly progress of the project once the methodology was laid out (Table 2).

Table 2. Timeline of the project

Task	Jun 8	Jun 15	Jun 22	Jun 29	Jul 6	Jul 13	Jul 20	Jul 27	Aug 3	Aug 10
Refine Data	█									
Create 2D Map		█	█	█						
Literature Review			█	█	█					
Extract Heights					█	█				
Draft Web Page							█	█		
Final Web Page									█	█
Presentation										█

Results

The final goal of the project was to create a 3D web map that could be visualized to assist CSULB facilities management personnel with the maintenance of the campus. Despite the limitations of QGIS and the qgis2three.js plug-in, it was still possible to achieve this outcome. As discussed above in the methodology, first a 2D map was created in QGIS and the symbology was defined. Various features were classified and intuitive colors were assigned for visualization. As for the 3D visualization, the building heights field was populated with the heights of the building features (Figure 5). This is a useful information that could be used by the university for future analysis.

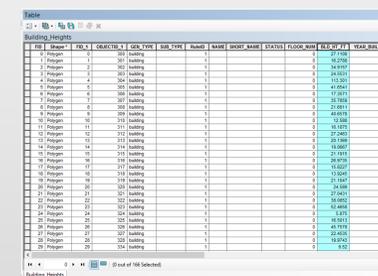


Figure 5. The highlighted field of this attribute table contains the heights of the buildings on the CSULB campus. This is a valuable information that can be used for future projects involving the campus.



Figure 6. 3D model with the 3D elevated model showing the heights points of the pixel values.



Figure 7. 3D model of the campus with the limitation of viewing each building as a block model extruded to its height.

The final result of the project is a web page (Figures 8-10) that allows us to view the map from all directions and perspectives. Since it can be toggled and gives us a 360 degree view, the campus can be viewed from north, south, east and west directions. Besides this, all the layers of the map come with a feature of changing the opacity and visibility.

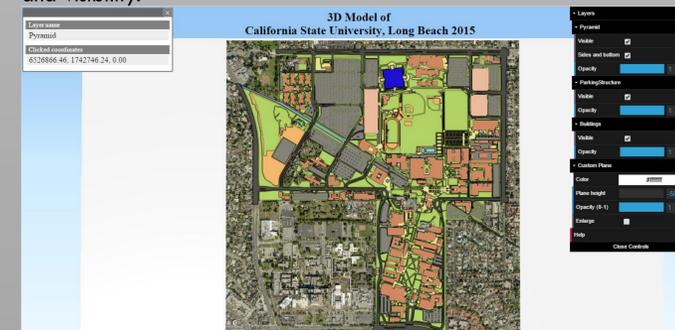


Figure 8. Final Web Map - Bird's Eye View

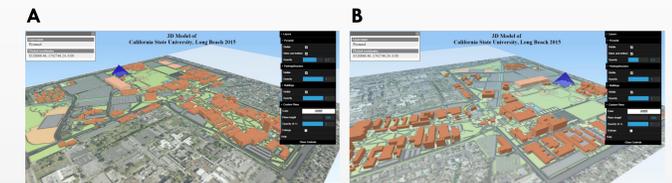


Figure 9A and 9B. CSULB campus 3D map with the flexibility of viewing from different perspectives



Figure 10. Final CSULB Campus 3D Map with realistic visualization of all layers and buildings

Discussion

The significance of building a 3D web map is that it is always easier to understand and analyze a 3D visualization as opposed to viewing data from a 2D map. Primarily, this web map was built to facilitate the maintenance of the Facilities Management of CSULB. since it is a web map, anyone can access it over the internet, making it very accessible to the users. It can not only be viewed on a computer, but its mobile-friendly also, which makes it helpful when used for directions. With the advancement of technology we can expect 2D maps getting completely replaced by such 3D maps which are more realistic, descriptive and highly accessible.

Conclusion

The final product of this project is an interactive web map. The initial work done to learn the techniques and methodologies to be used proved to be helpful. The failed results helped in learning the limitations of spatial analyst tools as a result of which, alternate methods to be explored.

For future work, apart from making the webmap stronger in terms of its interactivity on the web,

- More research would have to be done on overcoming the limitations of the qgis2threejs plug-in.
- The aesthetics of the map would be developed
- Additional building information could be pulled from the attribute table to show up when a pointer is placed on each building.

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For additional information please contact: Priyanka Hari, priyanka.hari@yahoo.co.in. You can view the web map at http://web.csulb.edu/~phari/Priyanka_GISC_FinalProject/Map/WebMap.html