

## Creating 3D model for new urbanized area from limited resources and data in developing countries

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**Abstract:** Technology developments ratify web based Geographical Information System (GIS) for further developments especially in the developing countries. However, the progress of technology made the consumers to expect the corresponding progression in the field of GIS too. Perhaps GIS recently developed further and allows visual tours over 3D models in numerous places, while these models are barely available in the developing countries, due to the lack of data, techniques and professionals.

One of the popular applications for GIS data demonstration is World Wide Web (www), which presenting spatial and Geo-data for period of time statically and dynamically. However, this study aims to increase the numbers of three dimensional models on the web for more GIS virtual tours in the developing countries where they suffer from lack and inadequacy of data quality. Nevertheless, this can be done by intriguing simple and poor quality data through different process of enhancement by applies different methods, techniques and tools to enhance and enrich the data to the level that can be uses in GIS application and 3D model production, therefore this study provide the stage of data improvements and 3D model production from a poor quality data.

3D data means the data with three dimensions that facilitates 3D model production using the third dimension. Although 3D model can built with three dimensional data, but building 3D model for GIS especially for the web virtual tour requires other attributes such as location reference, as it require the model to be build on the correct location. Consequently, the aim of this paper is to deliberate the opportunities for rising 3D model from limited data and resources, also this study over comes all the issues with the adequate data for this purpose.

**Keywords:-** Spatial Data, 3D Model, Web based GIS, SketchUp, Geo-referencing, AutoCAD, ArcGIS, Google SketchUp and GIS, Limited GIS data and 3D modeling.

### I. INTRODUCTION

The term GIS frequently applied to geographically oriented computer technology [1]. The benefits of GIS and its progresses increasing significantly in numerous fields to improve and develop public and private sectors [2] such as: urbanization, regional planning, cartography, tourism sector, environmental conservation and utilities [3]. However, GIS benefits come from integration of hardware, software and data for capturing, managing, analyzing, displaying, understanding, interpreting, and visualizing of information [4]. Although there are, many applications using GIS technology, but the users of GIS are also increasing significantly, since its growths and improvements touched a considerable level in approving GIS futures and it influence in many countries [5]. One of the GIS futures is 3D presentation, that is attracting many users since it has established, as it is presenting data in a ways, which have virtual depth, height, and width, similar to x, y and z-axes [6], this development can scale according to user's preference and desires. 3D data also have capability to rotate, zoom and represent multiple uninterrupted views, regardless of their attributes, beside they have ability to show and manipulate spatial relationships and support users to envisage an object in the way that is close to its real looking in reality [7]. Despite the fact GIS is a powerful tool, however the growth of Internet also created superior infrastructure to widespread distribution and dissemination [8], alongside to software developments which also helped GIS development further, these developments made it easy to integrate and create 3D model on the web application too. However, the image below showing the competences of 3D features in GIS that is combining different file formats [9] to achieve a particular work and make a use of different futures accurately.



Image No.1: 3D-GIS in the Cloud supported data sources and clients [12]

GIS technology relies significantly on data from different kinds to create 3D models, analysis and other form of location-based techniques. However, spatial data is one of the vital kinds of data to GIS, as they are easier to deployments and require less process for conversion, whereas the study area suffers from the lack of quality data and limitation of skills in developing GIS and it futures in the region that is also the case in many other developing countries. Therefore poor quality data affects the decision-making, developing, enhance of technology and often expensive to fix. The way 3D using GIS, also depending a great emphasis on data quality, as quality is paramount when using GIS especially 3D [10].

Developing countries suffers from lack, limitation and shortage of GIS data, it is important to mention the key answers to many problems in the developing countries often inhibited by lack of access and availability to relevant data, or to the data quality [11]. Consequently, this study looks into data enhancements, through combination of data, different procedures and tools to promote the best ways to enhance limited and poor data.

## II. CHALLENGES

In the field of GIS, the system to handles 3D map or model within web environment is scarcely available, since it requires advance browser and applications for that purpose. Hence this study intends to build a 3D model that is compatible and ready to demonstrate on web interface or web map from a limited and poor quality data. This is only achieved if developer manages to improve and enhance the data quality by enrich the data thorough adding more attributes. Consequently the challenge covers: conversion, methods, techniques and tool for the enhancement of insufficient data, and eventually converts the limited and the inadequate data to reach facilitation of 3D model production for GIS and web map.

## III. STUDY AREA

Department of Computer Science in University of Sulaimani/New Campus. It is located in the city of Sulaimani which is one of the Kurdistan Region of Iraq cities. This city situated in the northeastern tip of the country, and the city is known as a cultural capital of Kurdistan Region [13]. This campus initiated in 2006 that built on 1,000,000sqm land, located on the coordination of 35.575053 Latitude, and 45.362978 Longitude [14].

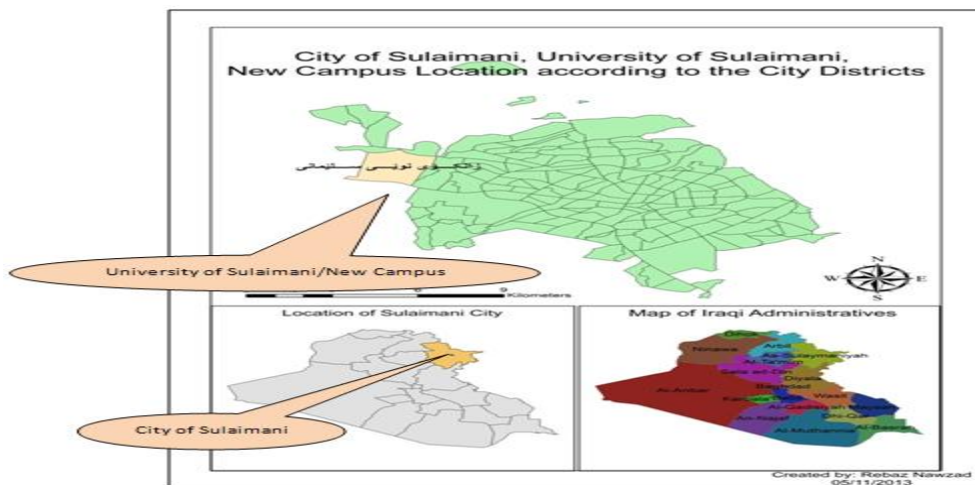


Image No.3: Research Area: Location of University of Sulaimani, New Campus according to the city Districts,



Image No.2: University of Sulaimani, New Campus Location [15]

#### IV. MATERIALS

The materials for this study came from different sources and quality:

1. Buildings floor plans for the entire university are AutoCAD files (.dwg) formats, created by Construction Company. This file contains the entire campus drawing in 2D. with no elevation and referencing.
2. City master plan and city satellite images are another source of materials, they contains city districts, roads, administrative areas. These data provided by the city Principality, these data are includes reference and coordination, which can be used for geo-referencing purpose.
3. Building actual photo, to complete the 3D model, someone requires taking the actual photographs of the building, from different points to assist the 3D model creation.
4. Height measurements of the building must be taken manually, if the wall drawing is not available, or it must come from other sources.
5. 3D model production software, which is Google Sketch Up.

#### Methodology and Design: [Data Enhancements, Design and 3D Model creation]:

Combination of tools and techniques used throughout this study to produce the demanding work. The key information are the AutoCAD and the Shape file data, however there are other source of data and information used during this study, such as JPEG Image, building height data and satellite images. This study tries to integrate different platform together (Mash-up) in order to improve data quality and produce better results.

Usually in the developing country data can be in any quality and formats or unorganized, Hence, it is important to know that different types of data require different techniques and tools for enhancements and developments, and this study focus on integration of multi-platform for 3D production, referencing and data enhancements due to the variety of data.

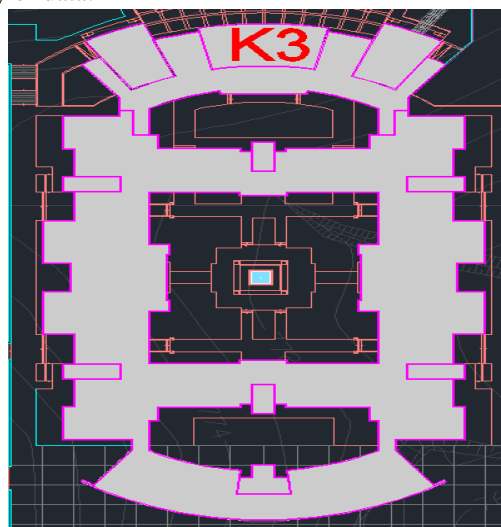


Image No 4: AutoCAD Drawing for the study area

One of the main issues with the AutoCAD data in this study is lack of reference. Perhaps it is one of the drawbacks of the existing AutoCAD data, therefore this will be the first challenge that the study should overcome thru different technique and tools to solve this issue, and add reference to the AutoCAD data. Otherwise, the model will not stand up on the exact real world location.

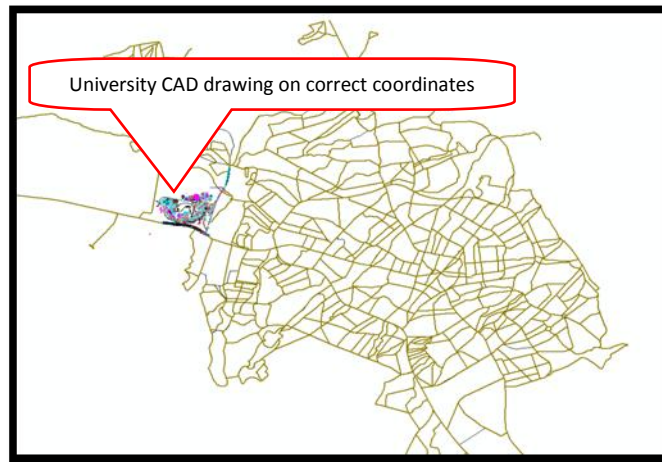


Image No.5: Geo-referenced University AutoCAD site plan using ArcMap software.

In order to add reference, there are different ways and techniques, perhaps the most popular way called Geo-referencing techniques which is achieved in different ways on different software and applications.

1. Applying the technique through AutoCAD: This procedure prepared by moving AutoCAD drawing on the AutoCAD software to its correct location, this achieved by using a specific plugin called *UHGEOREF*, which is used for Geo-referencing of raster maps to raster files. However, inside this plugin, World files are often included, this is a text files with six transformation parameters (affine) for the correct positioning of the raster map in a global coordinate system [16].
2. Applying the technique through ArcMap: this software have the ability to geo-referencing any drawing to its real location from different formats such as JPEG, PDF, AutoCAD, and even hand drawing. It work by scan the maps or drawing and then import it to the software, as it is shown on the image No.5 [17].
3. Applying the technique through Google SketchUp: The innovative geometry of any ground plan may create as an aerial photograph, which is then used as an underlay for a pencil sketch of a proposed re-working of streets and open spaces. However, the 3D model can also build and at the final stage, the model can be highlight and then move to its original location [18].

Figure No.2 concludes the three different techniques mentioned above in a simple diagram. Nevertheless, geo-referencing improves the data quality a step further, and it gets prepared to build the model on the correct coordinates. The experts plays an important role in enhance data, because it require a correct techniques and tools to be applied on the data. This procedure twitches by identify the data layers to be reference to a location, then it fit and scales to the area of interest. As soon as the first control point taken in one location, then the next control points on opposite ends of the image need to be taken, beside it is important to assess accuracy by measuring the disparity between the data layers at multiple points throughout the study area and then the desired geo-referenced location.

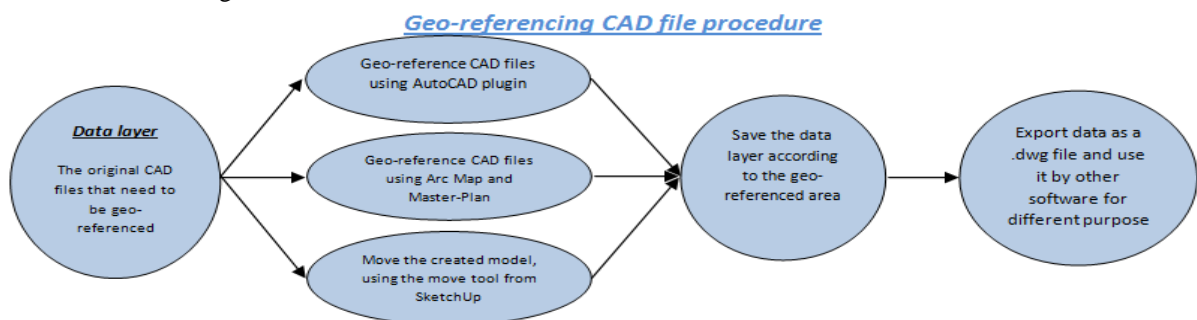


Figure No.1: Geo-referencing procedure and methods

It is important to consider geo-referencing in the field of GIS, although it is a complicated, on the other hand, it improve data quality to a high level. Google SketchUp nowadays has ability to add real location to the interface and user can built their model using the location for reference as it shown in image No.6, also because the AutoCAD data has been geo-referenced at the earlier stage, it can be seen on the correct location in image No.7.

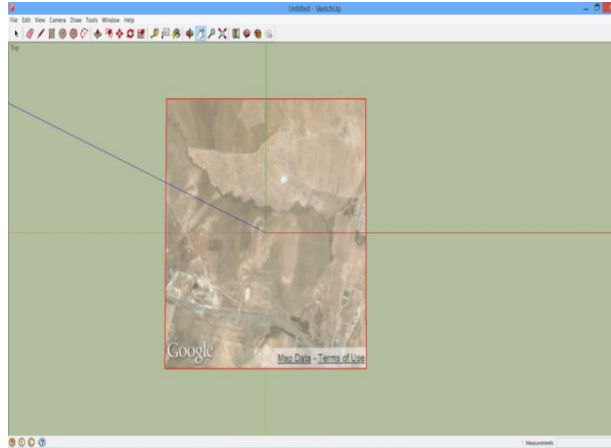


Image No.6: SketchUp adds real world location

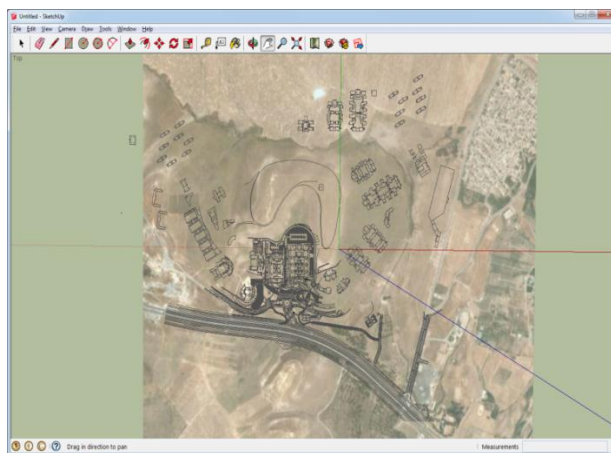


Image No.7: University Campus footprints on SketchUp

Finally, the procedure of 3D model construction can initiate, but the building height data is not available, hence one or more methods require in order to add third dimension to the building. Nevertheless, there are different methods to collect height information depending on the size of the working area.

1. Measuring the height of the building in person, this will require a lot of field work, but it provides accurate records.
2. Stereo image pairs used to perform third dimension data acquisition. Stereo photogrammetry or photogrammetry based on a block of overlapped images is the primary approach for 3D mapping and object reconstruction using 2D images.
3. Close-range photogrammetry, this is another technique that work out the distance between the camera and the building to calculates the building height.
4. Using 3D scanner can collects millions of points for the building or any objects, these points includes height distance and depth too.

Image No.8 showing a wall pushed up, but this is require the height measurements, because the data collected for this purpose, and then the height of building will standup correctly, image No.9 authorize the certainty.

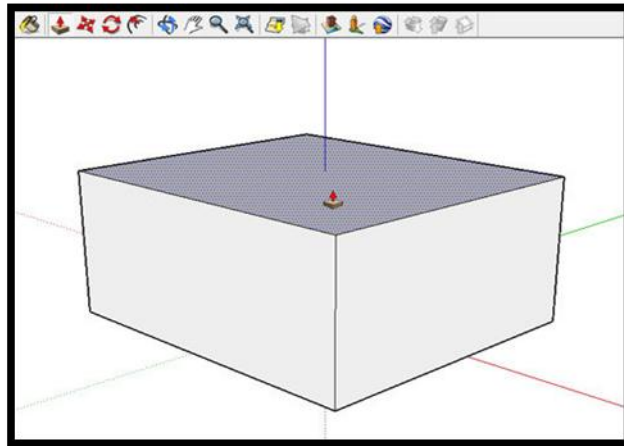


Image No. 8: step one for building first wall



Image No. 9: several wall building completed

Once the building structure completed and then details can be added such as doors, windows texture and colors, which is shown in image No. 10. Eventually as soon as the 3D model finalized, according to image No.11, and then it can be export as .kmz file. This is the file that is accepted by Google Earth for uploading the model into to local Google Earth as a trail, lastly the model can also be submitted to Google Earth forums for approval, once the file is validated and accepted, formerly the model get displayed globally. However, Google Earth and Google Map API (Application Programming Interface) are using JavaScript to allow users to modify applications and add maps to own website.



Image No.10:

Details added to the

Model

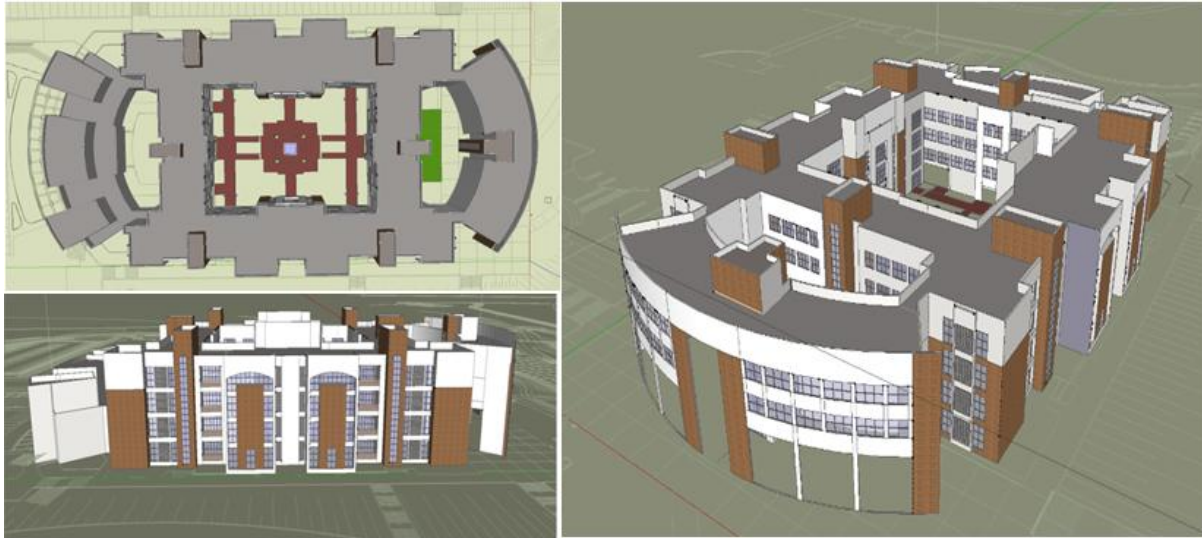


Image No. 11: the complete building from the top, Side (east) and front view

## VI. INTERFACE

After the 3D models for the dedicated building completed, and then the model need to upload into an interface. This is to make the models accessible and to provide mechanisms to manage it content. However, the interface for the produced 3D model is Google Earth, as it has a "3D Buildings" layer that allows anyone to view 3D models of any objects and edit the database side of the model. This interface enables users to add data after the completion to enrich the model with more information [19]. Google Earth offers opportunity to explore and visualize its stored data on the system, through uses of the visualization and navigation functionality.

## VII. CONCLUSION

Although 3D model is become common in the GIS applications, but it wouldn't be available to built without availability of advanced superior data, on the other hand, 3D model doesn't prevail to be part of GIS as a management tools (decision makers) and real world demonstration. Hence, this paper describes initial works to form a 3D model from scratch or limited data. Beside there are various aspects of 3D required to be addressed and investigated, also this research challenged and investigated those aspects. The study also describe approaches that can be used for further 3D model creation using combination of software, data and techniques. This is not only to build 3D model, but also to enhance and enrich simple and non spatial data into an advanced geo-reference and spatial data that make GIS life and 3D creation much easier. Eventually the model building not the only issue, but the details and demonstration is also very important to develop the topic in the future further and open the road for the much more model creation and movements towards a digital 3D model city.

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### Future work

The same principals can be applying to convert the entire University of Sulaimani from 2D drawing into 3D models. This study was an initiation of the entire university 1,000,000 sq. meters to be built in 3D in the future, although in the mean while this study focused on department of Computer Science, but it has produced enough guidance and techniques to for orientation. Conversely, the same method that applied to the single department can be apply to other buildings, as the available data for the university is the same for all the departments.

The same or similar techniques can be applied on other locations and objects even if the data are inadequate, since most of the available information in the developing countries are limited and unorganized.

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