JEDDAH HISTORICAL BUILDING INFORMATION MODELING "JHBIM" OLD JEDDAH - SAUDI ARABIA

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ABSTRACT:

The historic city of Jeddah faces serious issues in the conservation, documentation and recording of its valuable building stock. Terrestrial Laser Scanning and Architectural Photogrammetry have already been used in many Heritage sites in the world. The integration of heritage recording and Building Information Modelling (BIM) has been introduced as HBIM and is now a method to document and manage these buildings. In the last decade many traditional surveying methods were used to record the buildings in Old Jeddah. However, these methods take a long time, can sometimes provide unreliable information and often lack completeness. This paper will look at another approach for heritage recording by using the Jeddah Historical Building Information Modelling (JHBIM).

1. INTRODUCTION

1.1 Background

Jeddah is one of most important cities in the Kingdom of Saudi Arabia; it has a long history and there are many historic buildings that were built more than 300 years ago. Jeddah is a costal city, which is located in the western region of Hijaz. Jeddah is known as the gateway to the two holy cities of Islam, which are Madinah and Makkah. Its geographical features contain a natural harbour in the shape of a crescent, and the city is surrounded by a series of mountains and hills. However, this coastal area is hard to navigate for ships because the coral reef surrounding the harbour, which was formed to protect the city from invasion, attacks in older periods. This part will provide an historical background of Jeddah city, and its value as an Arab Muslim port since medieval times, which has preserved a major amount of its architectural and urban heritage(ADDAS, 2009).

1.2 Old Jeddah issues

The major issues that face Jeddah today are how the government can preserve and save them from the risk of collapse and erosion by natural and human factors, and disasters such as fires. In fact, many buildings have been lost in this area over the last thirty years and because of that a valuable source of information and a part of the city's history has been lost. Today, many buildings are abandoned and they became occupied by squatters. Many private experts believe that these building must be preserved, maintained and used; otherwise, they will lose their essence of culture and history(SAMI, 2013).

1.3 The Existing Solutions

The municipality of Old Jeddah City decided to preserve and develop this area by using an approach, which relies on independent engineering survey offices. These take a long time and can sometimes provide unreliable or conflicting information.

The procedures for this approach start with the owners of the building choosing one of the engineering offices that are recommended by the municipality of Jeddah. Following that the engineering office sends a project team that includes five sections to survey the location and prepare a drawing of the outlines and take photographic documentation. They use Totals Stations to obtain the dimensions of the buildings. Next, the other four sections start to do their fieldwork, and draw and write what they observe. Finally, these documents are sent to the municipality of Jeddah. The municipality sends an auditor to check reliability of the submitted reports so they can make a decision about this particular building. It has often been observed that these offices use old methods and techniques to perform the job. To complete these reports and get a decision, the process may take more than a year and this is only for smaller buildings, it could take more than two years for larger buildings. Moreover, this procedure costs a lot for owners and the Old Jeddah municipality (SAMI, 2013).

1.4 Aims

We aim at creating a full engineering drawing from a Building Information Modell (BIM), which is derived from Terrestrial Laser Scanning and photogrammetric survey data. The output Information could be used for several applications and different levels of remote managing. One of the historical buildings in Old Jeddah, Farsi House, was chosen as a test case for the project.

1.5 Objectives

1- Determining the damages in the buildings of the historical area.
2- Documenting these buildings as historical digital

documentation for deferent purposes such as Architectural, structural and constructional purposes.

3- Designing a system that can follow up running these buildings.

2. LITERATURE REVIEW

2.1 Terrestrial Laser Scanning "TLS"

Terrestrial laser scanning systems are available in the worldwide market for more than ten years. In the last five years laser scanning become as a familiar method of 3D data acquisition, taking its position on the worldwide market beside established methods such as photogrammetry and GPS (Hosseininaveh Ahmadabadian et al., 2013). Terrestrial laser scanning stands also for a paradigm change "from the representative single point to the exact and highly detailed 3D point cloud" (Kersten et al., 2008).

This advanced technology and new features of 3D laser scanners have been developed in the past few years, introducing additional instrument features like electronic levels, inclination compensation, forced centering, on the spot geo-referencing, and sensor fusion (e.g. digital camera and GPS). Most of these elements are obviously equivalent to features that can be seen in total stations, however, not as advanced (Kersten et al., 2008).

Due to the fact that the huge number of types of terrestrial laser scanning systems are difficult to find comparable information about potential and precision of the laser scanning systems in the market of technical specifications and to be able to validate the technical specifications, which are provided by the system manufacturers.

Therefore, it may be difficult to choose the right scanner for a specific application, which emphasizes the importance of comparative investigations into accuracy behaviour of terrestrial laser scanning systems(Kersten et al., 2008).

Moreover, there are several laser scanning systems in the market today and the common systems are Leica Geosystems and Trimble 3D Laser Scanner. By looking closely to these systems it could be noticed that these systems are quite similar but they have some differences between them in resolution, the accuracy, field of view, scanning distance, scanning speed and 3D scan precision. Moreover, the 3D laser scanning which was used to this project was Leica Scan Station C10.

2.2 Combining Laser scanning and Digital Images

For the most of new scanning systems, the camera and the image data are fitted in, these images can be used to colour the point clouds of the laser scan survey data. The point cloud represents the x, y, z coordinates of a scanned object (Abmayr et al., 2005). The RGB colour data from the images can be mapped onto range data by taking account of point translation, instrument rotation and perspective projection. Both camera and the laser must be correctly geometrical calibrated (Abmayr et al., 2005). The calibration of camera is introduced to correct the distortion of cameras lenses, and by mapping onto the point cloud any perspective contained in the images is removed. High-resolution colour images can be precisely mapped onto a geometric model represented by a point-cloud, provided that the camera position and orientation are known in the coordinate system of the geometric model (Beraldin, 2004).

2.3 Jeddah Historical Building Information "JHBIM"

Jeddah Historic Building Information Modeling (JHBIM) will be an interactive solution, representing architectures, which are based on historic data. These elements (including detail behind the scan surface) are accurately mapped onto a point cloud or image based survey (Murphy et al., 2009).

The Islamic Hijazi architecture will be introduced and we document advanced scientific rules for the production of architectural elements, which support the design of parametric models. The use of Jeddah historic data will introduce the opportunity to develop details behind the object's surface concerning its methods of construction and material makeup. In the final stage of the JHBIM process, the prototype libraries of parametric objects are mapped onto the point cloud and image survey data using a system of cross software platform management. Jeddah Historic Building Information Modelling "JHBIM" will automatically provide full engineering drawings orthographic, sectional and 3D models. The Heritage Conservation field can bring many things to the JHBIM such as understanding of heritage buildings in Old Jeddah and the context, Knowledge of materials, construction techniques and the building pathologies, understanding that heritage buildings in Old Jeddah contain a wide range of materials and assemblies that are not documented and are not available from stock libraries of 3D model parts.

Moreover, JHBIM can bring many benefits to the Heritage Conservation field such as allowing a full study of proposed renovations and changes before final decisions are made, assisting in building maintenance, aiding in budgeting for repairs and maintenance and allowing a wider public building experience as models can be viewed with free viewer software from remote locations.

3. SCAN TO JHBIM "METHOD"

3.1 Laser and Images survey data

3.1.1 Images survey

The project started with the images survey to discover the Farsi house characters. This step took from two to three days. A professional Canon 18 Mega Pixels camera was used to take free images of the house. In fact, the house has a lot of characters such as the Roshans and mashrabiyahs. Furthermore, these images could be used for 3D modelling "Architectural photogrammetry" by using professional software such as PhotoModeler.

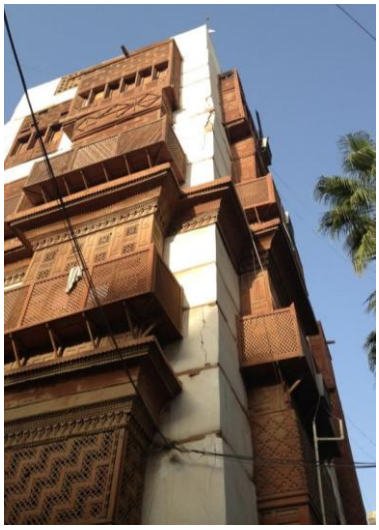

Figure 1. Farsi House Roshan and Mshrbih.

3.1.2 Laser survey

The Second steps started with scanning the Farsi house. The scanning took a week. In this step we chose best locations for scanning station and scan targets "black/white". Furthermore, the station locations are chosen in these points, which can cover the area that will be scaned so parfect visibility can be produced. Moreover, for more acuracy and to combine the stations, three targets at least must be used in common between these laser scanner stations. The selection of suitable viewpoint positions is very important for a successful survey of such monuments since the number of potential sensor stations is usually restricted by the complexity of the structure. The collected scans have sufficient overlapping area to allow for subsequent integration. However, due to the stations locations and the Height of the building, no scans cloud points could be collected from the roof of the building and from the Roshans.
The resolution for these scanning was 7 cm and the distance was 10 m for inside the house and 70 m to outside. Each scan settings and targets registering took more than 30 minutes; these depend on the target number. Moreover, the scan took less than 15 minutes; however, the scan images took more than 15 minutes.

Figure 2. Starting the Scan.

3.2 Data cleaning "Noise" and points clouds registration

There are different processing steps to generate the required 3D points clouds models were realized using number of software such as the Polyworks software and from Innov- Metric and Cyclone software from Leica Geosystems "the software which was used". The Cyclone program was used to remove the noises. This step took around three days to be completed.
Next, different scans corresponding points in overlapping areas were used for the registration. This can be shown in Figure (3), which shows the registration of two scans collected for Farsi House.

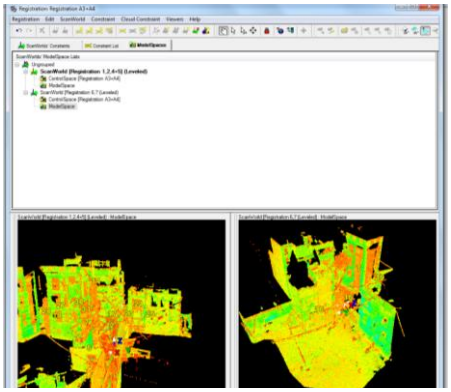

Figure 3. Point cloud registration.

3.3 Point Clouds to Autodesk Revit "Modelling"

After getting the cloud points from the laser scan, there are many useful programs that can be used to deal with cloud points. Autodesk Revit was used to deal with, that because quick built and Changes to the 3D model, High Quality Construction Documents and High Level of Flexibility.
Figure (4) shows the 3D points cloud for the Farsi House.
The Modelling took more than month to be done.

Figure 4. 3D Point cloud model.

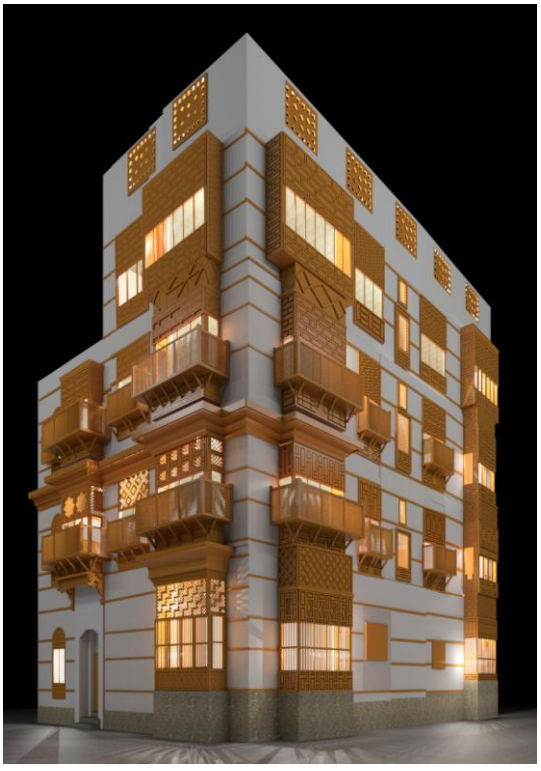

Figure 5. 3D model by Autodesk Revit.

3.4 Autodesk BIM 360 Glue

The 3D Revit model was linked to the Autodesk BIM 360 Glue on I pad. This can provide multidiscipline model coordination and clash detection, and provides access for stakeholders across the project lifecycle. Architects, engineers, owners, and builders across the globe can collaborate and coordinate in real time from the office or mobile devices(Autodesk, n.d.).

Figure 6. Autodesk BIM 360 Glue.

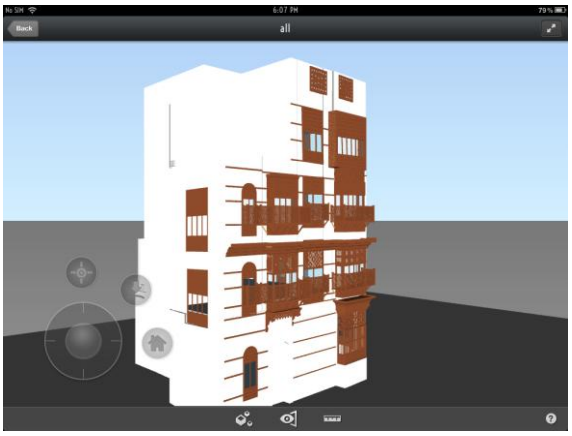

Figure 7. 3D model in BIM 360 Glue.

Figure 8. Roshan in BIM 360 Glue.

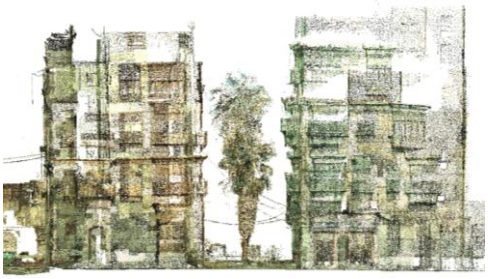

Figure 9. West Elevation from JHBIM.

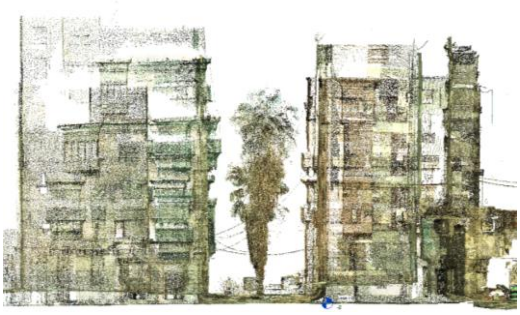

Figure 10. East Elevation from JHBIM.

Figure 11. Ground floor Outline plan from JHBIM.

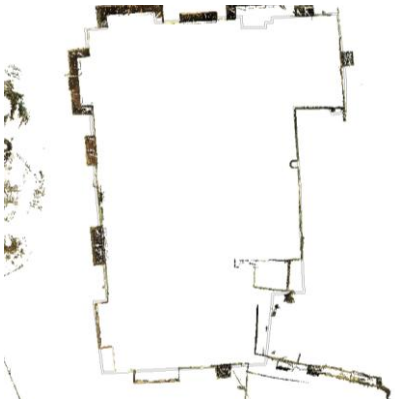

Figure 12. First floor outline plan from JHBIM.

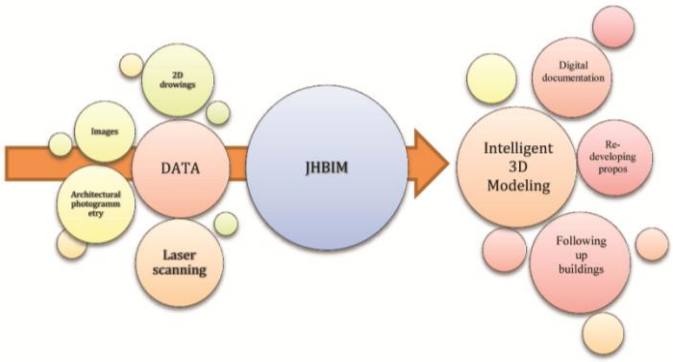

Figure 13. The approach of JHBIM.

Figure 14. Rendering South Elevation from JHBIM.

Figure 15. Rendering West Elevation from JHBIM.

4. CONCLUION

The most useful technologies and tools to serve Old Jeddah issue can be found by using geospatial technologies such as Terrestrial Laser Scanning "TLS", Remote Sensing, Global Position System "GPS" and Architectural photogrammetry. Next, these data sources will be used as input to the Jeddah Historical Building Information Modelling "JHBIM" and then analyse the outcome. Through this data we can decide which buildings need to be maintained, which cannot be maintained and which must be demolished. Furthermore, 3D models from JHBIM can enable remote reviewing of the interior and the exterior with better understanding than one shown in 2D flat drawings. Moreover, we can save time "4 D", cost "5 D" and represent reality in a few hours and more reliably than before. Furthermore, the outcome data can be used for a number of applications over time, as needed.

4.1 Limitations and Difficulties

There were many difficulties faced this research which related to the equipment, house and the historical area and here some:

1- There is just one laser-scanning device in Jeddah city and it was busy with other projects at King Abdul Aziz University.
2- The cyclone's License was not active for all laptops in Geomatics Dep. At King Abdul-Aziz University.
3- The weather was hot (35º) and max Humidity was (89%). From wunderground.com on 15 of Apr. 2013.
4- The 3D modelling needs a long time to be done in a professional way "more than one month" for just one building.

4.2 Further Work

This work should be expanded in the future to cover the other buildings and houses in Old Jeddah to form a complete documentation system. All the extracted information from the constructed 3D models, such as house structural condition and maintenance activities, can be stored in database for spatial modelling and follow-up purposes. Moreover, the system could be linked with fire systems and security systems to protect these building from the dangers. Other spatial information, related to the house system, such as road infrastructure, landmarks, hotels and other services would be entered as layers in ArcGIS for comprehensive landscape modelling. This system upon completion will be a necessary tool for all boards in the field of heritage management and urban planning, for assessment, maintenance, and monitoring of each house.

4.3 Acknowledgement

I would like to thank Prof. Sami Angawi for his corporation and the useful information about Old Jeddah in different areas. I am really thankful for Dr. Reda Yaagoubi the head of Geomatics dep. at King Abdul-Aziz University in Jeddah for his corporation and allowed me to use the Geomatics Dep. facilities.

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