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CS124555

How to Create 3D Digital Cities Using Drones

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Learning Objectives

- Learn how to evaluate different digital city types and select the best one for your project
- Learn a best practice for creating digital cities from drone-captured data
- Learn how to implement an effective workflow for big-city projects
- Learn how to apply quality checks on the generated models and make sure that they capture the reality

Description

Learn how to effectively create 3D digital cities that comply with CityGML standards using the data captured and obtained from drones with 3ds Max software, ReCap software, and AutoCAD software. We'll demonstrate real case studies of implemented digital cities developed for international clients in the Middle East. Learn which Autodesk tools we used that have already been implemented in multiple projects across the Kingdom of Saudi Arabia by FalconViz. This class will help you build an effective and reliable workflow for converting drone-captured data into an interactive digital city.

Speaker(s)

Khaled M. Abdelgawad has been in Architecture, BIM, visualization and multimedia industry for more than 14 years. After obtaining his Bachelor degree in Architecture engineering and Master degree in Information Technology specialized in Virtual Cities from Alexandria University, Egypt, he worked in multiple national and multinational companies across different industries such as Booz Allen Hamilton and King Abdullah University of Science and Technology. Now he is CAD/Multimedia Product Technical Manager in Falconviz Company one of the top 5 funded startup in Kingdom Saudi Arabia. In the last three years he was extensively

involved in innovative projects related to point cloud visualization, scan to BIM methodologies, photo realistic modeling, 2D as built based on high definition survey HDS and 3D as-built BIM modeling. Khaled will bring all his interdisciplinary technical and managerial skills and demonstrate real case studies for huge construction projects in KSA.

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Mohamed Shalaby, Education: PhD in Technical Mathematics, Johannes Kepler University, Austria Past Experience: Senior Research Scientist in the Visual Computing Center at KAUST. Software Developer in RISC Software GmbH, Austria. Postdoctoral fellow in Applied Geometry Institute at Johannes Kepler University. 20+ years in research, software development, teaching, research and industrial collaboration management. Core Expertise & Contribution: Dr. Shalaby is a Falconviz founder. He has served as VP Business Development since early 2013. Since then, he is utilizing his industrial network to build key customer relationships and improve FalconViz's market position and achieve financial growth. In addition, he works in identifying business opportunities by locating business deals; discovering and exploring opportunities. Dr. Shalaby is also co-inventor of FalconViz IP.

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Neil Smith's research over the past ten years has been in computational cultural heritage and archaeology. Prior to his current position as Research Scientist at the Visual Computing Center in KAUST, he was a postdoctoral research fellow at the California Institute of Telecommunications and Information Technology (Calit2), University of California, San Diego (UCSD). He played a critical role in developing novel software and hardware applications for archaeology and cultural heritage through Calit2's Center of Interdisciplinary Science of Art, Architecture and Archaeology (CISA3). Dr. Smith has co-founded a KSA based company called FalconViz, which provides aerial scanning and mapping services to the MENA region using drones. Since 2014, FalconViz has been involved in the scanning of all three UNESCO cultural heritage sites (Madain Saleh, Ad-diriya, and Al Balad Jeddah). Most recent work has involved placing these historic sites in VR experiences.

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Introduction

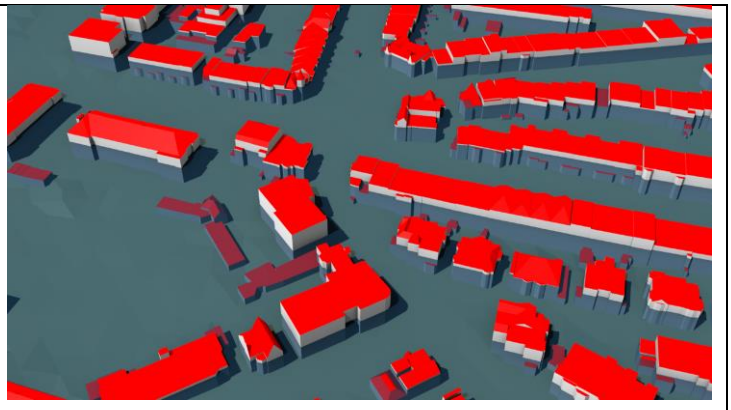
Section 1: Digital City Types

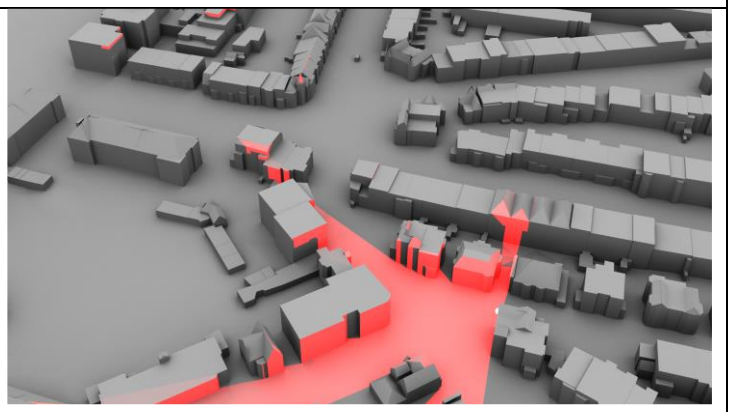
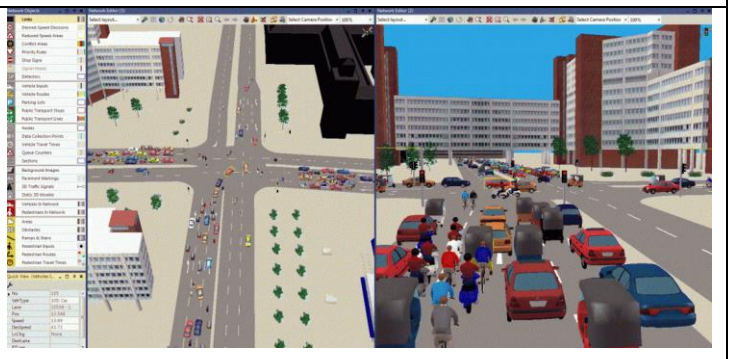
What is the digital City?

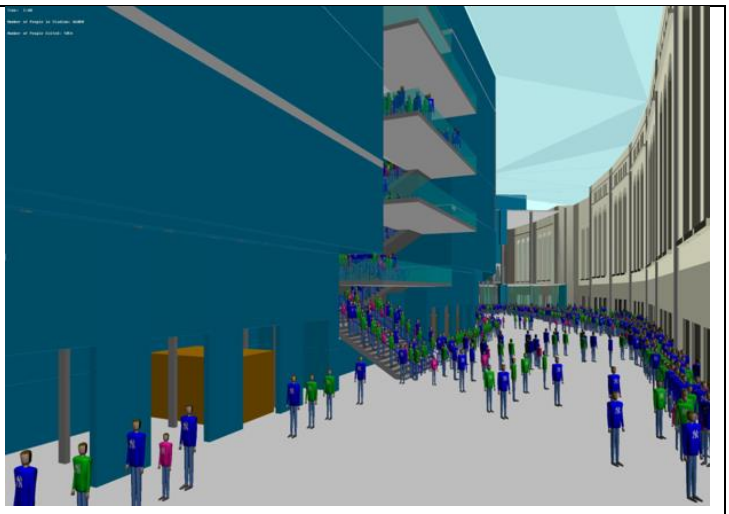
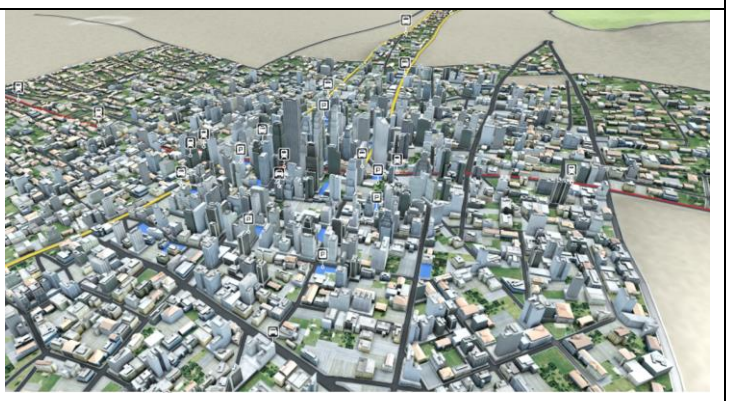
The digital city is as a comprehensive, web-based representation, or reproduction, of several aspects or functions of a specific real city, open to non-experts. The digital city has several dimensions: social, cultural, political, ideological, and also theoretical. In our lecture we are just focusing on different modeling methodologies that have been used recently to construct and develop 3D digital cities.

The 3D digital city can be defined as: A three dimensional representation (3D) of a city or an urban environment. Every city model consists of a digital elevation model (ground height) and 3D building data (building heights)

3D Digital City Applications

Flood simulation Flood simulation. Carrying out flood simulations with semantic 3D city models enables deeper insight, such as understanding which buildings and which of their storeys will be flooded in a certain disaster scenario, which is in turn useful for applications such as insurance and disaster management.	
Estimating noise pollution This is an illustration of noise from a planned tram track (red line) in an urban environment. Owing to analyses such as this one it is possible to predict how many citizens will be affected by noise if the tram line is built. This is a 3D analysis because	

noise propagates in 3D, and the analysis enables us to determine not only how many buildings are affected by excess noise pollution, but also which floors will be affected most.	
Estimation of solar energy of rooftops Several application domains benefit from this spatial analysis in which 3D city models are indispensable. For example, it enables finding optimal locations to place solar panels, and those that are susceptible to overheating.	
Visibility analysis This example showcases the use of 3D city models to predict the view from an apartment, benefiting applications such as security and mass valuation of real estate	
Traffic Planning Estimation of the propagation of noise in an urban environment	
Evacuation Planning	

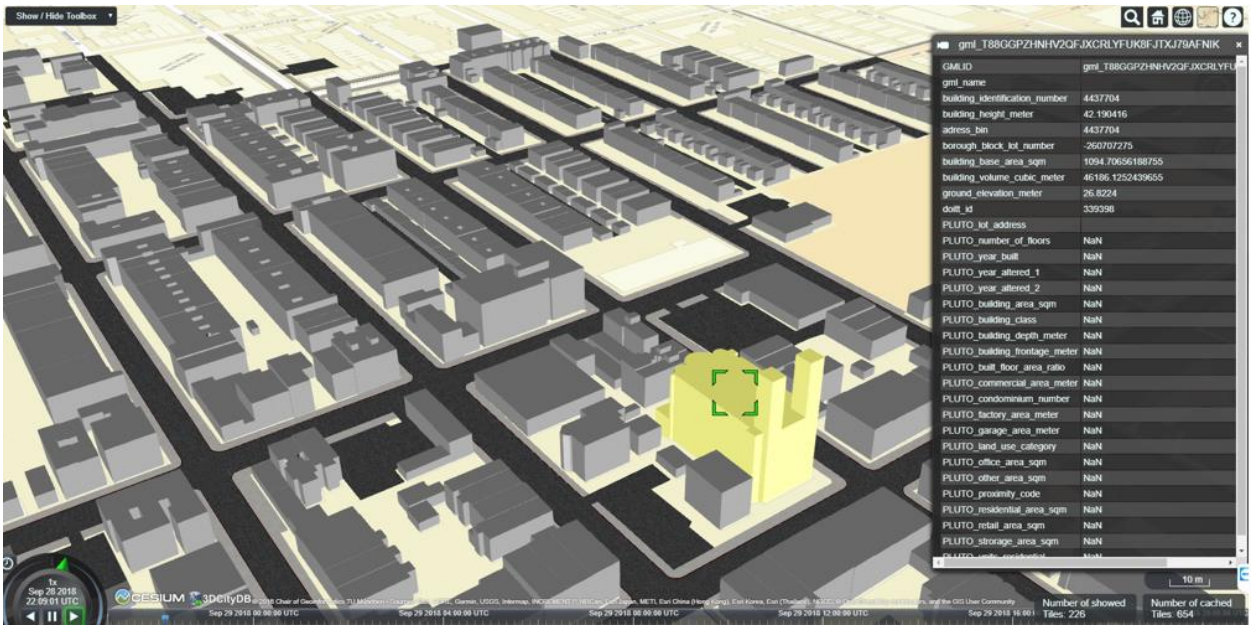
Emergency response planning on city, building, floor or interior space level.	
City Strategic Plans Testing different urban design alternatives and analyze each design implication virtually, to select the best socio-economical alternative for the city. Also, it helps in visualizing city growth and experiencing different growth strategies for the city.	

3D Digital City Types

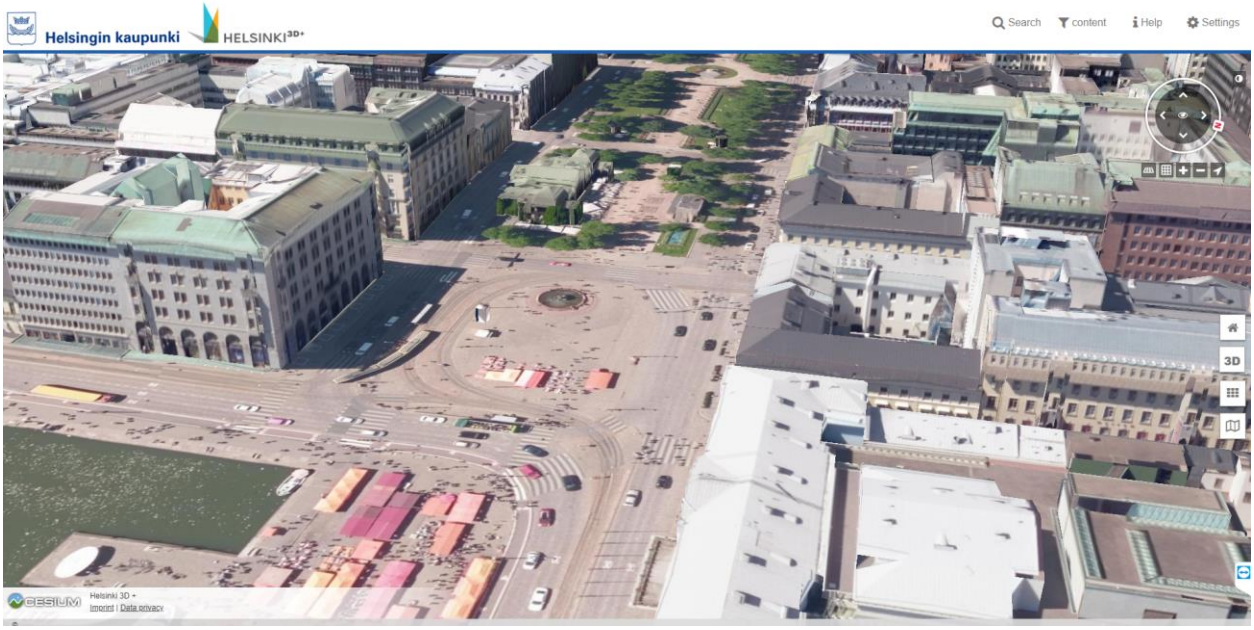
There are many types of the 3D digital cities in regards to the level of details (LoDs) of the city models. As per CityGML standard there are five LoDs types (from 0 to 4).

CityGML is an open standardised data model and exchange format to store digital 3D models of cities and landscapes. It defines ways to describe most of the common 3D features and objects found in cities (such as buildings, roads, rivers, bridges, vegetation and city furniture) and the

relationships between them. It also defines different standard levels of detail (LODs) for the 3D objects, which allows us to represent objects for different applications and purposes. For more information about CityGML standard, please check this link.

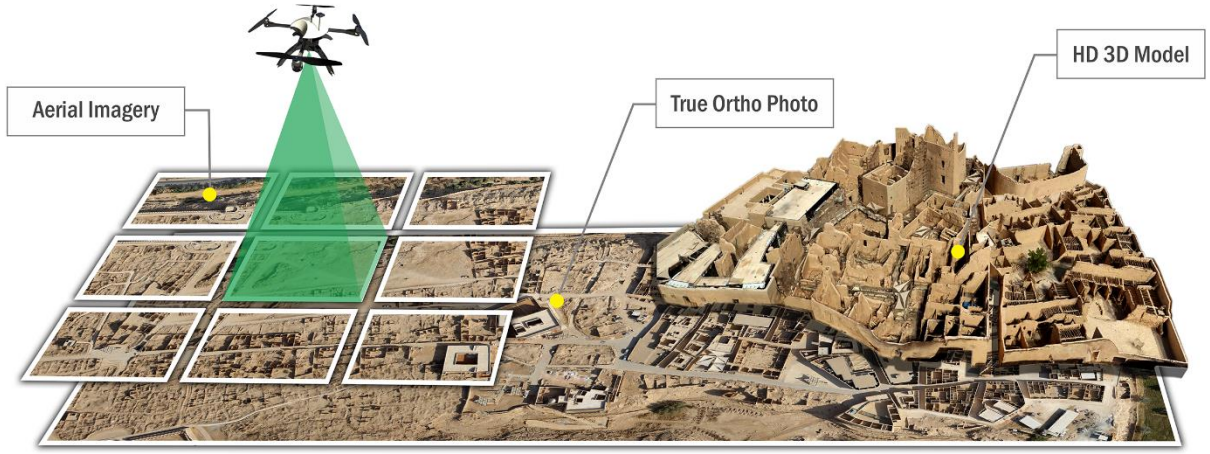


EXAMPLE OF LOD 1 3D CITY MODEL



Example of LOD 2 textured 3D City Model

Drone Based 3D Digital City



A DIAGRAM SHOWING HOW TO CONVERT DRONE CAPTURED IMAGES TO A HIGH DETAILED 3D TEXTURED MODEL

Using drones we can build an entire 3D digital city model, capturing thousands of images with specific settings, then processing all the images using a specific software that is developed based on Structure From Motion (SFM) algorithm to extract a complete textured high detailed 3D digital model. For more information about SFM, please check this link.

FalconViz Capabilities

FalconViz is the leading UAV based surveying and mapping company registered in KSA. We provide high-definition aerial and ground-based services to the Construction, Oil/Gas, and Real Estate industries who need survey grade scans of their assets. Improving upon traditional survey methods, our technology enables the acquisition of high resolution orthorectified aerial imagery, digital elevation model DEM/digital terrain model D**T**M topography, CAD drawings, and 3D models at an unprecedented quality, speed, and affordable costs.

FalconViz technology employs a fleet of unmanned fixed-wings and multirotors to rapidly and thoroughly 3D scan both expansive and congested areas such as cities, industrial complexes, and mountainous corridors.

FALCONVIZ DRONE FLEET

Recently FalconViz acquired very big clients such as Jacobs, BCG, JLL and others. We always keen to provide our clients with the best products and services as per the global standards and our established best practices.

Section 2: Falconviz Digital Cities Projects

Al Balad

Founded in 7th century C.E., the ancient town of Al-Balad served as the center of commerce and trade for the city of Jeddah. After more than 19 centuries, the ancient walls that surrounded this historic town, and the souk within, were torn down. As oil wealth flowed into Saudi Arabia, many moved out of the cramped spaces of Al-Balad, leaving its more palatial homes and buildings to slow dilapidation. What remains are exemplary vestiges of ancient building styles seldom seen elsewhere in Saudi Arabia.

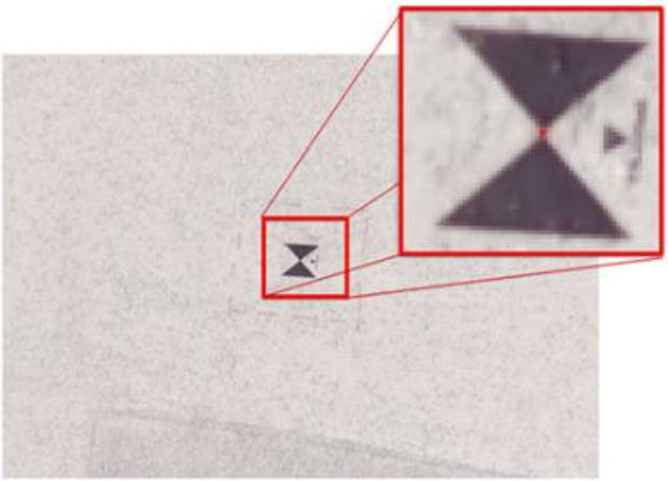
AERIAL SHOT FOR ONE AREA IN AL-BALAD

Al-Balad embodies traditional Hijazi architecture, with its unique use of cut coral stones and intricately hand-carved Rawashin protruding latticed windows. It is one of the few places left where such architectural styles can be seen first-hand, and are of intangible cultural and historical importance.

Workflow

Step 1: Pre-scanning

Traditional Mapping Markers
(Low Accuracy ~10cm, Large GSD Pixel Error)



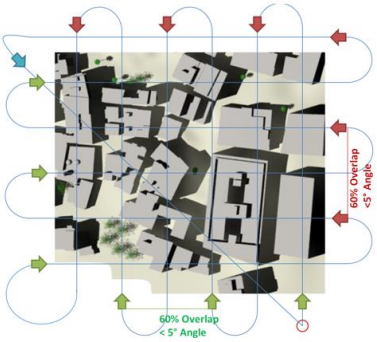
FalconViz Survey-Grade Markers
(High Accuracy 0.5cm XY, 1.0cm Z, Sub-Pixel Precision)

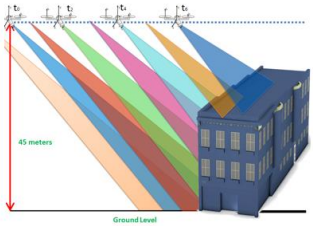
Fixing high accuracy, well distributed Ground Control Points is core to our approach. Before we go for scanning, our FalconViz geomatics engineers study the area of interest, determine the best ground control points (GCPs) distribution and stake them out using our high accuracy GNSS system to create a strong geodesic network. Unlike traditional aerial survey we use our own proprietary FV GCP markers that allow sub-pixel precision measurement and reduce sun reflectivity. Along with GCPs we also layout checkpoints to independently verify project accuracy.

During the pre-scanning stage we design the best effective flight path for our drones to make sure that we can capture and cover the whole area in less time with the maximum number of aerial images. We use our in house Mission Planning software to create redundant high overlap missions that ensure boundaries and difficult areas are sufficiently captured.

Step 2: Scanning

We strive to provide the best quality in every project. Our competitive technological advantage is the combination of our patented state-of-the-art acquisition technologies and certified highly trained team. We have a fleet of drones to handle to most difficult of projects equipped with 42mp cameras. We capture the whole area in nadir and oblique, using DJI M600 drone. We have covered the whole area of Al Balad in one day

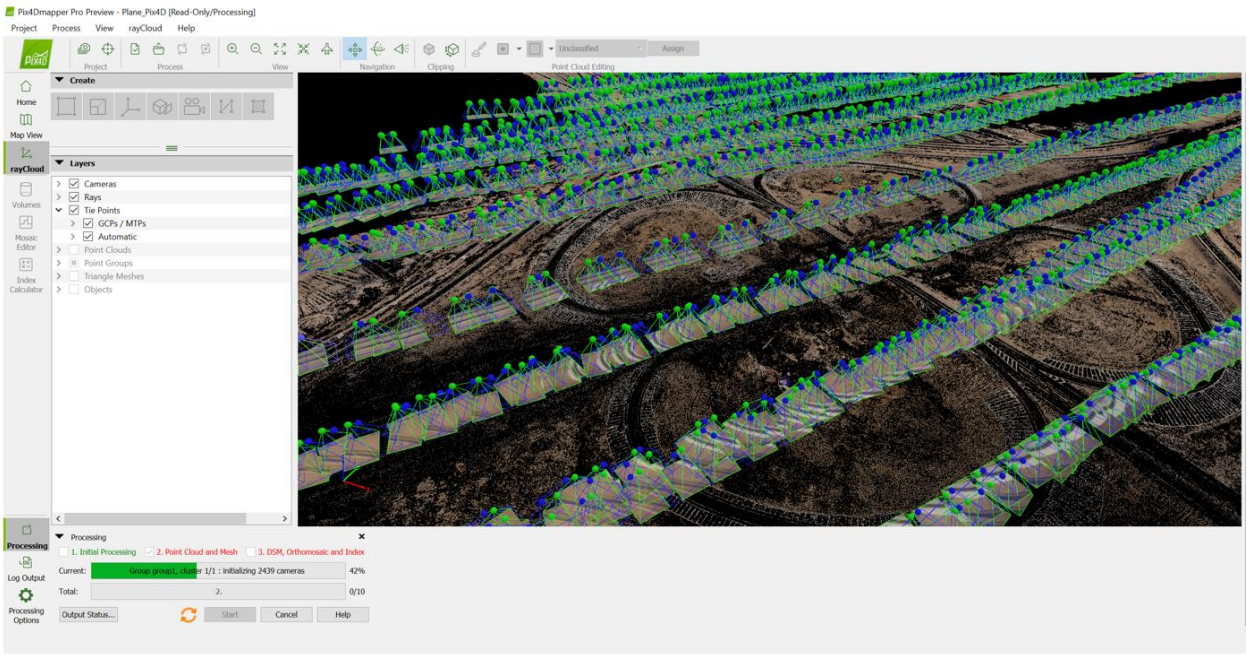




Step 3: Processing

After Scanning, we come to the processing phase, where we dedicate our super computer cluster to parallelize the dense reconstruction of the whole project area and generate initial results (e.g. Point cloud file, contour maps, orthophoto, digital terrain model DTM, and digital elevation model DEM)

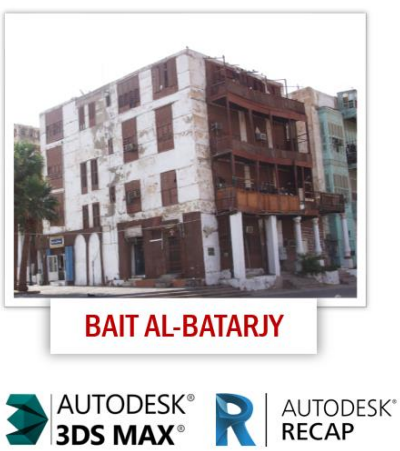
We make sure that all the captured images are meeting the quality standards. All blurry and non-sharp images should be excluded from the processing. We used Pix4D software to process the nadir images to produce true colored and georeferenced orthophoto, on the other hand we used Reality Capture software to process all the oblique images to produce the 3D textured mesh of the whole area.

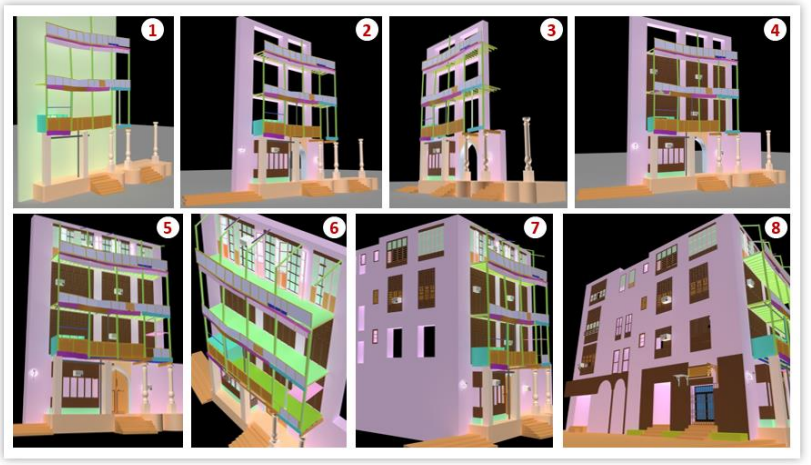


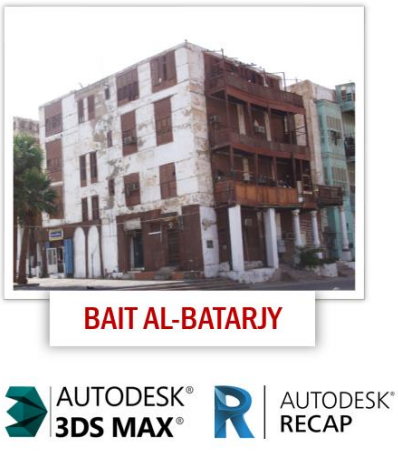
Step 4: Modeling

As the main objective of the project is to fully document the historical sites, a few buildings were selected to be 3D modeled with very high details. Here we show you two different buildings that already modeled using 3DS Max and Autodesk Recap, “Bab Jadeed” and “Bait Al Batarjy”.

For Bait Al Batarjy, it took two working weeks to finish two textured facades with very high details

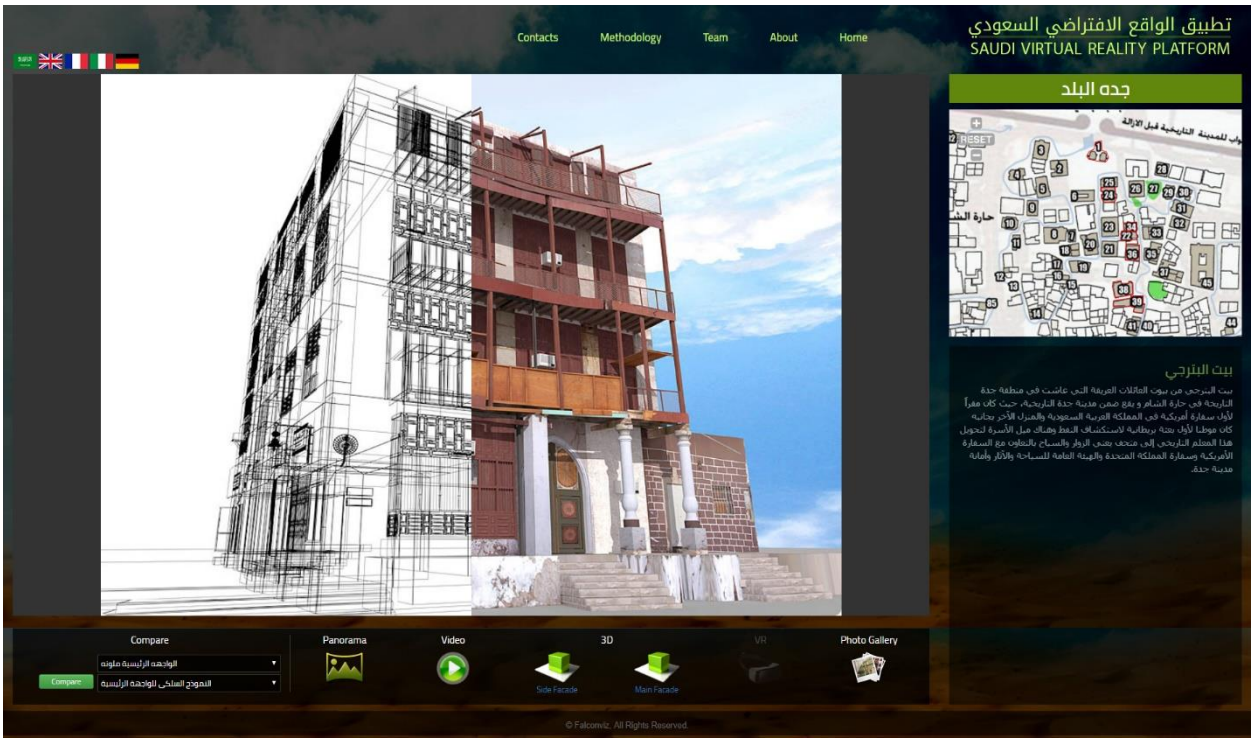






Step 5: Visualization

The final model was visualized inside Unreal Engine 4 for virtual reality application, also, we collected all the final deliverables and uploaded them to our VR web platform “Saudi Virtual Reality Platform”


Contacts
Methodology
Team
About
Home
تطبيق الواقع الافتراضي السعودي
SAUDI VIRTUAL REALITY PLATFORM
جده البلد
RESET
بيت البنرجي
بيت البنرجي من بيوت العائلات العريقة التي عاشت في منطقة جدة التاريخية في حارة الشام و يقع ضمن مدينة جدة التاريخية، حيث كان مقراً لأول سفارة أمريكية في المملكة العربية السعودية والمنزل الآخر بجانبه كان موطناً لأول بعثة بريطانية لاستكشاف النفط وهناك ميل الأسرة لتحويل هذا المعلم التاريخي إلى متحف يضم الزوار والسياح بالتعاون مع السفارة الأمريكية وسفارة المملكة المتحدة والهيئة العامة للسياحة والآثار وأمانة مدينة جدة.
Compare
Compare
Panorama
Video
3D
Side Facade
Main Facade
VR
Photo Gallery
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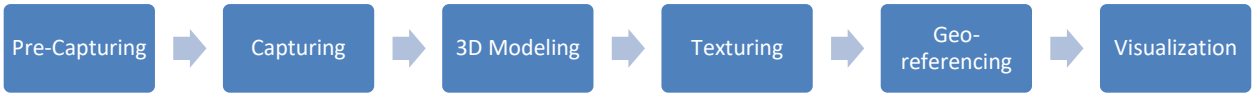
King Abdulla Economic City KAEC

The main objective of this project is to produce a 3D interactive digital map of the entire city to be used as a wayfinding and promotional tool for city visitors and potential investors.

Workflow

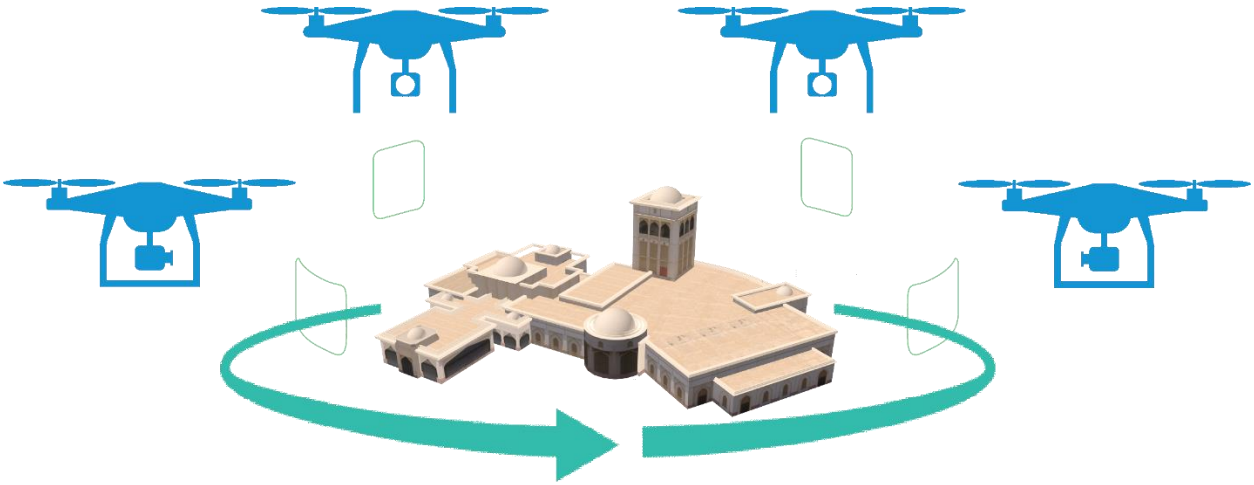


Step 1: Pre-Capturing

We have created a key map of all the unique buildings that need to be scanned with numbering system. The total unique buildings number was 21 buildings with multiple repetitions.

Step 2: Drone Capturing

We capture all buildings using DJI Inspire 2 Drone with ZENMUSE X7 Camera sensor, please check this link for more information about the used drone. For each buildings we capture an orthogonal photo for its roof and oblique images for all its facades.



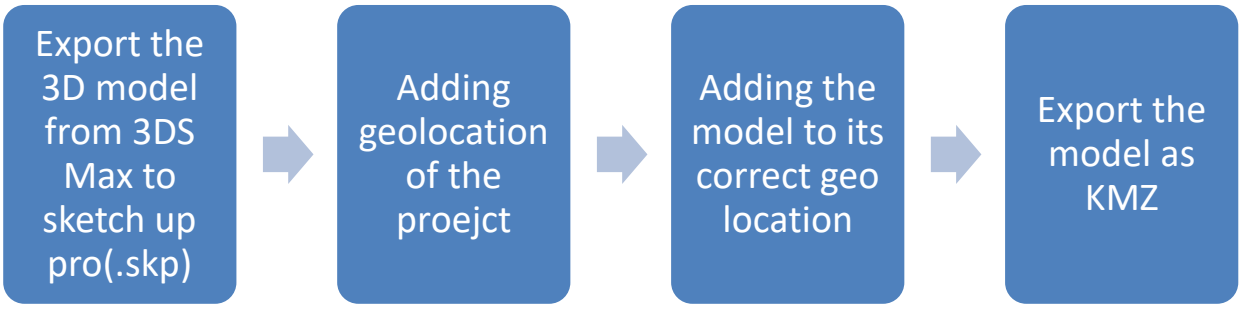
Step 3: Image based 3D Modeling

We used 3DS Max in modeling all the captured buildings. We follow the low polygon modeling technique with very sensitive polygon counts.

Step 4: Texturing

We used 3DS Max and Adobe Photoshop to fully texture all buildings. We used “Unwrap UVW Modifier” inside 3DS Max. Trying m

Step 5: Geo-referencing



Step 6: Visualization

We visualize the data on Cesium Ion, for more details, kindly check this link

References

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