Preserving the Heritage Cenotaphs with Geospatial Technology

Present by Muthukumaran Arjunan

17-Nov-2022

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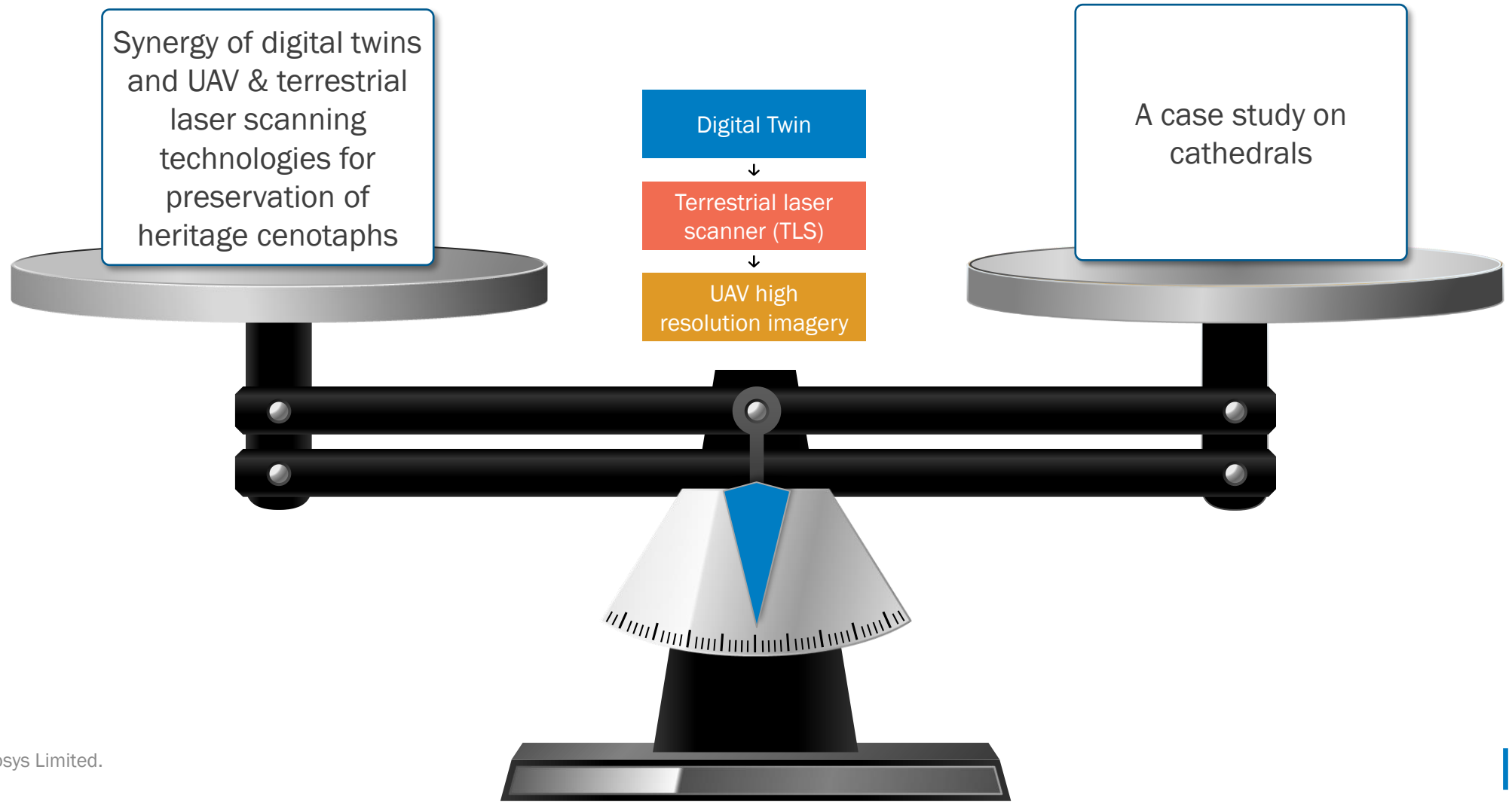


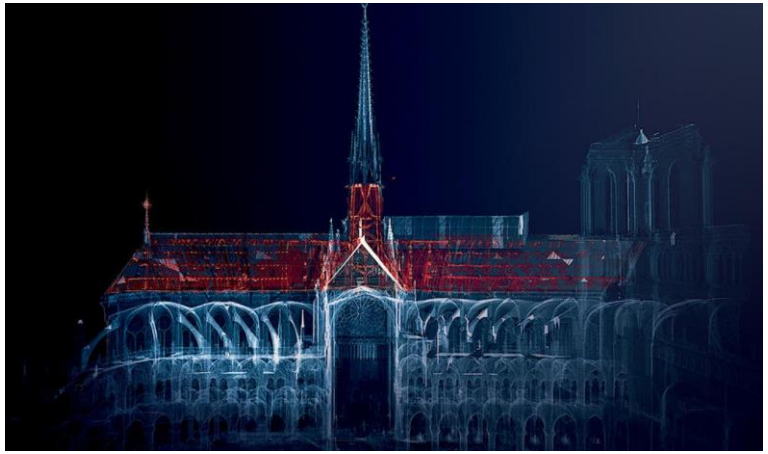
Why heritage is important

Our heritage offers hints about our past and the development of our society. It enables an awareness of ourselves by helping us reflect on our past and cultural practices. It aids in our comprehension of, and justification for, our behavior. Therefore, it is crucial to preserve historical monuments.

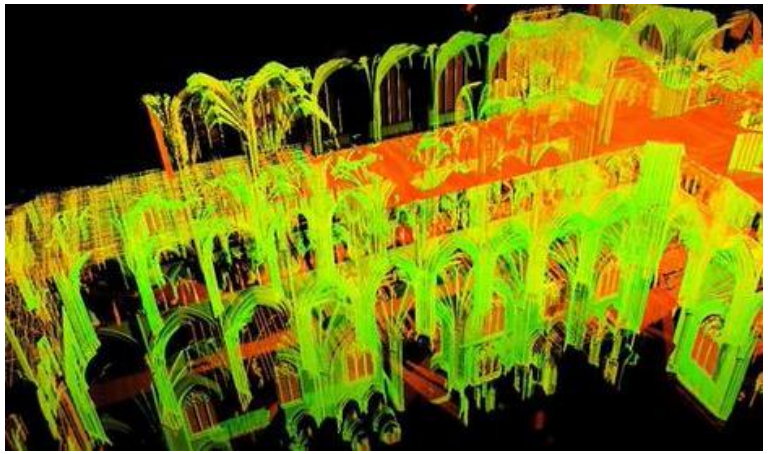
How geospatial technologies are helping to preserve historic cenotaphs – An overview

Utilizing Digital Twin, Terrestrial Laser Scanner (TLS), and UAV high resolution imagery to survey cultural monuments in great detail and with the utmost quality.

Digital Twin

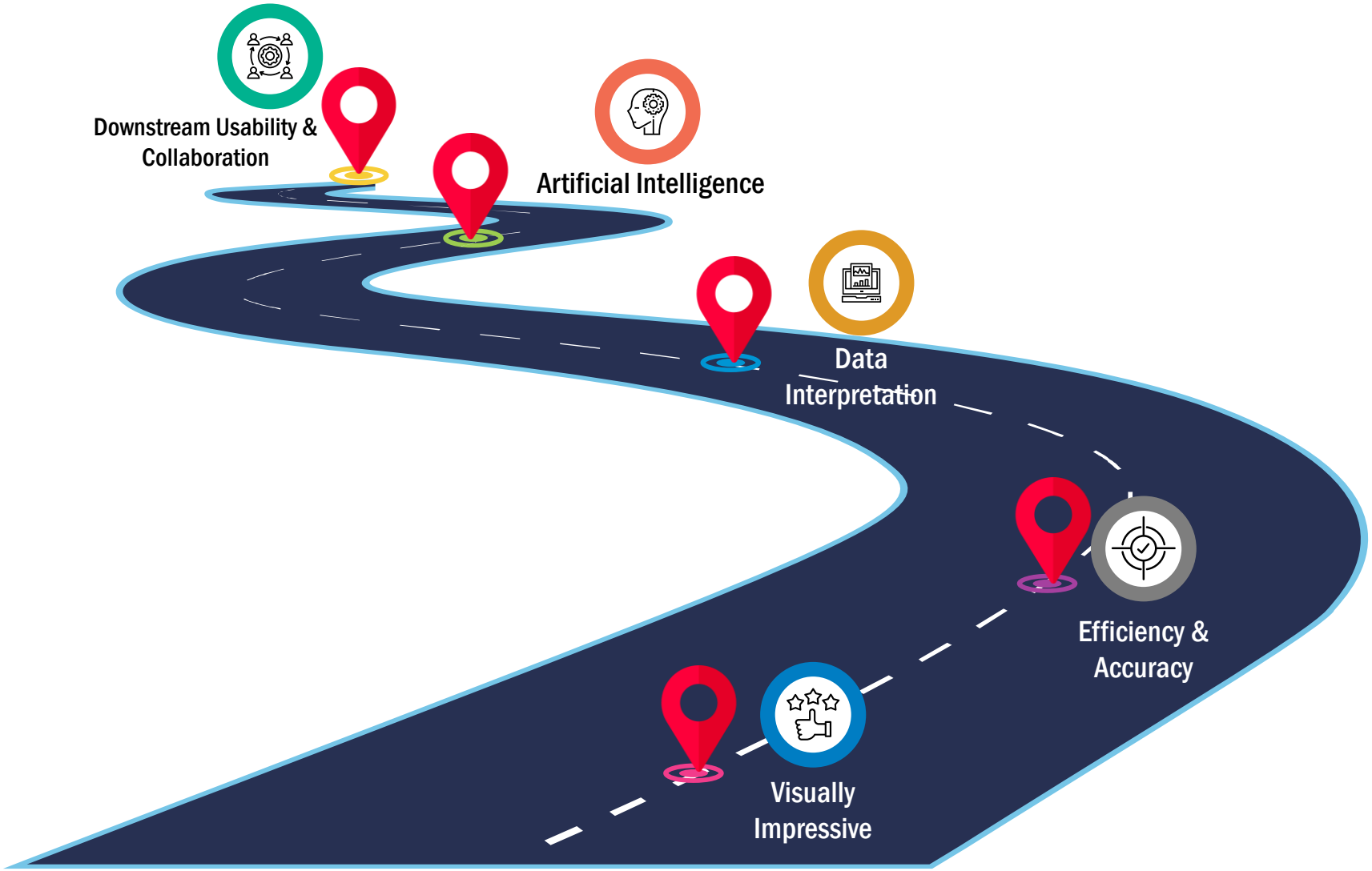


TLS



UAV IMAGERY

Synergies of Digital Twin, TLS, and UAV drones.



An overview of the three technologies

DIGITAL TWIN

- A digital twin is a visually immersive, accurate, and interactive 3D model of a real-world space.
- Digital twins are used to accurately represent the past, to observe and monitor performance, and to explore or predict the future.
- Create digital representations of the real world by using digital twins of built and natural environments.
- Digital twins can store, stream, and offer dynamic experiences to explore in 3D both the built spaces and the natural world around the assets.

TERRESTRIAL LASER SCANNER (TLS)

- TLS, also referred to as ground-based lidar, is a flexible geodetic imaging technology.
- The use of TLS is relatively new. It is widely utilized to protect monuments, buildings, etc.
- TLS instruments are very accurate and can be used for a variety of high-rise monument investigations, including meticulous mapping of weathering, cracks, and structural damage.

UAV HIGH RESOLUTION IMAGERY

- Unmanned Aerial Vehicles (UAVs), also known as drones, fly without a pilot on board and are controlled from the ground.
- UAVs can be used for researching requirements, such as monument maintenance, by collecting high-resolution imagery.
- Monument structures can be determined and combined with imagery to create 3D point clouds for better understanding of weathering, cracks, and structural damage.

Combined value proposition of the three technologies

- Frequently the only workable and cost-effective measurement method for 3D modeling of high buildings or rooftops.
- The combination of Digital Twin, TLS and UAV high-resolution imagery is logical, as they complement each other by overcoming the shortcomings of the other methods.
- TLS is more accurate but has data gaps in the higher portions, and by combination of technologies can fill every gap.
- DSM is expected to be generated almost completely with careful flight planning.
- The combination is economically advantageous and enables the creation of a dense and precise 3D model of the entire heritage monument structure.
- Future performance prediction with AI technology.
- Monitoring of operational performance for all downstream usability & collaboration.
- Fusing the technologies results in well-defined outputs and a visual design thinking approach.
- Clearly-defined information on architecture requirements of the monument structures.

Preserving heritage monuments with geospatial technology

Challenges:
While we now know much more about best practices in heritage building conservation, and our knowledge is expanding, there are still many problems to be solved.

- Repairs and maintenance of historic monuments and cathedrals
- Multiple formats of documentation, such as floor plans and blueprints

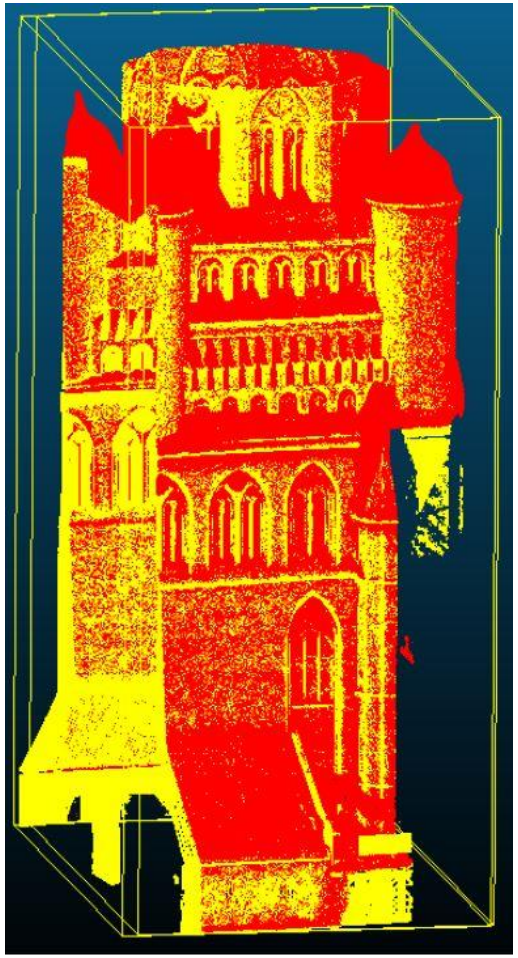
- Modification of usage
- Natural and man-made threats
- Sensitive renovation of heritage structures
- Pollution

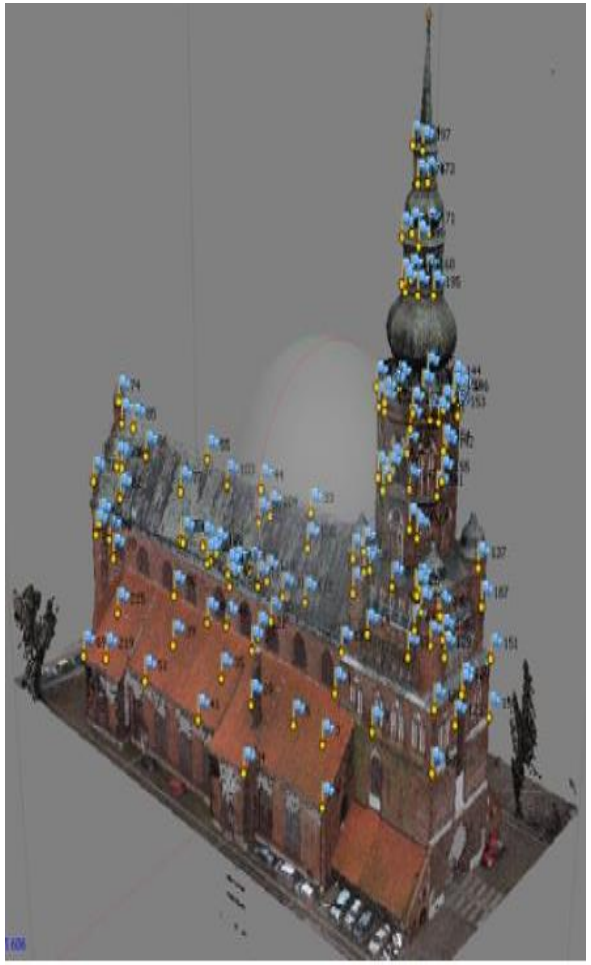
- Shortages in heritage skills
- Prevention of major problems by constantly monitoring the status of the cathedrals

- Usage of correct materials when working on these structures
- Deterioration of materials used in the exteriors
- Financing

Solution tenets

- Practical and affordable measurement of the digital twin for tall cathedrals and rooftops.
- Detailed 3D point clouds from UAV multi-image stereo high-resolution mapping.
- Use of search algorithms on a pixel-by-pixel basis to determine correlations in redundant image content.
- Identical points in multiple stereo pairs are used to create extremely dense surface digital twins.
- Creation of high-quality point clouds, esp. for brick-built tower facades and nearby naves, with very high point density and little noise.
- Accuracy comparisons using overlapping zone between TLS, UAV and a digital twin point cloud.
- Same coordinate system – output of the technologies can be easily compared.
- TLS angle and distance-based measurement method is dependent on the reflection properties of the measurement spots (affected by weathering and damaged portions). Work and material estimation can be easily calculated with this method.
- Greater accuracy is achieved by using higher image resolutions.





Benefits / Impacts

- Architects and planners benefit from quick visual inspections on demand.
- The Digital Twin model provides a valuable basis for assessing the current state to enable decisions on cathedral Maintenance.
- Dashboards and reporting on damage assessments are available.
- Use of robust statistical, machine learning (ML), deep learning (DL), and artificial intelligence (AI) techniques to analyze and make precise predictions.
- Accelerated risk assessment and real-time remote monitoring to enable better financial decision-making.
- Supports collaboration in project management tasks like upgrades, adaptations, and cleaning and replacing damaged features.
- Digital twin models can replace all documentation blueprints and other drawings. They can then be accessed as needed.
- Assisting in information exchange between collaborators, suppliers, heritage cathedral organizations, and builders.