DIGITAL DOCUMENTATION AND PRESERVATION OF HERITAGE STRUCTURE USING REVERSE ENGINEERING

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Introduction:

Heritage Structures often possess Historical, Architectural, Associative and/or Cultural Significance. These Structures need to be cared about and well preserved to keep up the legacy of the structure. The 3D model of the structure is obtained through various equipment like photogrammetry, LIDAR, Unmanned Aerial Vehicles (UAVs), Terrestrial Laser Scanner etc. Their usage has proved to be both highly accurate and time saving when compared to the traditional methods. The data obtained from them is in the form of a cloud, mesh or spatial data which helps in arriving at efficient methods for the conservation of the structure. Using spatial data, on site remains, historical sources, the structure (if partially or completely damaged) can be digitally reconstructed and it can depict the evolution of the structure over the years after being constantly subjected to various external factors. The digitally preserved structure can also be used in the virtual reality space for further applications for instance to promote tourism or creating virtual environments. Using UAVs, historic Structures can be monitored periodically to study the disintegration of the structure. Timely documentation and restoration of heritage structures is becoming the need of the hour. Heritage structures symbolizes the very existence and the thought processes of our ancestors and quite contrasting to it is Technology which is contemporary and reads well into the minds of people of the present and future. The following project involves the culmination of the values of both Heritage Structures and Technology to document the former in a digital manner and to use it for various further research purposes. Methods involving technology are also very time efficient as many structures can be accurately documented in a short span of time without much hassle. Recent technologies thus involved in this project include close range photogrammetry in both its manual and auto modes and Digital Single Lens Reflex (DSLR) photography to capture the fine details of the structure.

Objectives:

3-D Documentation of Cultural Tangible Heritage

The documentation process has been done after visiting our site i.e, the Rayagopura of Melukote. Several images from the unmanned aerial vehicle and the DSLR camera have been used.

To obtain Architectural & Planning details of the selected monument

The details have been obtained after rigorous study of the contemporary monuments and reviewing various literature. The planning details are obtained by combining the results obtained from the distometer as well as our knowledge gained from the course of civil engineering.

Digital Reconstruction of the Monument

The attempt of reconstruction has been carried out through conjectural drawing of the possible superstructure.

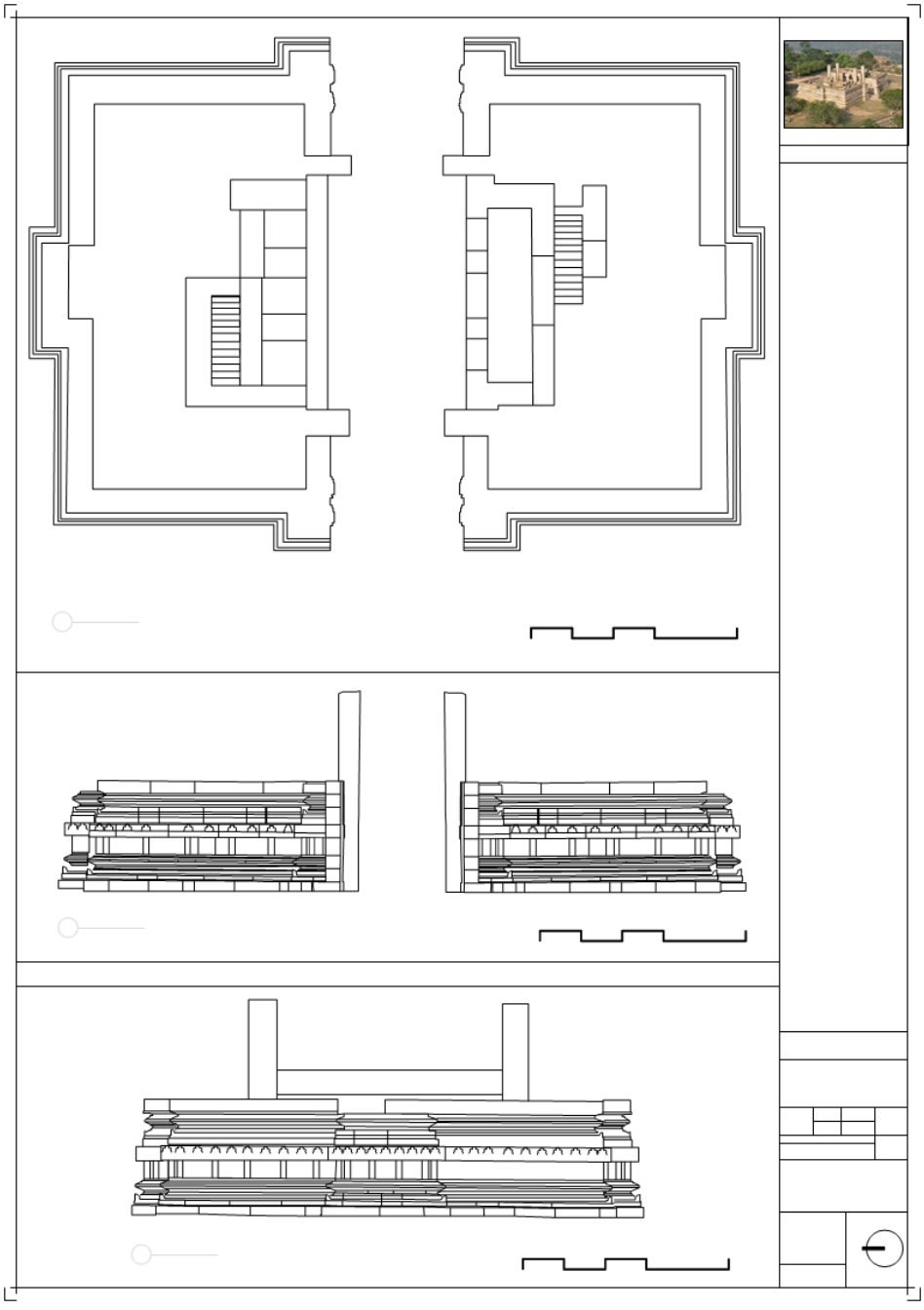
Methodology:

Examining and studying the structure was of utmost importance as a preliminary study of the structure, structures similar to the chosen structure in its form and architectural elements were studied closely to understand the comparative nature of all the structures. Preliminary plans of the structure were drafted on field with scaled down measurements and as the structure had quite a few sculptures on its pillars they were documented and drawn to scale to understand the iconographical concepts of the structure. Next, Close-Range Photogrammetry was initiated as a way to document the structure digitally. The equipment thus used in this process were a DSLR and a Drone (Aerial Vehicle).

Before attempting on documenting the main structure, smaller objects and smaller structures were documented using this method to get an understanding of the method. The first step in this method is to photograph the border of the structure using a DSLR, this is done primarily to structure the frame of the structure.

Further on detailed close-up images of all the architectural elements including the minute details of the sculptures were recorded. The images are captured continuously by maintaining an overlap of about 40% with every succeeding image. As the structure's height was beyond the reach of a DSLR mounted on a monopod in its entirety therefore a drone was used to capture the architectural elements at a height this also helped in achieving the elevation details. By the end of the process a huge data set was obtained amounting up to 4000+ images. The data set thus obtained was processed in a Free Open Source Software (FOSS) named Meshroom. An attempt was then made for conjectural restoration of the structure.

Fig: General and Interior view of the monument



Results and Conclusion:

Firstly, a preliminary set of data regarding the structure's architecture, plan and historic importance was studied and collected. After visiting the site and carrying out all the fieldwork, more than 4000 high resolution images were obtained which formed the base for the documentation process. The images were then combined and processed using softwares such as Meshroom and CADD. The result of the process was a 3D Realistic and Scaled model. Photogrammetric architectural elevations, roof plans and border framework of the structure were extracted and rasterized in Computer Aided Design and Drafting (CADD) Software. In our project ,contemporary equipment like Laser Distometer, DSLR photography cameras, CADD software have successfully replaced or have proved to be better options compared to traditional methods of tape measurement and manual drafting methods respectively.

Although the project's objective ended with the acquisition of a 3D digitalmodel of the heritage structure, the project was taken a step further by obtaining a 3D scaled down print of the digital data of the heritage structure. 3D printing is another latest technology that has been adapted into our project to document the heritage structure. The 3D digital model is used to create the print layer by layer. The most commonly used materials in the field of 3D printing include thermoplastics such as acrylonitrile butadiene styrene (ABS), metals (including powders), resins and ceramics. The scaled down 3D print model of the heritage structure gave a deeper insight and understanding into the structure's shape, dimensions and most importantly its architectural style and details.

Scope For Future Work:

The successful completion of our project consequently paves way to conduct more research in this area of preservation of our heritage structures, which is every citizen's responsibility. The documentation of these heritage structures won't just aid in the preservation of its cultureand heritage but will also advance its use in various other fields like 3D View of heritage structures to promote tourism and facilitate the tourism industry and in turn assist the economic condition of the tourism industry. The 3D digital data can also be widely used in research fields to study about the structure's architectural details and structural aspects from the comfort of one's compatible device without having to visit the structure in person repeatedly. The data can further on be used in the educational sector too, in order to impart knowledge about the structure and also increase awareness about heritage structures and the need to preserve them.

Virtual Reality (VR) and Augmented Reality (AR) are two advancements in the field of technology which can use the digital data to bring together the virtual world and the real world in contact with each other with enhanced 3D visuals. 3D and VR together make it possible to support better interpretation of cultural heritage materials because they engage more of our senses and enable interactions with digital representations that potentially engage the full range of bodily motions. The capture of 3D data is also increasingly used as a method of data collection and for the creation of digital surrogates in museums and other institutions, which bridges cultural heritage preservation and methods of scientific measurement, opening up new research, preservation, and exhibition possibilities. Most importantly the data set of the

heritage structure will be a prizedasset much like the actual heritage structure to understand and study the rich legacy of the structure it's associated with.