ASSESSMENT OF ARCHAEOLOGICAL GEOMETRY OF TUMAKURU HERITAGE MONUMENTS THROUGH ASSEMBLED AERIAL VEHICLE USING REVERSE ENGINEERING

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Background:

Our nation is home of glorious span of history, legends and heritage structures. Timely documentation and restoration of heritage structures is becoming the need of the hour. Heritage structures symbolizes every existence and the thought processes of our ancestors and quite contrasting to it is the technology which is contemporary and reads well into the minds of people of the present and future. The following project involves the values of both Heritage Structures and technology to document the archaeological features in a digital manner and to use it for various further research purposes.

Methods involving technology are also very time efficient as structures can be accurately documented in a short span of time without much hassle. Recent technologies thus involved in this project include LiDAR Technology, laser scanners, scene software, Mesh room, 3D-Point cloud, Auto CADD, Digital Single Lens Reflex (DSLR) photography and Assembled Aerial vehicle (drone) is used to capture the fine details of the structure. digital image capture can be used with the aid of a single medium range digital single lens reflex (DSLR) camera and drone, to transform two-dimensional images into three-dimensional spatial representations, and together with the use of additive manufacturing or 3D Printing technology, geometric representations of original cultural, historic and heritage artifacts can be fabricated in a process of Reverse Engineering.

The processing power of computers has increased and become more widely available, and with the use of computer software programs it is now possible to digitally combine Multiview photographs, taken from 360° camera around the object, into 3D representational virtual images. The resulting data is then reprocessed, with a secondary computer program, to produce the file (steep or stl) that the additive manufacturing machines can read, so as to produce prototype models of the original structure.

Introduction:

Heritage structures are a reminder that our history ever so glorious and expansive in its nature is gradually fading due to the improper care and preservation of these structures. History too that is not preserved or well documented loses its existence in time. So, history and heritage structures must be well preserved and done in digital manner without delaying the process.

Heritage Structures often possess Historical, Architectural, Associative and/or Cultural Significance. Tumakuru city has various heritage structures, 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 as mentioned in the above background.

The data obtained from them helps in assessing the archaeological geometric features *of the structures* for the preservation of the structure. 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.

Objective:

1. **To obtain the Archaeological features of the Tumakuru Monuments such as,**
    - Devarayana Durga, Lakshminarasinmha temple.
    - Hebbur, Varadarajeswamy temple.
    - Hiregundgal, Viragals.
    - Kaidala, Chennigaraya temple.
    - Kesturu, Veerabadra and Chokkanathaswamy temple.

The documentation process is done after visiting our site. Several images from the assembled aerial drone and the DSLR camera will be used.

2. **Assembling of Aerial Vehicle (Drone)**

Assembling of drone components with the support of the Electrical and Electronics Engineering Department, SSIT.

3. **3D Documentation of Archaeological Geometry of the selected monuments.**

By visiting the Monument detailed features study is carried using Assembled Drone, the different 3D images are captured and documented are taken to make a comparative study between them (Assembled Drone v/s DSLR).

4. **Digital Reconstruction of the Monument**

The attempt of reconstruction is to be carried out through conjectural drawing of the possible superstructure using LIDAR Technology and suitable software such as scene software, magic studio, mesh room, 3D Point-cloud, Auto CADD.

Methodology:

The following stages are involved in this study refer Figure.1 by conducting the literature study it is found that Archeological Geometry of Heritages are vital important to preserve the rich Heritage for our future generation. The study involves, Historical, Architectural and cultural significance. Hence in this study different Heritage structure are considered to make Digital Documentation of Archeological Geometry by creating drone as shown in Figure.2 to capture images. The different softwares will be used to reconstruct the 3D model using Reverse Engineering. Examining and studying the temple is of utmost importance as a preliminary study of the structure.Next, various advanced software's is initiated as a way to document the structure digitally. The equipment thus used in this process are a 360 degree camera, DSLR and a Drone (Aerial Vehicle). Before attempting on documenting the kaidala chennakeshava temple, smaller objects (kubera idol) are documented using this method to get an understanding of the method.The first step in this method is to photograph the border of the temple using a DSLR, this is done primarily to the frame of the temple. Further on detailed close-up images of all the architectural elements including the minute details of the sculptures are recorded using 360 degree camera. As the structure's height is beyond the reach of a DSLR mounted on a tripod in its entirety therefore a drone is 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 is obtained. An attempt is then made for conjectural restoration of the structure.

Our project's objective was ended with the acquisition of a 3D digital reconstruction output of the kaidala temple. our project was taken a step further by obtaining a 3D scaled down print of the digital data of the kaidala chennakeshava temple.

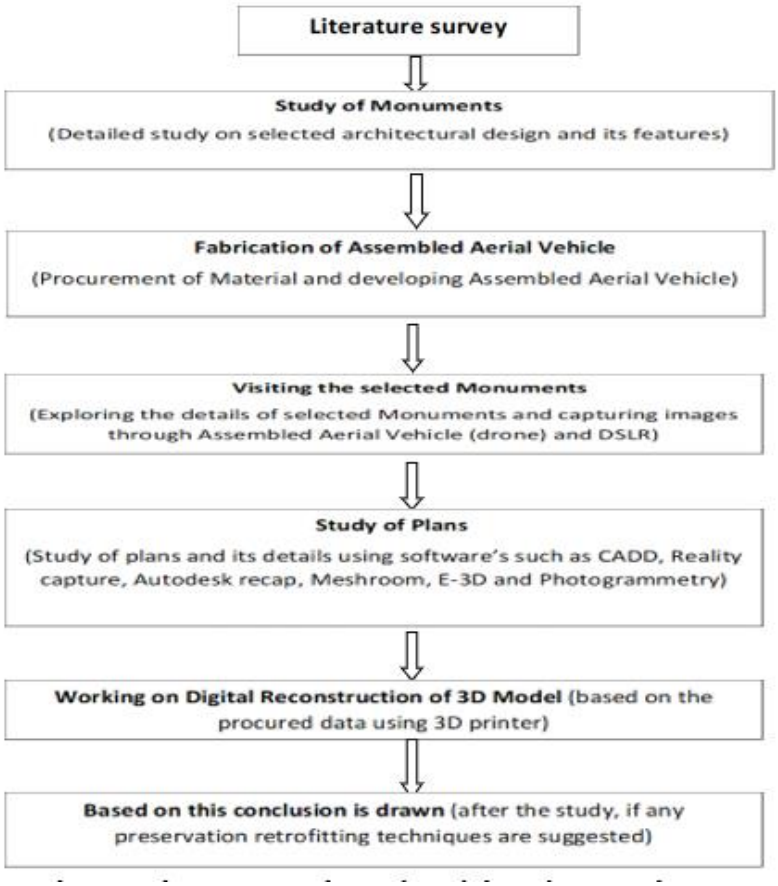

Figure.1 stages involved in our project

The following Figure 2. is the Assembled Aerial vehicle.

Figure.2 Assembled Aerial Vehicle

Methodology Involved in Various Software:

Following Figure.3 is the flowchart of the various software used in project.

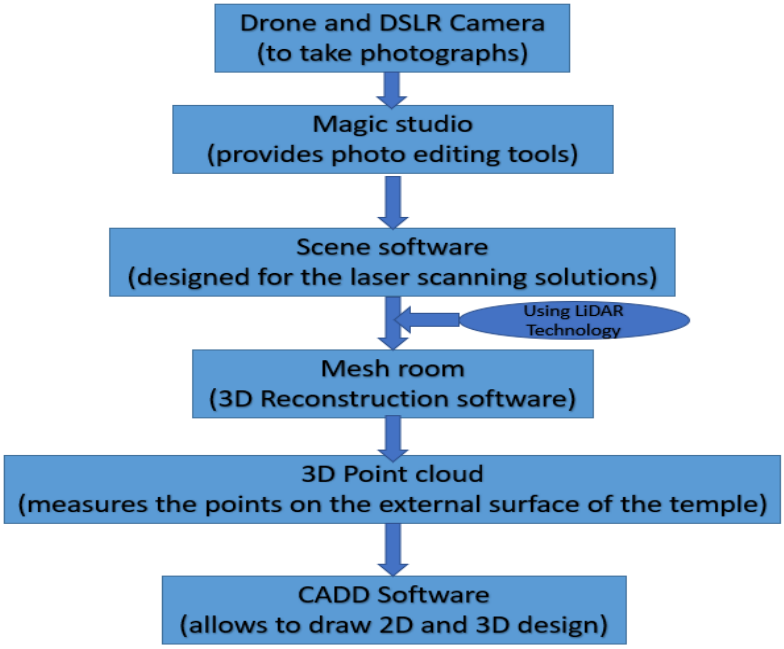

Figure.3 Flowchart of various Software

The first step in this method is to photograph the border of the temple using a DSLR, this is done primarily to the frame of the temple. Further on detailed close-up images of all the architectural elements including the minute details of the sculptures are recorded using 360

degree camera. As the structure's height is beyond the reach of a DSLR mounted on a tripod in its entirety therefore a drone is used to capture the architectural elements at a height, this also helped in achieving the elevation details. Then captured images were edited using magic studio software (if required). The scene software is used which is designed for the laser scanning solutions with the help of experts, this software process and manage scanned data in real time and positioning using LiDAR technology. Next, several scanned 2D images are meshed using mesh room software for 3D reconstruction. Then this data is processed using 3D point Cloud software which measures many points on the surface of the temple. The Auto CADD plan is drawn to the scale. By the end of the process a huge data set is obtained. So An attempt is then made for conjectural restoration of the structure.

Result:

1) 3D Reconstruction of the temple will be achieved using Mesh room software.
2) An Archaeological Geometric feature of the temple will be recorded, measured and documented using 3D point cloud software.
3) An Auto CADD plan of the Heritage structure will be drawn to the scale.

Conclusions

The conclusion of our project is as follows:

- **Innovation:** The Archaeological study of our heritage of Tumakuru monuments, technology involved, History, and features of the monuments are thoroughly studied.
- **Societal contribution:** Through available technology the preservation techniques and reconstruction of monuments is suggested (if any). The current status of the monuments is digitally documented for the Public**.**
- **Technology Adopted:** Assembled Aerial Vehicle constructed by the project team is used. An attempt of Reconstruction to be carried out by using LIDAR Technology, through conjectural drawing of the possible superstructure using suitable software such as magic studio, scene software, Mesh room, 3D Point cloud, Auto CADD.
- **Justified Cost Effectiveness:** To reduce the cost of the Drone(Purchased) the team was engaged in learning technology and constructing of drone, and made a low-cost drone.

Innovation

- The Archaeological study of our heritage of Tumakuru monuments, technology involved, History, and features of the monuments are thoroughly studied.

Scope of future work

- The Historical, Architectural and cultural significance of Chennakeshava temple and its Archaeological Geometry is Digitally Documented.
- Usage of LIDAR Technology and advance software's such as magic studio, scene software, Mesh room, 3D Point cloud, Auto CADD, DSLR photography, Aerial Drone are understood clearly.
- The Technology involved in fabrication and Assembling of Drone was learnt through interdisciplinary Engineering techniques.
- The data procured under this study is provided to the Department of Archaeological survey, Government of Karnataka.
- The Documentation of Archaeological Geometric features helps to the public and tourism in preserving our rich heritage for future.
- The Monument is digitally reconstructed (3D Model) and the current status of our rich heritage kaidala chennakeshava Temple of Tumakuru is popularised through this study.