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Virtual Reality Modelling for 18th Century Peshwa Period Cityscape of Pune

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Abstract: Archaeological research involves the study of material culture. History, on the other hand, is built based on the documented evidence from the past. The synthesis of both sheds light on the past human societies and associated landscapes. Most of the time, the excavated remains and textual corroboration are insufficient to rebuild the cultural and historical values for the society at large. As a result, data and its analysis remain restricted in the realms of academia. While this is still relevant to the masses, they cannot connect with it using traditional means of expression such as text, images or physical exhibits in rare cases.

In this paper, we attempt to connect common people with academic research using virtual reality as a medium of expression. VR enables people to relate themselves to the historic landscape and experience it as it could have been. The present project describes the process and results of VR modelling prototype for the medieval city of Pune. A small village situated on a confluence of rivers Mula and Mutha emerged as the capital of the Peshwas empire in the 18th century. For the first time, they developed it as a capital with detailed attention to local amenities and city layouts. The VR model of medieval Pune is a virtual tour of the past.

Keywords: *Heritage, History, Modelling, Pune, Virtual Reality*

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Introduction

In the last few decades, digital data is being extensively used at various stages of heritage conservation work. The traditional methods of physical restorations and reconstructions have been benefited by the digital format and associated technology to an extent, that the entire monument or structure can now be virtually reconstructed in the digital space. Thus, the variety of limitations encountered during physical conservation are being handled effectively and efficiently than before. Such digitization has opened avenues where close-to-real reconstruction of structural complexes and landscapes can be

created in the digital format using information derived from literature, excavations, existing structures, and historic accounts. At times, these digital reconstruction processes and their results have provided inputs for the physical conservation efforts. In this paper, we attempt to reconstruct a part of a historic city in India through Virtual Reality - VR technology, built on top of mapping and 3D modelling. The paper describes the process and results of VR modelling for the medieval city of Pune. Pune, A small village, situated on a confluence of rivers Mula and Mutha on the Deccan plateau, emerged as the capital of Peshwa empire in the 18th century. They developed it as a capital with detail attention to local amenities and city layouts. The VR model of part of historic Pune is a prototype for virtual reconstruction and its applications in multiple domains, especially those of heritage and culture, tourism, archaeology, and so on.

VR enables people to relate themselves to the historic landscape and experience it as it was. Hence this paper aims to connect common people with academic research using VR as a medium of expression.

Conceptualisation

Archaeological research involves the study of material culture. History, on the other hand, is built based on the documented evidence from the past. The synthesis of both sheds light on the past human societies and associated landscapes. Most of the times, the excavated remains and textual corroboration are insufficient to rebuild the cultural and historical values that the common people can realise. While this is still relevant to the masses, they cannot completely relate with it using traditional means of expression such as text, images, or physical exhibits in some cases. As a result, the study remains restricted in the realms of academia. The philosophical question of 'research for whom' has thus become a daunting one and in need of urgent attention.

In this situation, digital media is a rational choice to bridge the gap. Both digital data and their respective devices have become ubiquitous in the present-day world. Prototyping of the VR model is based on utilising their capability for heritage education and appreciations.

The task of digital conservation of local heritage is challenging because the information is often available in unorganised forms such as folklores, local history, old books, maps and collective social memory. Also, it undergoes continuous change. Besides a few glamourous examples which pass the test of time, digital reconstruction of local heritage is rare in most parts of the world, often because of the lack of material or literary evidence, lack of funding, or local administrative lethargy. In many instances, heritage sites or structures have completely vanished with urbanisation. Our current work is an effort to collate this information from diverse sources and bring it to people in the form of VR for them to experience the lost heritage.

Mobile phones, especially smartphones, have an important role to play in this situation because they create, deliver, and transform a variety of data. This electronic device, now acting like a gadget, functions beyond the basic need of communication. Because of the ease of programming these platforms and the rich user experience possible with them, mobile applications have been transformed from simple-minded gaming or content delivery platforms to encompass complete content creation platforms, too.

Data Creation

The creation of a digital spatial dataset of a historic landscape is a key in the present piece of work. 3D modelling and VR is rooted in accurate mapping of the city as it was in the 18th century. Maps created by the British officers at the beginning of the colonial period and the historic descriptions and survey

report created by the native enthusiast scholars form the basis for spatial data creation in the present paper.

Bharat Itihas Samshodhan Mandal (BISM), Pune (India) based organisation established for historical research, has published a set of survey reports titled Pune Nagar Samshodhan Vrutta (PNSV Vol. 1-4) during 1943-52. The British took control of the city in 1818, marking the end of Peshwa rule. So the PNSV survey was carried out 125 years after the political shift to the British. A group of committed citizens voluntarily undertook a detailed survey of the city of Pune around this sensitive period of Indian independence. They aimed to document the remains of the Peshwa's capital which had undergone quite a few modifications during the colonial period. The level of detail and the method of describing features along the roads have immensely helped this project locate these features. Today, most of these structures and their details exist only in the text or social memory.

Historic maps were acquired from various sources such as Maharashtra State Archives' office in Mumbai (Poona City Survey, 1876), BISM museum (Light, 1869-1872), Pune (both in Maharashtra), British Library, London (UK), and few more published in the Gazetteer of the Bombay Presidency (1885). Following the standard georeferencing procedure, important places and roads identified on the physical maps were captured in digital format (Gokhale, 2018; in-press). These were used as references to locate other places by correlating textual references and maps, resolving conflicting information, performing field verification and discussions with local residents. The description of some of these places with reference to nearby temples, Wadas, cisterns, etc., from PNSV volumes and other texts helped populate the spatial data. The entire exercise was carried out using QGIS and its plugins (QGIS, 2016). The sample of digitised maps can be seen in **Fig. 1.**

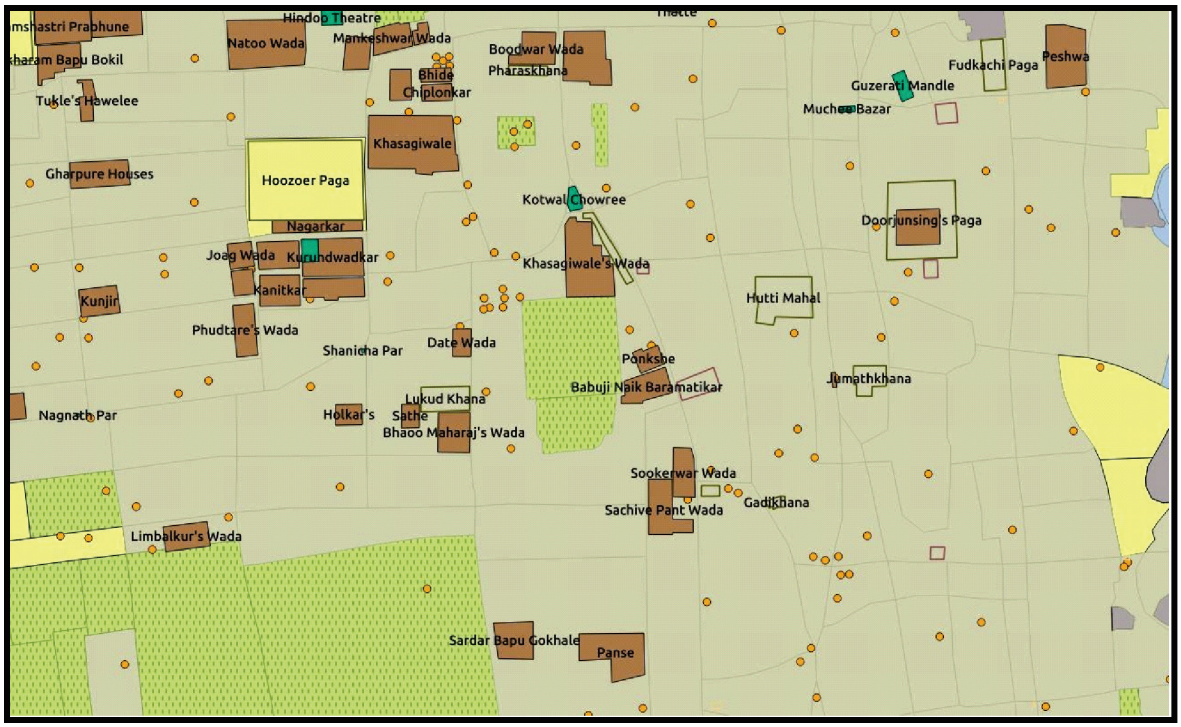

Figure 1: Part of digital map of historic Pune

Digital 3D Modelling

A small portion of the historic map was selected for building a 3D model. Structures like cisterns, wells, temples, administrative offices, Wadas, and areas like public places, gardens, and neighborhoods from

the old city were studied based on old photographs and textual references. A previous work by Gokhale and Deo (2016) in this regard established the reliability of this digital geospatial data for mapping exercises in historic studies. 3D models of these were then recreated using Sketchup (SketchUp Make 2017 User, formerly Google Sketchup). Architectural details of these structures were captured from fieldwork and other literature. To reconstruct the exact structures and features of the period, the models were created with similar materials and colours used for the structures in contemporary times. While building these models, only one generalised typical example of the structure was used. For example, various types of Wada structures were built in Medieval times. There were Wadas with the ground floor only or with few more additional floors above it, or with variations in the layout and planning. As a representative, only one typical layout was selected for recreating the Wada structure. Similar is the case with the other structure like administrative offices, temples, wells, etc.

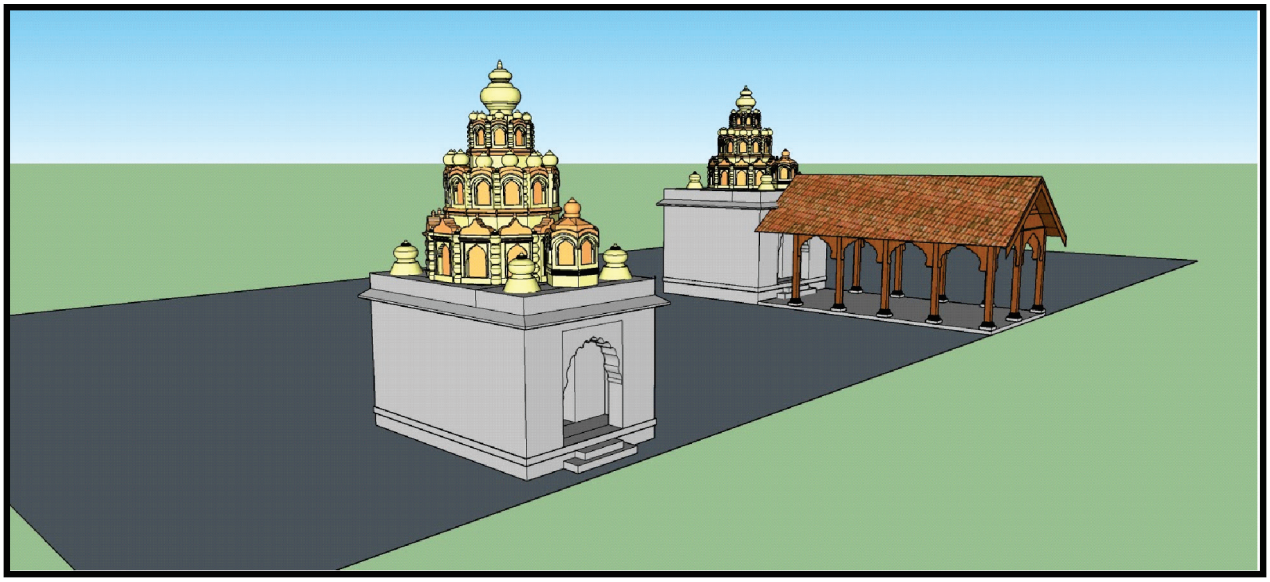

Figure 2: 3D digital model of typical Peshwa period temple

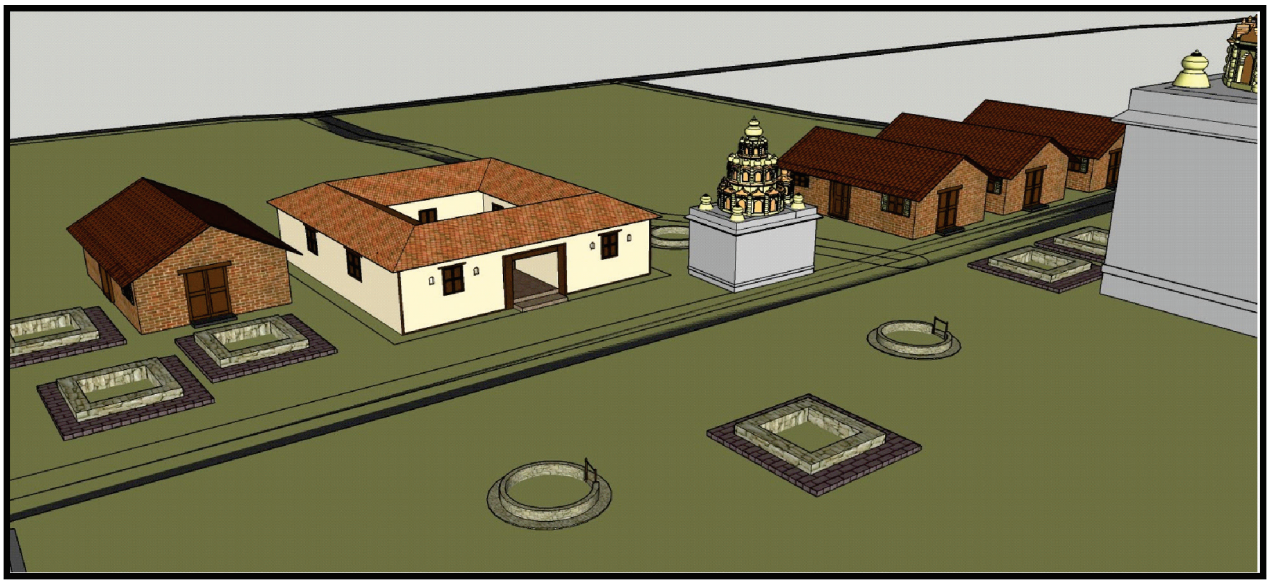

Figure 3: 3D digital models places as per historic map

In the case of temples, a number of temples were located on the map. These temples were of typical Peshwa-style architecture. However, various alterations and additions were observed, including new

structures being built in and around these temple complexes. Therefore, to create a temple model, a typical simpler form was adapted from the subsidiary shrines within the Tulshibaug temple complex. Similar to *Wadas*, various layouts were observed in this case. Hence, a typical layout of a temple with a *Gabhara* and semi-open mandap was created for this visualisation. These generalisations used for the built forms can be attributed to the prototype nature of this work and the main aim of establishing the workflow and feasibility of such exercise. Once both these are successfully established, even complex and varied forms can be incorporated for more realistic representation.

Fig. 2 depicts these 3D digital models built in SketchUp. These 3D digital models of the structures were then placed on the specific locations with varied orientations as per the city layout interpreted from the map, assisted with ground survey. Roads, gardens were added as land cover features. **Fig. 3** shows a part of the map populated using these models.

For the realistic representation, trees were added in some locations. Due to the destruction in the urbanisation process, most places have no trace of the original structure. Temples seem to survive in the majority. In such cases, artistic liberty is taken to recreate the structure. However, this creativity is contained by the historic records and academic discretion.

VR Creation

By definition, Virtual reality means 'an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment' (Merriam-Webster dictionary – online version). This means that if converted into an artificial environment, the 3D digital historic landscape could be traversed using VR.

Once the 3D models were built in Sketchup, some online VR conversion tools were evaluated for building a prototype. A tool named Modelo was selected because of ease of use, flexible data exchange formats and useful featureset. The layered information from map and 3D models was converted into various virtual layers of houses, temples, roads, wells etc., in the VR model. The tool allowed to create views of the scene from different viewpoints. The light and shadow effects could be introduced depending on the place and time, giving the veristic effect.

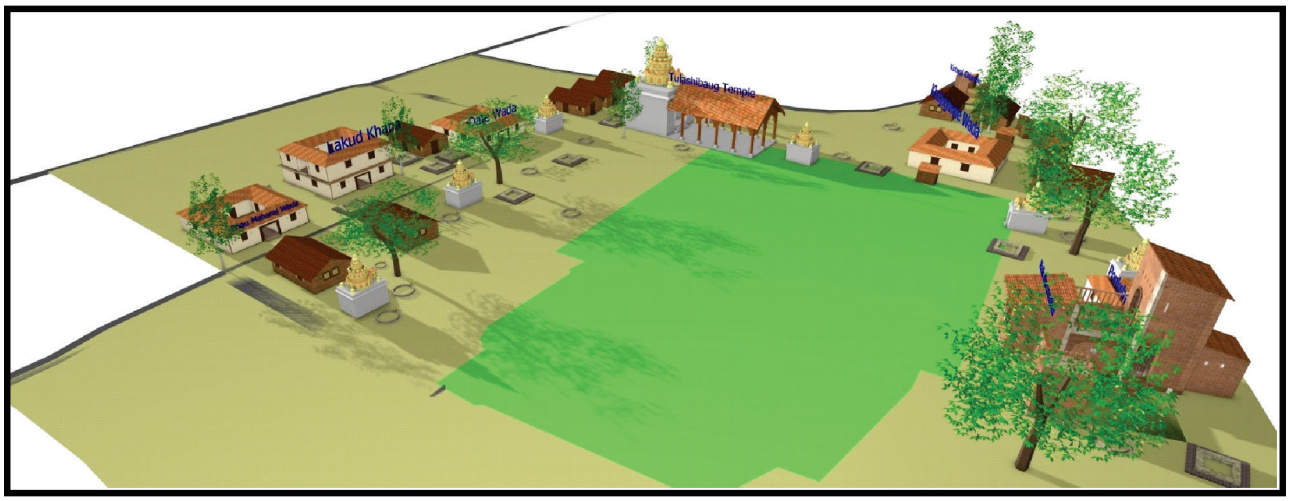

Figure 4: Top-view of the 3D digital model of part of historic city

Fig. 4 shows the top-view of the scene where as **Fig. 5** is a view from an oblique angle looking westwards to Tulashibaug temple.

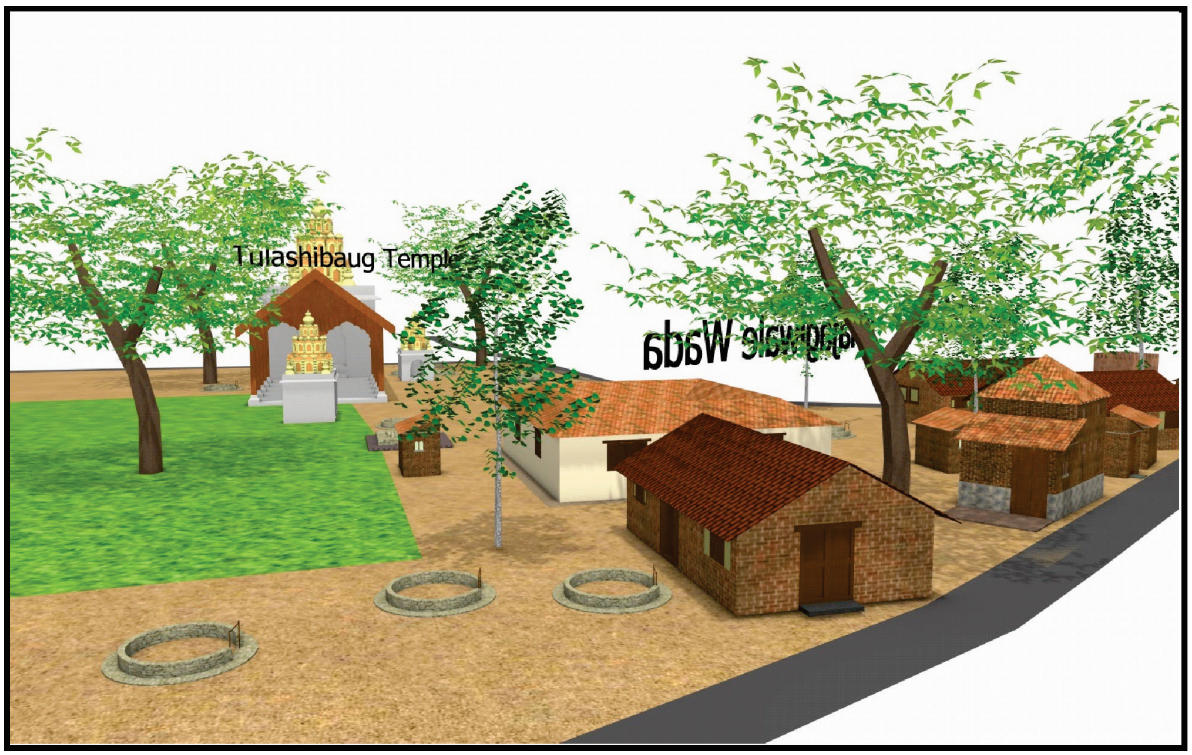

Figure 5: Westward view from an oblique angle towards Tulashibaug temple

Since the model was built in 3D space, the tool allowed creation of a virtual walk, in this case a Virtual Heritage Walk for experiencing the landscape in it's true sense, as seen in **Fig. 6**.

Figure 6: Virtual Heritage Walk -
Blue circle and line on the left side is the location and direction of viewing seen on the right side

This model was later rendered in a smartphone and the VR mode was enabled. This converted the viewer into VR mode by creating dual screens of the scene. Pair of images was seen, which appeared to be the exact same thing. The images seen were designed specifically to work with the lenses that come with VR accessory.

Once enabled, the smartphone was slipped into a Google Cardboard, which was a VR accessory in our case. Inside the VR accessory, there is a pair of Biconvex lenses, which is what takes the images on display and warps them to fill the field of view. The eyes perceive these individual images as a single image. This creates the illusion of depth through stereoscopy.

By wearing the headgear on our eyes, we could see and 'experience' as being part of the historic landscape, surrounded by *Wadas*, temples, wells, houses, and trees. As we virtually moved around, the 3D views seen through the VR changed accordingly and provided a seamless, true-to-life illustration of the surroundings. A sense of motion and position to the VR App is provided by the accelerometer and gyroscope in the smartphone, allowing the user to tilt head and even spin around completely to have 360 degree view of the virtually created world. However, this experience is fixed, and user can't walk around to experience the virtual world around in the present case study. **Fig. 7** and **Fig. 8** depict the VR views.

Figure 7: VR model as seen through the mobile - View 1

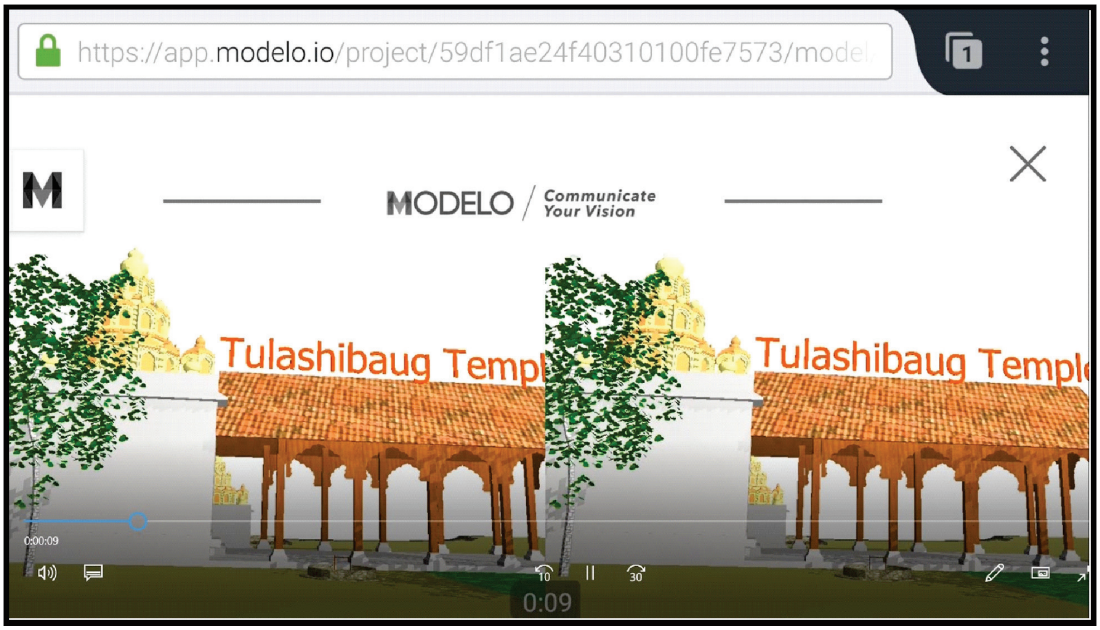

Figure 8: VR model as seen through the mobile - View 2

To introduce informative VR view, a small video was captured of the scenes as seen through the VR accessory describing the features seen from a particular viewpoint. It is hosted at https://youtu.be/48cAAG0CE5g.

Conclusion

Beyond the amazement of the VR experience and the technological marvel, we, as students of cultural and archaeological studies, realise the power it encompasses. Beyond connecting to the public at large, which was the major aim of this study, we learn that such exercises can also help build the context of academic studies. Creating layers of abstraction on top of geospatial data and then visualizing it via a VR-like medium may provide tools for investigative research. For example, looking at locations of religious places in the past, their areas of influence and settlement patterns within the city may help understand if these places were of only religious significance or were rather social gathering platforms for the native population irrespective of their ideological believes. Building abstract surroundings quantifying such societal characteristics can provide insights into the internal workings of the population, their connectedness, and boundaries in terms of their believes and thought processes.

Acknowledgment

This VR prototype was presented and demonstrated at the Joint Annual Conference of IAS, ISPQS & HCS, held at BHU, the Department of AIHC & Archaeology, during November 2017. The demo was seen and experienced by noted historians, archaeologists, academics and museum researchers. The feedback was very positive and encouraged us to write this paper, establishing the feasibility, applicability and process. Its probable use cases in the fields of museums, tourism industry, advertising were discussed. It is evident that there is ample scope to improve and build better VR models for historic studies, heritage appreciation, and digital conservation itself.

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