

Visualizing the Lost Script of South Asia Under the Umbrella of the Digital Humanities Tool-VisualEye

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ABSTRACT

Brahmi Script is one of the earliest scripts known to India and South Asia and it is also an ancestral script for all the indigenous scripts present in India. Researchers, historians, laymen, etc. need these sources of information systematically and handily. In the scholarly world, a huge amount of data and information (Digital Humanities based collections) related to Brahmi script is available but all this information is scattered in the form of texts, images, videos, etc. This creates chaos to understand the overall story of the Brahmi script from its inception to till date. With these issues, we felt motivated to present the data and information related to Brahmi script among their users in a more informative, easily accessible, and comfortably understandable manner. In this paper, we have tried to connect all the dots related to Brahmi script under one umbrella with the help of the Digital humanities tool- Visual Eyes. Further, we have mapped these multimedia formats with each other on the historical timeline, interactive maps and story events to establish and understand the relationship among the various facets of the Brahmi script. The impact of this research is more appealing as it has presented a new dimension for any other script to make it more accessible and easily understandable worldwide while using an innovative open-source tool.

Keywords: Brahmi script; Data visualisation; Digital humanities; Visual eyes; Open data

1. INTRODUCTION

Traditional knowledge or Indigenous knowledge is a term that refers to the information, abilities, and ideologies created by communities with a long history of interaction with their natural surroundings.¹ In modern times indigenous knowledge has been of great importance in various research fields like drug discovery, engineering, architecture, and humanities areas.² India is a country, known for its rich source of traditional knowledge in the field of Ayurveda, Yoga, literature, medicine, architecture, linguistics, etc.³ Writing has a long history that dates back to prehistoric times, long before the arrival of the Aryans, and continues up to the present. The script is a representation of speech in writing. The word “script” first appears in the Asthadhyayi, a grammatical treatise by Panini that was composed in 800 B.C. The Arthashastra of Kautilya also refers to a script (lipi) as one of the subjects taught to a child prince. The inscriptions of Ashoka also describes a script as lipi or libi or dibi all meaning are the same.⁴

One of the oldest script son the Indian subcontinent is Brahmi which is also considered the mother of many scripts.⁵ The term Brahmi comes from the fact that this script is said to have been created by Brahma, the God

of Knowledge.⁶ The inscriptions of Asoka, the Mauryan Emperor, contain the earliest remaining evidence of the use of the Brahmi script (269 - 232 B.C.).⁷ At numerous locations around his empire, he had his words to his citizens written on rocks and pillars.⁸ His inscriptions, throughout major Buddhist sites and along trade routes have given us proof that ancient India had a fully developed alphabetical writing system.⁹ All traditional Indian writing systems are regarded as descended from the Brahmi script.¹⁰ At the present huge amount of data relating to Brahmi is available as open data in the form of manuscripts, inscriptions, and edicts as digital files.

The term “visualisation” is dubious in and of itself. It might relate to the scientific field, a technology, a particular approach, or the visual outcome. Visualisation refers to a technology that provides pictorial descriptions of results from computations and simulations.¹¹ Data visualisation transforms abstract data into physical visions (for example, length, position, shape, colour, and so on), and is a powerful means to present compelling data stories to more visually oriented humans.¹² Nowadays data visualisation is used to explore knowledge graphs, which helps to understand even ostensibly unrelated datasets to show their importance for a particular task.^{13,14} Further, the visual elements and visualisation tools (graphs, maps, charts, etc.) that are used in data visualisation provide

a way to understand the trends, patterns, and outliers in the data.¹⁵

2. STUDIES ON BRAHMI SCRIPT

In the recent past, there are only two prominent areas in which work has been done on the Brahmi script first linguistics and the second is character recognition. A study by Anil K. Singh¹⁶ was conducted in which he tried to determine the extent of similarity between two letters of the Brahmi script by using a Stepped Distance Function (SDF). Pieces of evidence were also found for the corpus of Turkish text, written in Brahmi was based on the North-western Brahmi script system.¹⁷ In the year 2015, Brahmi-Net an online transliteration system was developed which supports the English language, Dravidian language (four) and Indo-Aryan languages (thirteen).¹⁸ Further, it was revealed that phonetic letters are more closely linked to the Indus valley script as compared to the Brahmi script by using a convolutional neural network (CNN).¹⁹ Gautam, Chai & Gautam²⁰ developed an automatic technique to translate Brahmi text into Pali text based on one-to-one and many-to-many mechanisms of translation.

Premaratne, Jarpe & Bigun²¹ proposed that the Hidden Markov Model (HMM) and Lexicon model are more effective in improving the accuracy rate of recognition for the Sinhala script – a descendent of the Brahmi script. Further, it was found that a pixel-level processing technique is beneficial for images at the pre-processing stage for the Brahmi OCR system²², and for efficient recognition, the binarisation technique may be used to identify the Brahmi texts from the deteriorated manuscripts, palm leaves and rock edicts.²³ In a study conducted by Gautam & Chai²⁴, the Geometric method was used to extract the features of Brahmi script

characters from six different entities and concluded that these features can be used for both hand-written and printed characters. Further, a comparative analysis of the Brahmi script-based Pali language was done with two additional scripts Akkhara-Muni and Ariyaka and was found that the accuracy of the Brahmi script was more than the other two.²⁵

A study was conducted by Singh & Kushwaha to review various segmentation techniques and suggested a projection profile method for segmenting the Brahmi script.²⁶ Another study suggested that the segmentation of the Brahmi script is a two-step process one was a horizontal projection profile for segmenting the lines and the other is a novel method for dividing the characters.²⁷ If we review the character recognition stage/step of the OCR system then various studies were conducted like Linear Support Vector Machine classifier along with gradient information was used for the Brahmi recognition system.²⁸ The Deep convolutional method was used to develop a recognition system for the Brahmi script.²⁹⁻³⁰ The CNN, SVM, and Mobile Net Method was also used to recognise handwritten Tamil Brahmi characters.³¹ Further, in this paper, we will explore the application of VisualEyes – a Digital Humanities tool for Brahmi Script-based collections.

3. VISUALEYES

The University of Virginia developed SHANTI INTERACTIVE a suite of tools to create interactive web-based visualisations.³² VisualEyes is one of the tools among them which weaves charts, videos, maps, images and data into highly interactive visualisations. It is HTML 5 web-based authoring tool which enables researchers to present their research findings to general and targeted audiences.³³ For effective use of VisualEyes,

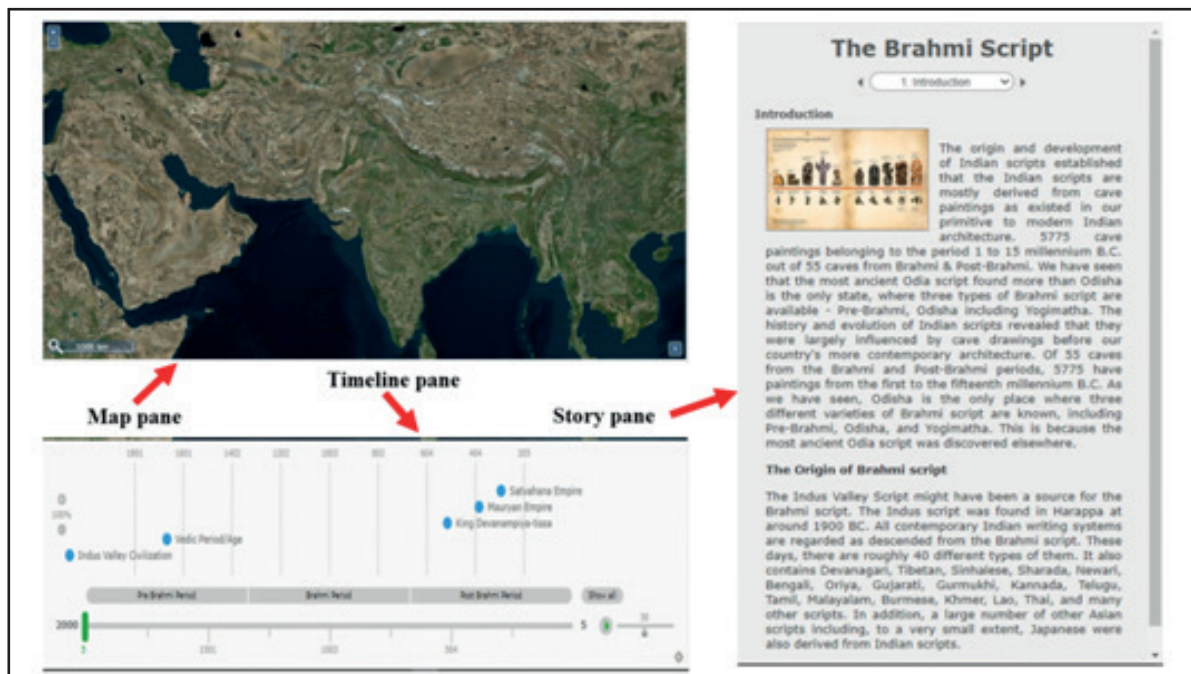


Figure 1. VisualEyes project user interface displaying parts of the screen.

we have to understand the structure of the screen, the anatomy of the VisualEyes project and the various fields in the spreadsheet.

3.1 Parts of the Screen

VisualEyes screen primarily has three parts namely Map pane at the top-left, the Timeline pane below the map pane and the Story pane to the right (see Fig. 1). Map pane is a draggable map similar to google maps in several ways it has icons, image overlays, animated paths, and map bases like roadmaps, terrain, satellite, etc. The timeline pane is very interactive which can display many events along with a scrolling timeline view. For closer assessment of a shorter period, a time span can be partitioned into sections by segment bar and while scrolling the timeline we can observe actions on the map and story pane. Further, we can control the map's zoom level and position by clicking and scrolling. The story pane can display the overall narrative of the project which is a collection of events where each section in the story pane is represented by a row in the spreadsheet with text and images.

3.2 Structure of the VisualEyes Project

The VisualEyes project has three main components namely, VisualEyes, Spreadsheet and VisualEyes settings (Fig. 2). VisualEyes is an HTML 5 web application which loads the project information from the VisualEyes settings, which further retrieves your spreadsheet containing actual project content.

VisualEyes settings is an entry point through which you may set foot into the VisualEyes database. It is the component where you may load your spreadsheet from the cloud and to your browser for visualisation. The spreadsheet contains the project content and event in text form which are linked with images, videos, markers, layovers, stories, paths, segments, etc., that make up

your project and each line represents a story or event in the spreadsheet.

3.3 Project Spreadsheet Information

The spreadsheet is the heart of any VisualEyes project as it provides all the data and instruction which is required for the visualisation on the VisualEyes web interface. In a spreadsheet, each line represents a certain type(s) of information which is displayed on map, timeline or story panes. This information can be any one of the following types as shown in Table 1.

4 PREPARING THE BRAHMI SCRIPT PROJECT FOR VISUALISATION

Before any project begins there are certain tasks which are to be performed so that our project does not become aimless or end in the dark. Such preliminary tasks along with other routine tasks which are performed before the final visualisation is called preparing the project. The project preparation steps for the new VisualEyes project can be broadly categorised into five major steps as shown in Fig. 3.

4.1 Collect Raw and Primary Data

To visualise any project, we need data as input for the visualisation tool. So, in this step, we collect the raw and primary data from various sources like historic sites, open data, libraries, museums, etc. After collecting the data, we have to clean it and organize it logically to get the desired result. In 'The Brahmi Script' project we have organised data under fields like year, place, geographical coordinates, description, images, scripts, etc. related to an event. Further, we have uploaded all the relevant images related to 'The Brahmi Script' project on <https://flickr.com/> and generated a unique URL for each image. Now this organised data along with unique URLs for images will act as input for the Google spreadsheet.

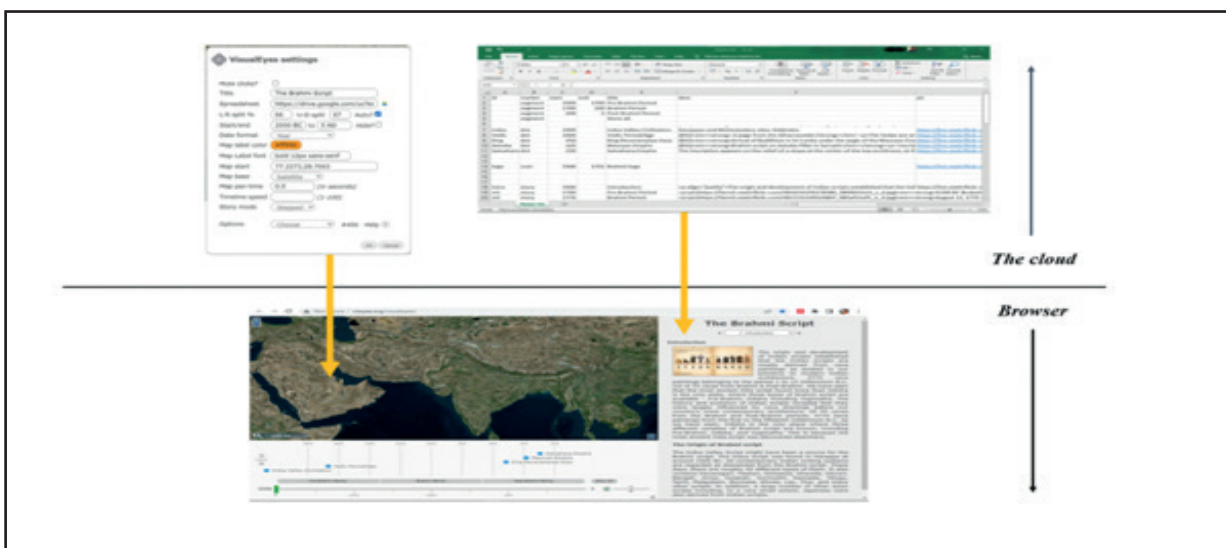
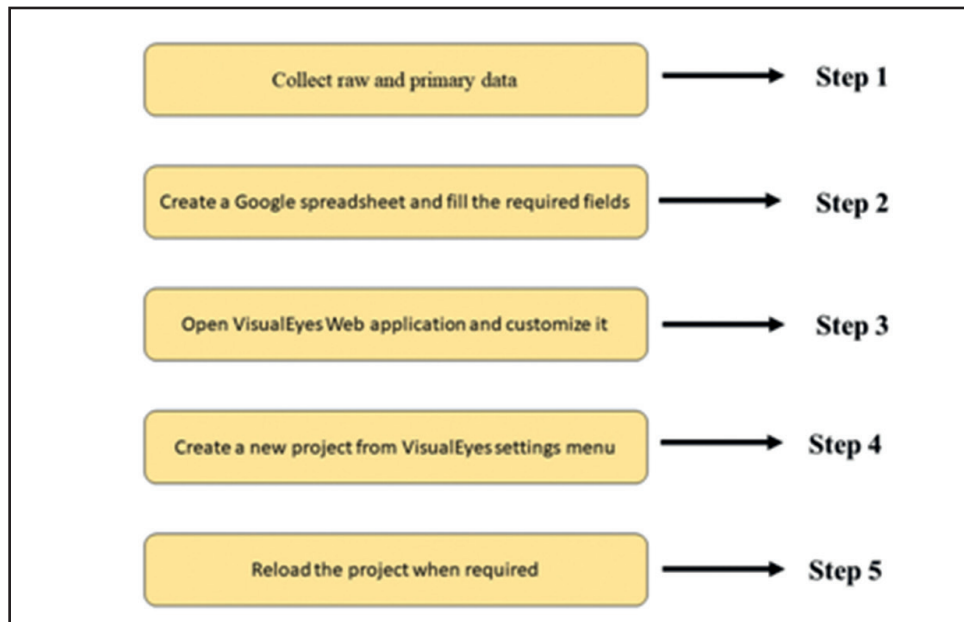


Figure 2. Structure of VisualEyes project - (a) VisualEyes settings, (b) Spreadsheet, and (c) VisualEyes.

Table 1. Types of spreadsheet information in VisualEyes web application

S. No.	Type	Description
1.	Event	The time-based event that appears on the timeline with some marker like dots, stars, etc. (see Figure 1 & Figure 7)
2.	Overlay	Images can be overlaid on the maps, i.e., overlaid images will move/zoom when the map is moved/zoomed (see Figure 6)
3.	Story	It displays the images and text in the story pane (see Figure 1)
4.	Path	Allows to animate the path between any points on the map (see Figure 9)
5.	Booklet	Booklets are pop-ups that display the text and images in a book form whose pages can be browsed by clicking arrow buttons
6.	Segment	Historical time spans are generally broad, so to narrow down the time span we divide the time bar into a series of segments (see Figure 7)

**Figure 3. Steps for preparing the project for visualisation in the Visual Eyes tool.**

4.2 Create a Spreadsheet in Google Drive

To create a spreadsheet, we logged in to our Google account and then created a blank spreadsheet file named 'Master File'. After that, we published that file on the web for everyone and generated a shareable link. Then we manually ingested the 'Master File' with all the relevant fields like id, marker, start, end, title, desc, pic, pos, etc. required to describe any event in the story, timeline or map pane. A sample spreadsheet which will be used in the next step has been displayed in Figure 4.

4.3 Open Visual Eyes Web Application

We opened the Visual Eyes web application with the link <http://www.viseyes.org/visualeyes> in the Google Chrome web browser. There we found the default project named 'Introducing VisualEyes 5' which introduces and guides how a new project can be started. Here we customised the web application according to our project goals and are

ready for the next step.

4.4 Create a New Project

In the VisualEyes web application, there is a gear icon at the bottom-right of the timeline pane. We clicked on it and a dialog box opened named 'VisualEyes Settings'. We filled all the relevant fields in that dialog box like title, spreadsheet, L-R split %, start/end, date format, story mode, etc. as shown in Figure 5 and then clicked on the 'OK' button to create our VisualEyes project titled 'The Brahmi Script'. This project was saved with the help of an email id & password and a unique project id was generated which can be used for reloading the project in the future.

4.5 Reload the Project

From the VisualEyes settings dialog box, we can reload our project from the options menu by entering a valid email id and password.

5. RESULTS AND DISCUSSION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
1	id	marker	start	end	title	desc	pic	pos	color	size	opacity	edge	mapMarker	mapColor	mapSize	where	show	click	citation	tags	
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					

Figure 4. Sample spreadsheet with all the fields for creating a google spreadsheet.

VisualEyes settings

Mute clicks?

Title

Spreadsheet

L-R split % U-D split Auto?

Start/end to Hide?

Date format

Map label color

Map Label font

Map start

Map base

Map pan time (in seconds)

Timeline speed (1-100)

Story mode

Options #456 Help ?

OK Cancel

Figure 5. VisualEyes settings dialog box.

For ‘The Brahmi Script’ project, we acquired data from various sources which was freely available in the form of open data. This open data was organised and utilised for visualising ‘The Brahmi Script’ project with the help of a web-based application tool called VisualEyes. Being a researcher, enabled us to present the scattered data related to the Brahmi script in an interactive form (Fig. 6-11) and also helped us to illuminate the relationships between various information available across space and time. The results and discussion are shown as follows:

5.1 Timeline/Map Events

In most of the VisualEyes projects, timeline/map events are the central feature where they display the event that had occurred at a particular time or period and may have a location connected with them. Each event in the project has a marker field defined which controls the icon’s shape of an event that appears in a timeline or map. A Map Marker has been used to mark an event on the map which is visualised in Figure 6. The shape of the marker is diamond and the colour is orange for Indus Valley Civilisation (location: 73.9049,26.5392),

Vedicperiod/ age (location:84.5727,20.5916) and, King Devnampiya-tissa (location:80.7494,8.1026) and red for Mauryan Empire (location:82.6611,25.0854) and Satvahana Empire (location:79.409,15.8768).

A time bar consists of years and periods of a certain time-span but every time-span is not small in size, few are so large that it becomes difficult to visualize or read all the events at a given point in time. To tackle this problem VisualEyes allows us to narrow the time-span by dividing it into segments of smalltime-span. For example in Fig. 7, we have divided the time-span of the time bar into three segments (Pre-Brahmi period, Brahmi period and Post-Brahmi period) of equal size. Segmenting the time-span reduces the chaos and increases the visibility irrespective of the number of events that are large for a given time-span.

Every researcher has their own research information needs, so each researcher may need the same information in different variants. For example, a researcher from geology working in the field of flora and fauna of any city may need geographical information in the ‘Satellite’ map base but a researcher from the tourism field who wants to explore the same city will require a ‘Roadmap’



Figure 6. Map Markers for the events related to various civilisations and empire.



Segments

Figure 7. Segments of the timeline pane for a time-span of 2000 years.

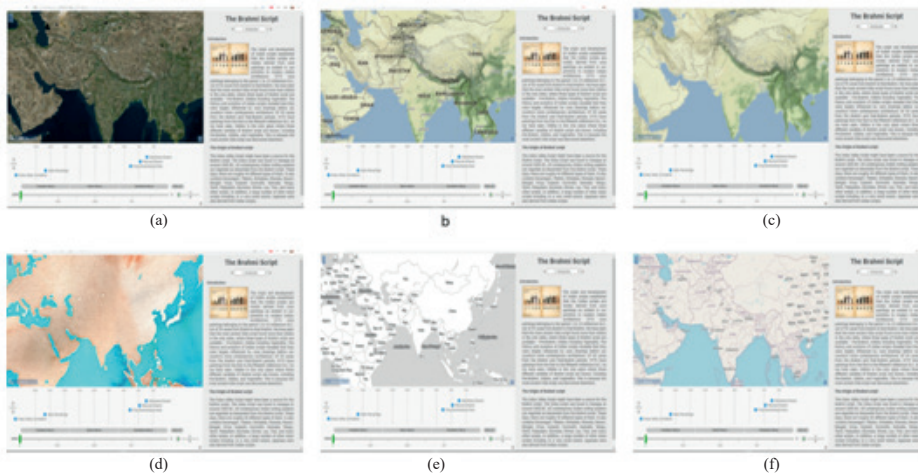


Figure 8. Map base of 'The Brahmi Script' project in six different map bases - (a) Satellite map base, (b) Terrain map base, (c) Earth map base, (d) Watercolour map base, (e) Black and white map base, and (f) Roadmap map base.

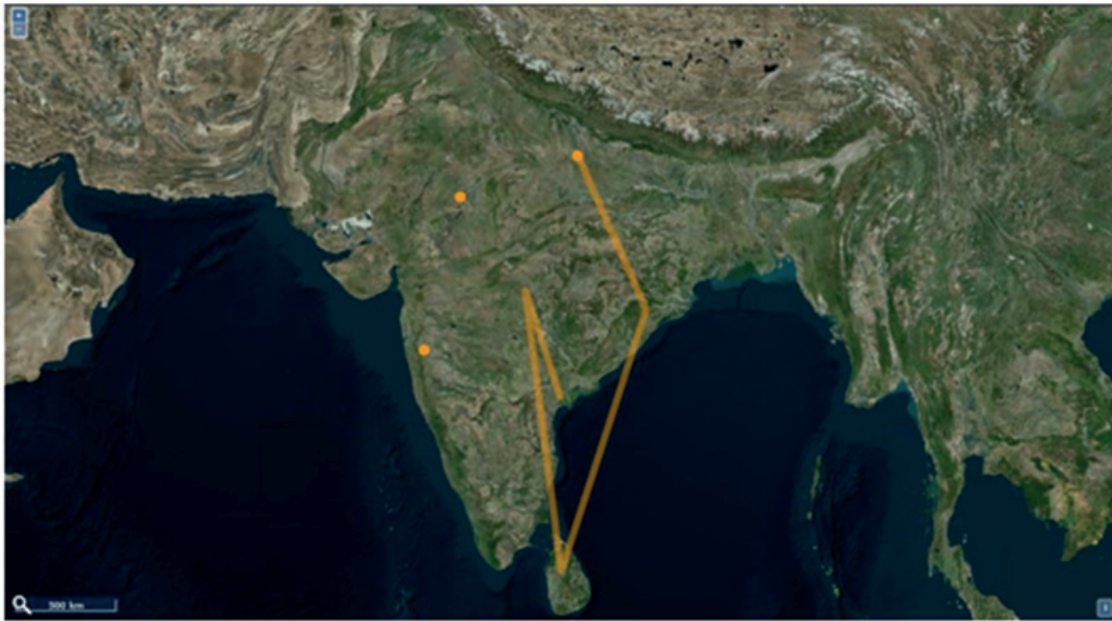


Figure 9. Animated path for the various points on the map.



(a)



(b)

Figure 10. (a) Normal view and (b) Zoomed view.



Figure 11. Story mode of 'The Brahmi Script' project - (a) Stepped and (b) Scrolled.

map base for better understanding. So, to satisfy such needs of a researcher we have visualised the information in the six different map bases as shown in (Fig. 8).

5.2 Map Overlays

In VisualEyes we can easily animate the line between any two points on the map and this path is called an animated path. This line can be displayed in different colours, sizes and opacity as shown in Fig. 9, which displays the path in yellow colour with an opacity of 0.8 and connecting various locations of the ancient Indian subcontinent. Animated paths are very useful for understanding how any information or culture has travelled/ passed from one part of the world to another.

The map in VisualEyes may contain various overlays like historic maps, icon markers, images, map events, etc. These overlays are attached to the maps which means that they move in the same way as the maps are moved i.e. if the maps are zoomed then the overlays will also be zoomed. Further, we can also zoom the images which are overlaid along with the pop-up box as shown in Figure 10. This feature helps to visualise efficiently all the events and images shown in the map pane which enhances the overall data visualisation.

5.3 Story Items

On the right-hand side of the VisualEyes web application, we have a story pane where story events appear and each story represents a single event in the same order as arranged in the spreadsheet. Further, this story can be visualised in two modes one is the ‘stepped’ mode and the another is the ‘scrolled’ mode as shown in (Fig. 11). In stepped mode, controls are at the top of the story pane from where you may jump from one story to another, while in scrolled mode stories are arranged in collapsible outline format.

6. CONCLUSIONS

Data visualisation is an interactive method through which we make our data multidimensional by adding various features and characteristics to it. Information and Communication Technologies have played an important role in such development worldwide. Here we have tried to weave all the facets of the Brahmi script under one umbrella with the help of the Digital Humanities tool (Data visualisation tool) and to a great extent, we have achieved it. There are some challenges we faced while working on this visualization tool as we cannot write/visualize the story (in the story pane) in the Indic languages, we have to transliterate it into English; the data collection process was rigorous and we considered only open data available for the Brahmi script; lastly, the secure version (HTTPS) of the VisualEyes web application is not reliable so each time we have to manually update the spreadsheet in the Google drive. Although, there are some limitations of this tool. But, any story which has space and time facets can be visualised easily with this VisualEyes tool.

REFERENCES

1. Zhang, Hao & Nakagawa, Hajime. Validation of indigenous knowledge for disaster resilience against river flooding and bank erosion. *In Science and Technology in Disaster Risk Reduction in Asia: Potentials and Challenges*, edited by Rajib Shaw, Koichi Shiwaku and Takako Izumi. Academic Press, Cambridge, 2018, 57-76.
doi: 10.1016/B978-0-12-812711-7.00005-5.
2. United Nations Department of Economic and Social Affairs. *State of the World's Indigenous Peoples*. United Nations Publication, New York, 2009.
3. Kapoor, Kapil. Indian Knowledge Systems: Nature, Philosophy and Character. *In Indian Knowledge Systems*, edited by Kapil Kapoor and Avadhesh Kumar Singh. D.K. Printworld (P) Ltd., New Delhi, 2005, 11-32.
4. Pandey, Raj Bali. *Indian Paleography*. Motilal Banarasi Das, Banaras, 1952.
5. Kaur, Sandeep & Sagar, B. B. Brahmi character recognition based on SVM (support vector machine) classifier using image gradient features. *J. Discrete Math. Sci. & Cryptography*, 2019, **22**(8), 1365-1381.
doi: 10.1080/09720529.2019.1692445.
6. Padakannaya, Prakash & Mohanty, Ajit K. Indian Orthography and Teaching How to Read: A Psycholinguistic Framework. *Psychological Studies*, 2004, **49**(1), 260-271.
7. Upasak, Qhandrika Singh. *The history and development of Mauryan Brahmi Script*. The University of London, 1959. PhD Thesis. 389p.
URI: <https://eprints.soas.ac.uk/29390/1/10731524.pdf> (accessed on 30 Nov. 2022).
8. Allchin, F. R. & Norman, K.R. Guide to the Asokan inscriptions. *South Asian Studies*, 1985, **1**(1), 43-50.
doi: 10.1080/02666030.1985.9628331.
9. Gaur, Albertine. Scripts and writing systems: A historical perspective. *In scripts and literacy*, edited by Insup Taylor and David R. Olson. Springer, Dordrecht, 1995, 19-31.
doi: 10.1007/978-94-011-1162-1_2.
10. Magotra, Shikha; Kaushik, Baijnath and Kaul, Ajay. A comparative analysis for identification and classification of text segmentation challenges in Takri Script. *Sadhana*, 2020, **45**(xx), 1-20.
doi: 10.1007/s12046-020-01384-4.
11. Wijk, Jarke J. van. Views on Visualisation. *IEEE Trans. Visualisation and Comput. Graphics*, 2006, **12**, (4), 421-432.
doi: 10.1109/TVCG.2006.80.
12. Qin, Xuedi; Luo, Yuyu; Tang, Nan & Li, Guoliang. Making data visualisation more efficient and effective: A survey. *VLDB J.*, 2020, **29**(1), 93-117.
doi: 10.1007/s00778-019-00588-3.
13. Li, Haotian; Wang, Yong; Zhang, Songheng; Song, Yangqiu & Qu, Huamin. KG4Vis: A Knowledge Graph-

- Based Approach for Visualisation Recommendation. *IEEE Trans. Comput. Graphics*, 2022, **28**(1), 195-205. doi: 10.1109/TVCG.2021.3114863.
14. Liu, Shusen; Maljovec, Dan; Wang, Be; Bremer, Peer-Timo & Pascucci, Valerio. Visualizing High-Dimensional Data: Advances in the Past Decade. *IEEE Trans. Visualisation and Comput. Graphics*, 2017, **23**(3), 1249-1268. doi: 10.1109/TVCG.2016.2640960.
 15. Batt, Steven; Grealis, Tara; Harmon, Oskar & Tomolonis, Paul. Learning Tableau: A data visualisation tool. *J. Economic Educ.*, 2020, **51**(3-4), 1-12. doi: 10.1080/00220485.2020.1804503.
 16. Singh, Anil Kumar. A computational phonetic model for Indian language scripts. In *Constraints on Spelling Changes: Fifth International Workshop on Writing Systems*, 2006. pp. 1-19. <http://cdn.iit.ac.in/cdn/ltrc.iit.ac.in/anil/papers/cpms-long-iwlc-06.pdf> (accessed on 30 Nov. 2022).
 17. Proverbio, Delio Vania. Further observations on the status of the graphemes qa (Ka) and g_a in Turkic Brahmi. *Acta Orientalia Academiae Scientiarum Hungaricae*, 2014, **67**(2), 137-150. doi: 10.1556/AOrient.67.2014.2.1.
 18. Kunchukuttan, Anoop; Puduppully, Ratish & Bhattacharyya, Pushpak. In NAACL-HLT 2015, 31 May – 05 June, Denver, Colorado. 2015. pp. 81-85. doi: 10.3115/v1/N15-3017.
 19. Daggumati, Shruti & Revesz, Peter Z. Data Mining Ancient Script Image Data Using Convolutional Neural Networks. In *IDEAS 2018*, 18-20 June 2018, Villa San Giovanni, Italy. 2018. pp. 267-272. doi: 10.1145/3216122.3216163.
 20. Gautam, Neha; Chai, Soo See & Gautam, Megha. Translation into Pali Language from Brahmi Script. In *Micro-Electronics and Telecommunication Engineering: Proceedings of 3rd ICMETE 2019*, edited by Devendra Kumar Sharma, Valentina Emilia Balas, Le Hoang Son, Rohit Sharma & Korhan Cengiz. Springer, Singapore, 2019, 117-124. doi: 10.1007/978-981-15-2329-8_12.
 21. Premaratne, H. L.; Jarpe, E. & Bigun, J. Lexicon and hidden Markov model-based optimisation of the recognised Sinhala script. *Pattern Recognition Letters*, 2006, **27**(6), 696-705. doi: 10.1016/j.patrec.2005.10.009.
 22. Devi, Anasuya H. K. Thresholding: A pixel-level image processing methodology preprocessing technique for an OCR system for the Brahmi script. *Ancient Asia*, 2006, **1**(xx), 161-165. doi: 10.5334/aa.06113.
 23. Saxena, Lalit Prakash. An effective binarisation method for readability improvement of stain-affected (Degraded) palm leaf and other types of manuscripts. *Current Sci.*, 2014, **107**(03), 489-496. <http://www.jstor.org/stable/24103502>(accessed on 30 Nov. 2022).
 24. Gautam, Neha & Chai, Soo See. Optical character recognition for Brahmi script using geometric method. *J. Telecommun., Electron. Comput. Eng.*, 2017, **9**(3-11), 131-136.
 25. Gautam, Neha; Sharma, R. S. & Hazrati, Garima. Handwriting recognition of Brahmi script (an Artefact): Base of PALI Language. In *Proceedings of First International Conference on Information and Communication Technology for Intelligent Systems: Volume 2, Smart Innovation, Systems and Technologies 51*, edited by S.C. Satapathy and S. Das. Springer, Switzerland, 2016, 519-527.
 26. Singh, A. P., & Kushwaha, A. K. Analysis of segmentation methods for Brahmi script. *DESIDOC J. Libr. Infor. Technol.*, 2019, **39**(2), 109-116. doi: 10.14429/djlit.39.2.13615.
 27. Nagane, Aniket Suresh & Mali, Shankar. Segmentation of characters from degraded Brahmi script images. In *Applied Computer Vision and Image Processing. Advances in Intelligent Systems and Computing*, vol 1155, edited by Brijesh Iyer, A.M. Rajurkar & Venkat Gudivada. Springer, Singapore, 2020, 326-338. doi: 10.1007/978-981-15-4029-5_33.
 28. Kaur, Sandeep & Sagar, B. B. Brahmi character recognition based on SVM (support vector machine) classifier using image gradient. *J. Discrete Math. Sci. Cryptography*, 2019, **22**(8), 1365-1381. doi: 10.1080/09720529.2019.1692445.
 29. Subadivya, S; Vigneswan, J & Yaminie, M. Tamil-Brahmi Script Character Recognition System Using Deep learning technique. *Int. J. Comput. Sci. Mobile Comput.*, 2020, **6**(6), 114-119.
 30. Gautam, Neha; Chai, Soo See & Jose, Jais. Recognition of Brahmi words by using deep convolutional neural network. Preprints.org, 2020, 1-9. doi: 10.20944/preprints202005.0455.v1.
 31. Dhivya, S. & Usha Devi, G. TAMIZHI: Historical Tamil-Brahmi script recognition using CNN and MobileNet. *ACM Trans. Asian Low-Resour. Lang. Inf. Process*, 2019, **20**(3), 1-26. doi: 10.1145/3402891.
 32. The University of Virginia. SHANTI Interactive. <https://www.viseyes.org/> (Accessed on 30 Nov. 2022).
 33. Ferster, Bill. Visualeyes⁵. 2021, pp. 1-44. www.viseyes.org/visualeye (Accessed on 30 Nov. 2022).

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