Techniques for Immersive Data Storytelling

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ABSTRACT

Developments in immersive technologies has led to the emergence of immersive analytics. Immersive analytics takes data visualisation beyond the traditional 2D displays. At the same time, data storytelling has become a prevalent method for communicating data. Combining both data storytelling and immersive analytics gives rise to "immersive data storytelling". Immersive data storytelling refers to telling visually compelling data stories in an immersive environment such as as virtual reality, augmented reality, mixed reality and 360 videos. Currently, immersive data storytelling is under-explored from an academic stand point. The research presented here aims to develop techniques and guidelines for effective data storytelling in various immersive environments.

Index Terms: Immersive Data Storytelling—Immersive Environments—Wearable Computing—Human-Centered Computing

1 INTRODUCTION

Narrative visualisation is a form of data storytelling that aims to help communicate a consistent and coherent story described by underlying data [12]. Narrative visualisation techniques combine data visualisation and narrative techniques including sequencing, narration, and pacing to deliver an engaging experience and better comprehension of the data. There are many applications of data storytelling across various domains [9, 11, 13]. Such methods are crucial in a world challenged with unprecedented crises; COVID-19, food insecurity, inflation, climate change, gender inequality are a few of the many pressing global issues. Understanding and communicating data effectively can help in tackling these societal issues.

To increase the engagement of data storytelling, the concept of immersive data storytelling is emerging [8]. With the advancements in technology and the commodification of virtual reality and augmented reality devices, it has become feasible to integrate immersive technology with data storytelling to foster a better understanding of the data. Immersive data storytelling is starting to be used in heath care [6], education [10], manufacturing, and defense and military sectors [4] .

Despite of having numerous potential applications, immersive data storytelling is under-explored. More established fields, such as data visualisation, graphic design, and even cinema, have a rich history of experience and practice. These fields have well defined design patterns (i.e. design solutions or techniques) that may be applied to particular problems. A design pattern is a common repeatable solution to a general problem [7]. In the case of cinema for example, the "grammar" of cinema represents patterns that define the transitions between scenes, pacing, and even visual metaphors. Such patterns are well-understood (and expected) when presenting cinematic stories [1]. While immersive data stories could benefit from the knowledge of these diverse fields, the unique aspects of immersive technologies require a new understanding.

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This research aims to explore immersive data storytelling techniques across a range of immersive environments to help establish new knowledge in how to create effective immersive data stories.

2 METHODOLOGY

The following research questions will explore immersive data storytelling in three different immersive environments based on two dimensions: 1) Static vs Dynamic, 2) Fully Virtual vs Mixed, highlighted in the matrix (Figure1). Each research question aligns with one of the quadrants of the matrix and each research question will be addressed by a project where every project will leverage techniques from the previous project.

RQ1 How should virtual reality (VR) spaces be designed in relation to data visualisation to effectively convey a data story?

RQ2 How do we effectively integrate data storytelling (and data visualisation) into 360 videos?

RQ3 What are the effective techniques for situated immersive data storytelling?

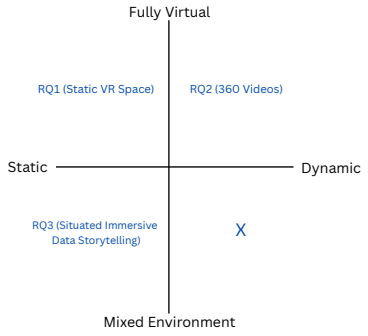

Figure 1: The design space of immersive data storytelling that this research project investigates.

2.1 Project 1. Effective Design Patterns for Immersive Data Stories

The first project will address **RQ1** by investigating design patterns for virtual spaces in VR which will be a static fully virtual environment to find out which design pattern is most effective in conveying a data story in a virtual space. This project will investigate the relationship between the virtual space and the data visualisations to identify effective patterns.

This project will begin by identifying design patterns from a multidisciplinary perspective, leveraging techniques from disciplines that have a pedigree in designing physical and virtual spaces, including architecture, museology, and game development. A group of 6–7 domain experts including museologists, architects, design experts, and film makers will be interviewed.

The insights from the domain experts will be used to develop the design patterns using the Unity game engine with the Immersive

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Analytics Toolkit (IATK) [3]. There are several ways of conveying a data story such as Martini glass structure, drill down story and so forth. Therefore, the design patterns will present how the layout of a virtual space should be designed in order to convey various types of data stories effectively.

The user study participants will be presented with various immersive data stories set in different virtual spaces designed using the design patterns. Each data story will be of an equivalent complexity using the method proposed by Cao et al. [2]. Information regarding recall, engagement, presence and immersion will collected from the participants using a survey after each condition.

2.2 Project 2. Data storytelling in 360 videos

The second project will examine the techniques identified in Project 1 in the context of dynamic fully virtual environment 1, top-right). This project will address **RQ2** by engaging 360 videos expert, developing techniques to integrate data visualisation in 360 videos which is a dynamic fully virtual environment and testing the 360 videos with data visualisations through a user study.

This project will begin with workshops with 360 videos experts to achieve an understanding about how 360 videos work, and identify how the techniques in Project 1 may contribute to data storytelling in 360 videos. The techniques will primarily focus on how to effectively integrate the data visualisations such that they support data storytelling in the video (Figure 2)

A group of 15–20 participants will be presented with two 360 videos developed using the techniques curated in phase 1. One with the data visualisations supporting the content of the video and one without any data visualisations. A survey will be used to evaluate participants engagement, immersion, presence and recall.

Figure 2: Initial sketch showing data visualisations integrated in the 360 video tour of New York attempting to a tell story of the relation between NYC population and MC Donald's sale

2.3 Project 3: Data storytelling for Situated Analytics

The third project will address **RQ3** by leveraging techniques and design patterns from project 1 and project 2 and develop new techniques for situated immersive data storytelling (Figure 3). The techniques will be implemented in an augmented reality environment. A group of 15-20 participants will be presented with a data story developed using the curated techniques. A survey will be used to evaluate participants engagement, immersion, presence and recall.

Figure 3: Visual representation of Situated Analytics [5]

3 Expected Contributions and Future Work

Immersive data storytelling is significant not just for the research community but also for the society, but it has not been thoroughly investigated as a research field. This PhD project will provide a better positioning for Immersive Data Storytelling as a field of research. By looking at immersive data storytelling through the conceptual framework shown in Figure 1, researchers and practitioners can better categorise existing and future work within this domain. Furthermore, this PhD project aims at designing techniques in each scenario in the matrix. This is expected to enrich our understanding of what constitutes effective immersive data storytelling in a wide range of scenario as well as provide evidence of impact on user's engagement, immersion, presence and recall.

Currently, I am finishing up the interviews for phase 1 of the first project with a range of experts on designing techniques, aiming to run a user study in Q2 2023. I am looking to gain additional information and improvement advice on the following questions:

Q1. The presented project can easily come across as broad and ambitious. In what ways, I can narrow down the project in order to still be able to achieve effective immersive data storytelling?

Q2. What are the different ways in which the interview responses can be analysed and synthesised to develop data storytelling techniques?

Q3. Immersive data storytelling work spans across multiple disciplines. Do you have any suggestion on a good approach to do a such a multidisciplinary research?

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