AI Based Multidimensional Data Visualization On Augmented/Virtual Reality Platforms

Xianling Zhang   Adam Niederer   Adlan Ramly   Yuya Ong   Andrew Cheng
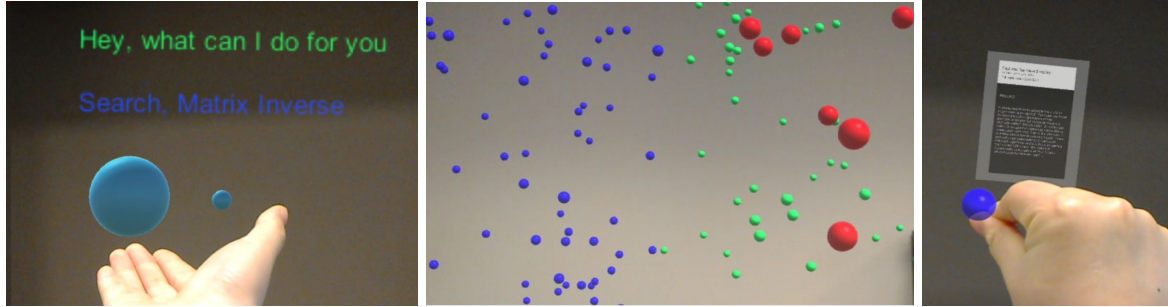Augmented Reality Lab of Penn State University

Figure 1: User interacts with data points through augmented reality headset(hololens)

Abstract

We propose a real-time data visualization system that enables users to interact with the AI-based interface on augmented/virtual reality platforms. This method differs from the traditional 2D display by offering data distribution in an immersive manner. Users can use gesture and voice commands to retrieve analyzed results and interact with each data point.

Keywords: multi-dimensional, cross-platform, cross-languages, cloud computing

Concepts: Data Visualization, Augmented Reality, Virtual Reality

1 Introduction

Traditionally, researchers analyze data with personal computers. This system has inherent limitations; flat, 2D displays cannot meaningfully portray three dimensional data and offers a distant, non immersive perspective for the user. With the advanced development of the VR/AR toolkits, we could improve the immersiveness of data presentation with head mounted VR/AR toolkits. Our approach consists of both backend and frontend work, as shown on the right in Figure 2. From the backend, the cloud server computes the data and sends it to the client for visualization. From the frontend, the AI is called by a gesture, then the user can search topics
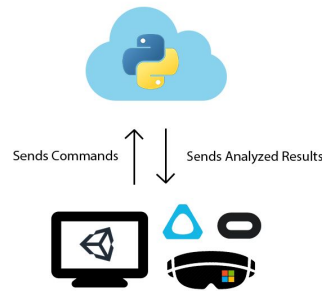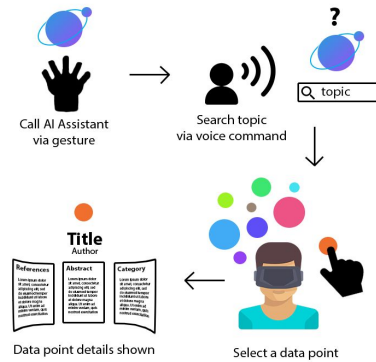

Figure 2: The pipeline of the method

via voice commands. After searching for desired topics, the corresponding data distributions will show up on the head mounted display. The user can select each data point to check the corresponded documents.

2 Our Approach

Figure 2 shows a workflow of our method.

Pre-processing: Le's method of numerical representation of sentences[Le et al, 2014] is used along with a Tipping and Bishop probabilistic principal component analysis method of vector decomposition with whitening into a three-dimensional space[Tipping et al, 1999] to process the documents and place them into 3D space. The documents may then be searched via a streaming Latent Dirichlet Allocation, as described by Hoffman[Hoffman et al, 2010]. This produces a scalar similarity index which is represented in the 3D space as proximity to the searching user. This data, along with additional scalar quantities about each document may be acquired over a websocket and are streamed to the Hololens/Oculus in real time.

Run-time processing: The user puts on the headset, and with the command "search"+"keywords", the cloud server will respond with the dictionary of relevant keywords. After retrieving the dictionary, the client end will visualize the data points with X, Y, Z coordinate positions. An individual data point will not have much meaning on its own, but each cluster of data points will represent a group of documents with similar keywords.

The reason for choosing Python as the backend processing is because it is widely adapted for data analysis with machine learning algorithms. For the frontend, we use C# in Unity because with Unity's built-in 3D coordinate system, the data visualization could be displayed in a more immersive manner.

3 Future work

The current version of the approach uses research papers as the data resource. We intend to add basic optical character recognition (OCR) features, which will use a head mounted camera with computer vision algorithms to recognize text in real life and retrieve data from it.

Reference

Le, Q. V., & Mikolov, T. (2014, June). Distributed Representations of Sentences and Documents. In ICML (Vol. 14, pp. 1188-1196).

Tipping, M. E., & Bishop, C. M. (1999). Mixtures of probabilistic principal component analyzers. *Neural computation*, *11*(2), 443-482.

Hoffman, M., Bach, F. R., & Blei, D. M. (2010). Online learning for latent dirichlet allocation. In *advances in neural information processing systems* (pp. 856-864).