A Portable Interface for Tangible Exploration of Volumetric Data

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Introduction

Volumetric data exploration is an important task in many fields, such as medical science, geoscience or fluid mechanics.
Desktop computers are not well suited to interactively explore 3D datasets, due to the **limitations of input devices** such as the 2D mouse.
A more powerful approach is virtual reality, which places the dataset in the same space as the user. This allows the user to directly interact with the data as if it were a real object. However, **VR interfaces require dedicated, expensive and intrusive hardware** (CAVE, HMD, data gloves...). Because of that, they remain **unwieldy and impractical** for end users.

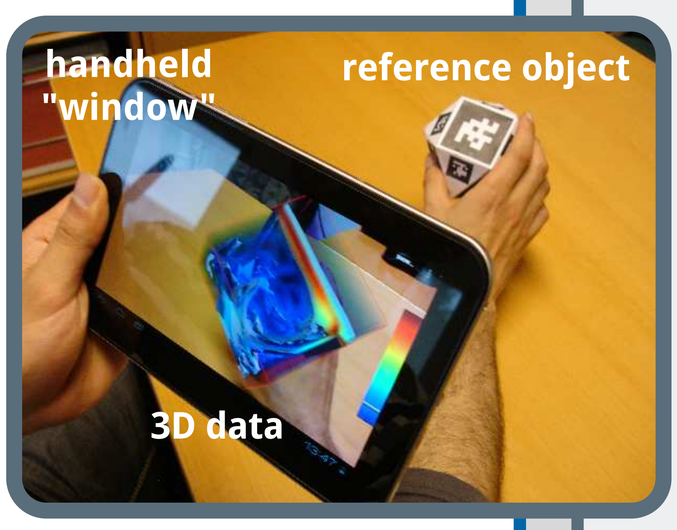
Proposed solution

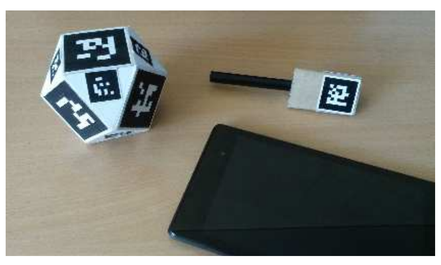
We propose a **fully portable**, **affordable** and **non-intrusive** interface that allows 3D interaction with volumetric data.

Our approach is based on a **tactile tablet** and a set of two simple **tangible objects**:
– the “reference object” represents the data volume
– the “stylus” represents an exploration tool

The tablet is a *see-through window* that turns tangible objects into their virtual counterparts.

By manipulating the objects behind the tablet, the user can interact *directly and naturally* with the data.





This configuration provides the advantages of non-intrusive prop-based manipulation [1] and co-located 6-DOF interaction [2].

But unlike previous approaches, it only needs common off-the-shelf hardware, and is fully portable and self-contained.

Dataset visualization

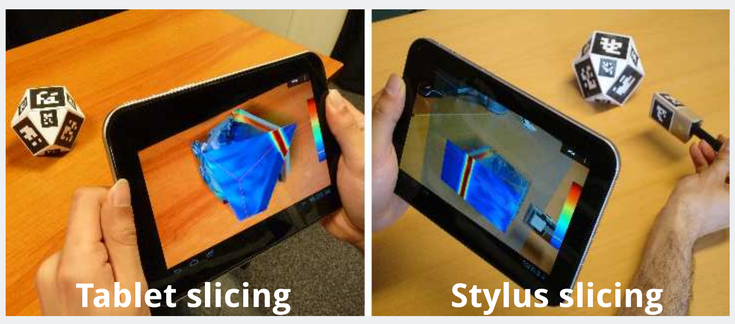
Exploring a volumetric dataset generally requires to observe it from different angles.

When seen through the tablet, **the reference object visually turns into the data volume**.

By manipulating the reference object, the dataset can be **directly observed and manipulated in 6-DOF**.

Multiple markers on the reference object allow tracking to be maintained regardless of its orientation relative to the tablet.

Volume slicing



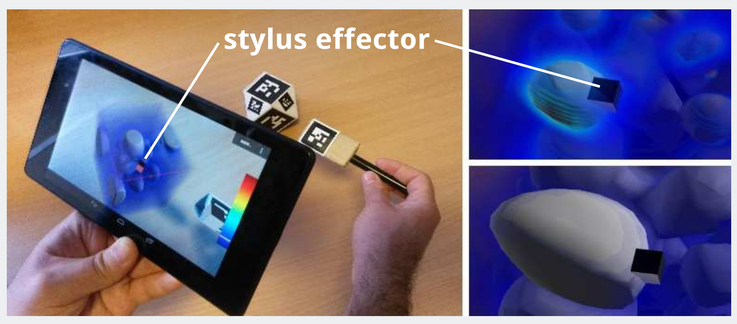
Combining a tablet with tangible objects opens new possibilities for interactively slicing the data volume.

– **Stylus as a slicing tool**
A virtual “blade” is attached to the stylus.

– **Tablet as a tangible plane**
The slice plane is defined by positioning the tablet relative to the volume.

A more detailed study of these two slicing techniques can be found in [3].

Isosurface picking

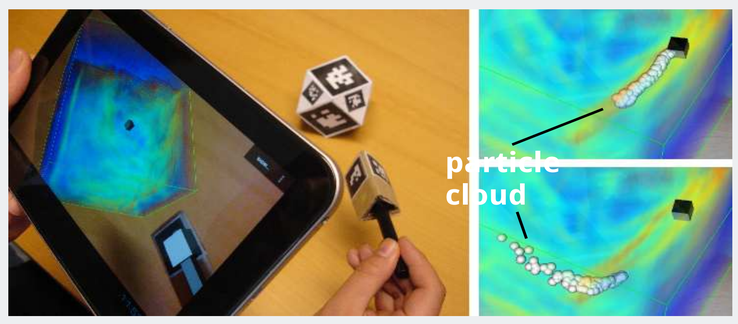


To construct an isosurface, most visualization software lets users manually enter the desired value. However, this value is not necessarily known beforehand.

Our interface provides a more direct way:
– **designate a 3D location** with the stylus
– generate an isosurface **from the value at this point**

The isosurface value can be updated in real-time as the stylus moves through the volume.

Particle tracing



Particle tracing is a technique to explore vector datasets, by visualizing the trajectory of particles in the vector field.

In our interface, the stylus can be used as a **particle source**:
– designate a 3D location
– generate a particle cloud at this point
– observe the motion of virtual particles through the tablet

References

[1] K. Hinckley, R. Pausch, J. Goble, and N. Kassell, “Passive real-world interface props for neurosurgical visualization,” CHI ’94, ACM, 1994.

[2] J. Mulder and R. Van-Liere, “The personal space station: Bringing interaction within reach,” VRIC ’02, ACM, 2002.

[3] P. Issartel, F. Guéniat, and M. Ammi, “Slicing Techniques for handheld augmented reality,” 3DUI ’14, IEEE, 2014.

Conclusion

Our proposed interface allows **direct and natural 6-DOF interaction** with volumetric datasets on **fully portable**, **affordable** and **non-intrusive** hardware. We also presented several tangible exploration techniques supported by this configuration.

This work opens new perspectives to make interactive exploration of volumetric data **more accessible to end users**.