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# Virtual reality for surface topography analysis

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## Abstract

Immersive technologies, such as virtual reality (VR), have seen widespread adoption across multiple industrial sectors. Nevertheless, the application of VR in surface topography analysis remains notably limited. This paper presents a VR-based framework for surface analysis, providing an interactive platform for in-depth exploration of surface features.
The proposed tool is intended to advance both the understanding and practical application of surface topography.

## Proposed framework

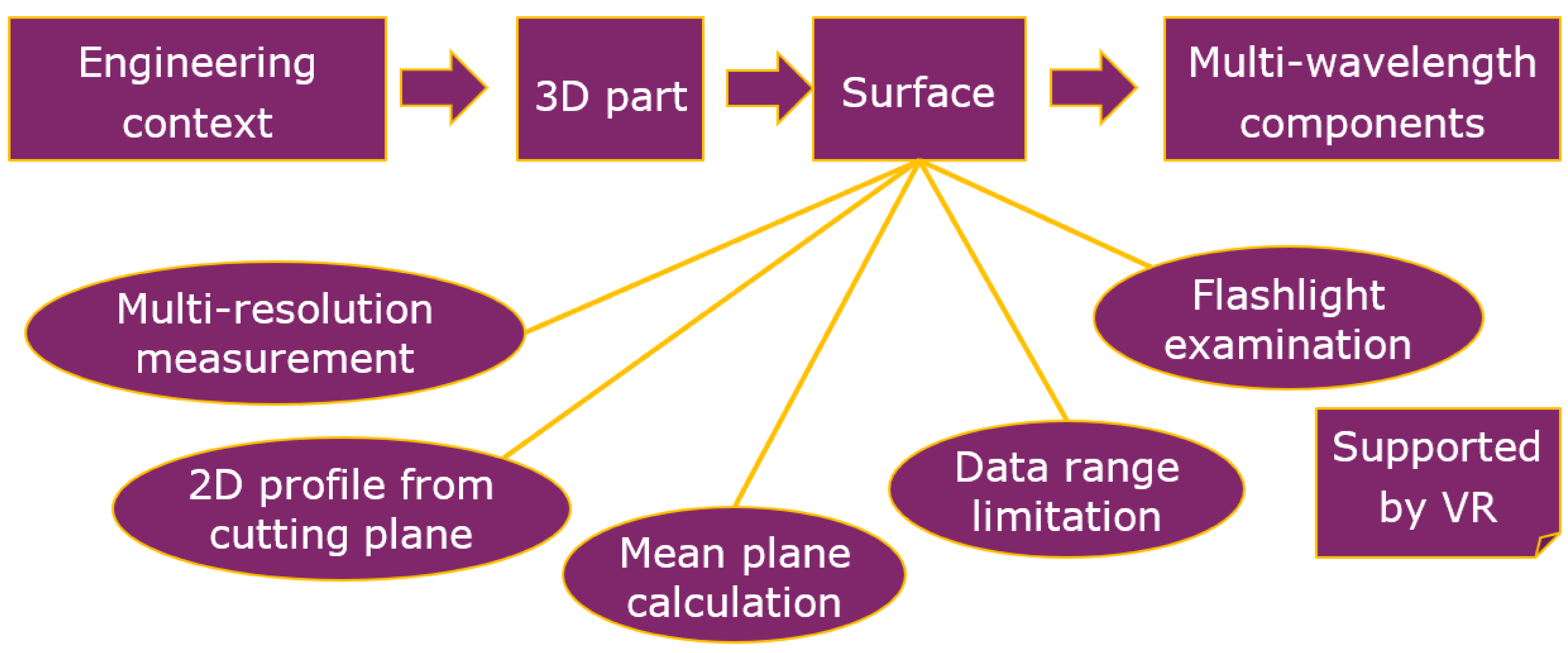


Figure 1: Data structure and main functions

A framework of VR application for surface analysis is proposed in Figure 1. Starting with virtual immersion in engineering context (*e.g.*, a factory equipped with milling machines), users can take 3D part (*e.g.*, cutting tool) according to their study interests. To conduct a topographic analysis, users can extract a surface part for further examination:

- observing multi-resolution metrological measurements;
- defining and analyzing cross section 2D profiles;
- computing the mean plane of the surface;
- limiting the data range of the surface height;
- using a flashlight to examine surface roughness;

Finally, user can apply multi-wavelength decomposition

## Prototyped VR application

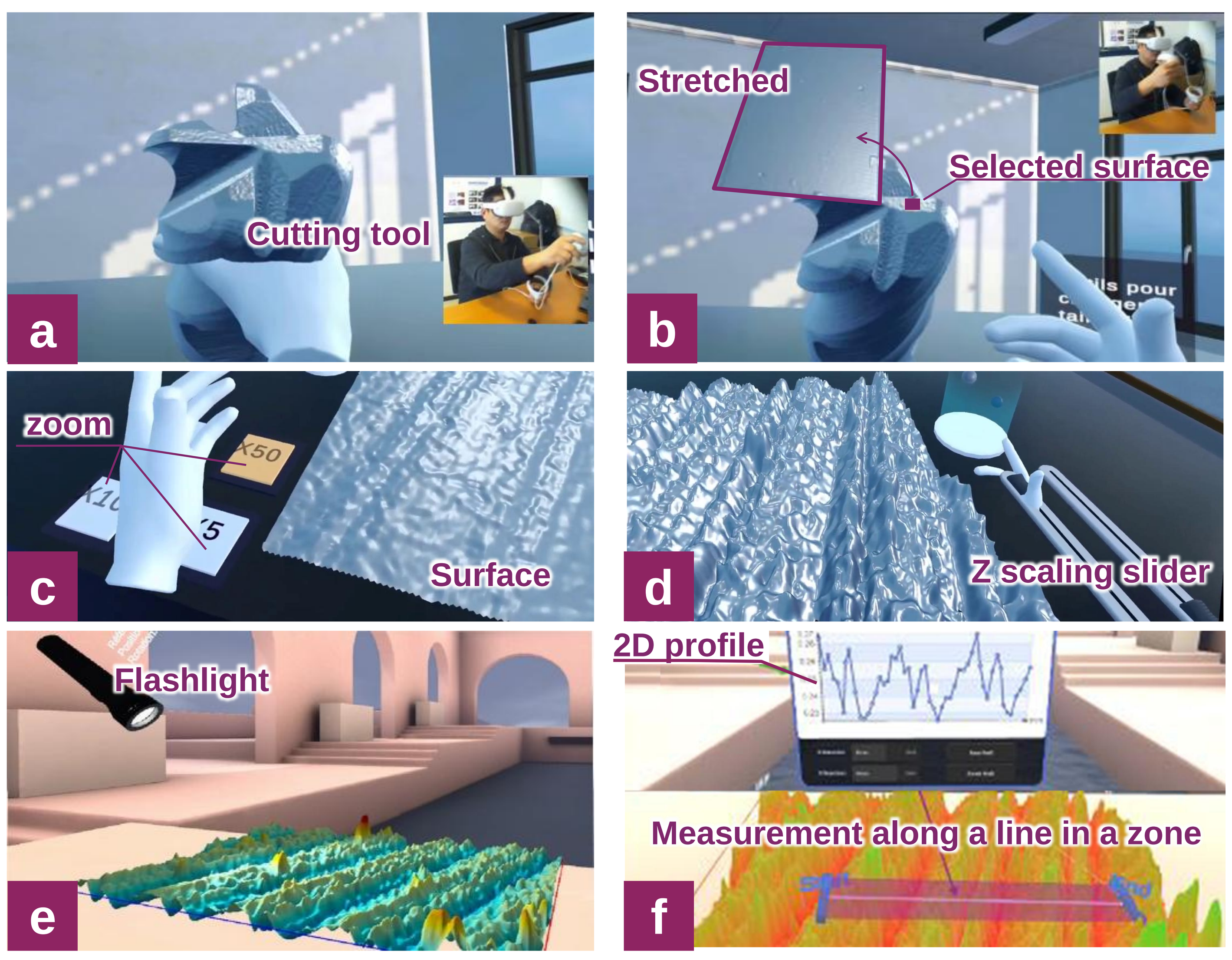


Figure 2: Interactions and functions implemented in the VR prototype.

A prototype is developed using Unity (game engine) for Meta Quest (VR headset). When launching the application, the user enters a workshop showing a milling machine for the engineering context.

- The user can take off the cutting tool from the machine (Fig.2.a), select and stretch a surface for detailed examination (Fig.2.b).
- Once the surface is spread on the desk the user can switch between different zoom levels of the measurements (Fig.2.c). "Z scaling" slider on the right hand allows user to amplify the height of the surface for observing all features (Fig.2.d).
- A flashlight can be manipulated by user in order to illuminate the surface from different points of view and highlight different surface roughness features (Fig.2.e).
- The user can draw a line with a certain width (zone) for observing 2D cross-section profile (Fig.2.f)

## Conclusion

In this paper, we introduce a VR based approach for surface analysis. This approach marks the beginning of a new era in digital metrology. Ongoing developments will be validated through a series of forthcoming tests to illustrate that virtual reality can serve as both an innovative exploration tool and a robust solution to increase the reliability and reproducibility of surface analysis. A critical upcoming phase involves conducting comparative experiments between existing conventional tools and the VR based solution. The aim is to demonstrate the tangible value that VR adds to topographic surface analysis.