Chapter 8

Conclusion

8.1 Summary and conclusion

Mechanized tunneling is becoming increasingly challenging. More and more tunnels are constructed beneath urban areas to improve the regional infrastructure. During the construction process the surrounding environment, in particular, buildings on the surface, have to remain undamaged. However, the geological conditions have a major influence on the tunneling performance and risk containment. Therefore, to support an efficient and detailed planning, a consistent data management concept is required to manage geological information. Additionally, complex simulations, computations, and analysis are performed more frequently to ensure the quality of the construction process. These computations in the field of mechanized tunneling naturally require a consistent, detailed, and adaptable geological model along with context-specific interfaces. Information on geological conditions is often provided and requested either in the form of boundary or point cloud geometry, depending upon the available software or the level of required detail. Novel and robust integration and conversion concepts are necessary to allow efficient and consistent exchange of data between different data sources in mechanized tunneling.

This thesis presented a novel concept for consistent ground data management and an automated exchange of geological information between independent software tools in mechanized tunneling. The base is a hybrid Ground Data Management Concept which consists of three different levels: the data modeling level, the data management level, and the query processing level. The data modeling level captures the two sub-models of the GDMC, the B-Rep model, and an octree based voxel model. Each sub-model stores multiple model versions containing updated geological information for different regions of the tunnel environment. The version manager of the individually stored versions belongs to the data management level. It also includes various adapted algorithms to convert between boundary and point cloud geometry representations. In particular, the octree based voxel model is used as the key component for the conversion between the two
geometry representations. However, fast and reliable conversions are essential in order to provide a consistent data flow and efficient processing of geological information. In this context, new algorithms, as well as adaptations of existing algorithms, are presented for the conversion between B-Rep and octree as well as for the conversion between octree and point cloud with respect to geological information. The query processing level of the GDMC provides new concepts for storing geological updates and requesting geological information in different formats. Consequently, incoming geological data can immediately be saved independent of the type of geometry representation or spatial resolution.

A case study has been carried out where each of the proposed access concepts of the data processing level are presented. The study shows that the presented GDMC is capable of enabling an automated exchange of heterogeneous geological information between different data sources and components in mechanized tunneling. For each of the individual examples of the case study the introduced methods for the conversion and merging of geological information in different representations are applied. This validates that the adapted and newly developed algorithms are suitable for the consistent conversion of geological information. Additionally, the individual examples of the case study present the feasibility of the proposed access concepts to extract geological data from the data model of the GDMC in either B-Rep or point cloud representation.

### 8.2 Future work

The presented GDMC handles geological data in B-Rep and point cloud representation. In the future, this set of representations could be extended by further representations such as NURBS. NURBS are also a surface-based representation. In contrast to B-Rep, NURBS generate a smooth surface. Therefore, the visualization is nicer compared to polygonal surface representations and they also generate a better finite element mesh. However, to implement NURBS in the GDMC, methods have to be developed for the required merging and conversion algorithms.

To improve the accuracy of the GDMC the existing conversion from octree to B-Rep can be revised. The generated B-Rep based on this conversion is not represented by smooth boundary surfaces but generates a zig-zag shape at inclined surfaces. Therefore, methods are required to generate a smooth boundary surface from an octree shape. The problem when generating these smooth boundary surfaces is that the generated faces have to perfectly match each other. The generated B-Rep bodies are not allowed to overlay or to include free space inbetween. Therefore, this approach has to be tested for its applicability in the GDMC. Furthermore, the result of the octree to B-Rep conversion process influences the performance of B-Rep operations due to the large number of generated faces of the B-Rep body. Thus, an algorithm should be developed which revises the generated mesh of the B-Rep body and, therefore, reduces the number of faces significantly. Consequently,