Large-scale point cloud data enables the automated creation of realistic VR imaging

Hans Grobler

The industry support of AECI Mining was instrumental in the establishment of the AECI Mining Explosives Chair for Innovative Rock-breaking Technology in 2018. This is a joint research chair in the Department of Electrical, Electronic and Computer Engineering (EECE) and the Department of Mining Engineering, utilising the capabilities of the University's Virtual Reality (VR) Centre for Mine Design.

The Department of EECE's Virtual Reality Project forms an important part of the activities of this research chair. The overall goal of this project, under the management of Hans Grobler, senior lecturer and leader of the Department's Intelligent Systems Research Group, is to develop techniques that will allow the visualisation of real-world mining environments using VR technology. As such, it contributes to the University's mining footprint. The University of Pretoria is ranked globally in the top 50 universities for minerals and mining engineering according to the 2020/21 QS World University Subject Rankings.

Advances in sensor technology enable real-world environments to be digitalised in the form of a collection of 3D points called point clouds. At the same time, VR technology has advanced to the point where affordable platforms for the visualisation of 3D environments are available. Although sensors may also capture colour information, point clouds can typically only be visually interpreted at a distance and lose meaning when viewed at close proximity.

This effect is particularly problematic when point clouds are visualised directly in a VR environment. In order to produce realistic VR visualisations, a number of transformations must be applied to the point cloud. Among other things, surfaces must be generated, and these surfaces must be colourised and ideally texturised.

Another factor to consider is the constraints of the commercially available VR platforms, which typically limit the size of the point clouds that can be visualised.

These aspects were addressed during the early stages of the Virtual Reality Project, and a system was developed to allow the VR visualisation of static real-world environments. However, the surfaces produced by the approach described above do not have a geometric and/or semantic meaning attached to them. The generated VR visualisations are therefore static in nature and do not generally allow manipulation.

During the final stage of the project, methods are being researched to extract domain-specific geometric and semantic meaning from point clouds using techniques from the field of artificial intelligence. Researchers involved in the project are also investigating the automated extraction of 3D models, as well as motion analysis performed for sequences of point clouds and other data sources such as image sequences. They are also planning to investigate techniques to utilise both the 3D models and the extracted motion information in order to produce dynamic 3D visualisations of real-world environments.

As the current industry approach to the generation of VR simulations typically entails the laborious hand crafting of models and their motions, the primary objective of this research is to significantly enhance the viability of using VR for the realistic visualisation and analysis of real-world dynamic environments.

ADVANCES IN SENSOR TECHNOLOGY ENABLE REAL-WORLD ENVIRONMENTS TO BE DIGITALISED IN THE FORM OF A COLLECTION OF 3D POINTS CALLED POINT CLOUDS. AT THE SAME TIME, VR TECHNOLOGY HAS ADVANCED TO THE POINT WHERE AFFORDABLE PLATFORMS FOR THE VISUALISATION OF 3D ENVIRONMENTS ARE AVAILABLE.