Mapping Mars using Virtual Reality: the Pathfinder Experience

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The Pathfinder mission made use of a unique capability to rapidly generate and interactively display three-dimensional photo-realistic virtual reality (VR) models of the Martian surface. The Stereo Pipeline, an automated machine vision algorithm, produces dense range maps of the near visible field by matching features in the left and right IMP camera images using the known camera geometry. The resulting range maps are then projected into a three-dimensional model as a connected polygonal mesh. IMP images or color composites are then overlaid onto the mesh as textures to provide photo-realism. Upon receipt at JPL mission control, IMP images were shipped to NASA Ames Research Center via internet where models were computed and then shipped back to JPL for display. The time from receipt of image data to display of complete models was less than 30 minutes. The VR models were viewed interactively using MarsMap, an interface that allows reprojection from any perspective driven by a standard three-button computer mouse. Rapid rendering of the scene allows the user to move smoothly though the interactive model environment. The model can be viewed on a monitor either mono or stereoscopically, or using a head-tracked VR display. The VR model also incorporates graphical representations of the lander and the sequence and spatial locations of rover data. Graphical models of the rover show the rover′s position at the end of each sol and the rover′s traverse track can be displayed. Images taken by Sojourner are projected into the model as two-dimensional "billboards" to show the proper perspective of these images. Distance and angle measurements can be made interactively within the model using a mouse-driven three-dimensional cursor and a point-and-click interface. The VR model was used to make detailed measurements of surface features, such as wind streaks and rock size and orientation, that are difficult to perform using two-dimensional images, as well as to plan and archive rover activities.