Touring Mars On-line, Real-time, and in 3D for Educators and Students.

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Abstract: This paper presents a project started in 2003 that placed over 97% of Mars' topography from NASA into an interactive on-line learning environment for use by educators and students connected to the Internet. The possibilities for bringing students into an immersive environment to discuss and participate in math and science are many. This paper will discuss the 3D technology being developed and the educational use for math and science in 5th grade.

Introduction

The planet Mars has always fascinated us; however, much of that fascination started with misunderstanding and myth. (James, 2003) Mars now represents a future challenge of our nation that the President is proposing in a new space initiative. (Bash, 2004; The Whitehouse, 2004) We have been sending missions to Mars to study the planet since 1964 when the Mariner 4 spacecraft flew by the planet Mars and sent back the first pictures of the Martian surface. (NASA, 2004a) In 1997, the Mars Global Surveyor reached the planet to begin its research. Part of that voyage of discovery included an experiment called the Mars Orbiter Laser Altimeter (MOLA). This experiment collected elevation data (heights) of the surface of Mars. While the research was released during the experiment, not until late 2002 did a normalized data set become available.

When the MOLA normalized data became available (NASA, 2004d), we saw this as a perfect opportunity to show the potential that 3D on-line environments could have in education. The MARS on-line project allows student/teachers/researchers to access information that represents real data collected about the planet Mars. Mars on-line allows a visitor to view in real time across the Internet on as low as a dial-up modem some 1 billion elevation measurements gathered between 1998 and 2001 by NASA (some 2 gigabytes of information). Our technology approach allows us to present small environments like a classroom discussion or scale up to very large environments like Mars within a single methodology. Students can tour and discuss the environments using collaborative tools (audio, text, etc). The real potential in this approach is the ability to provide equal interactions across various Internet user connection speeds. This is an important consideration for students affected by the digital divide.

Mars Global Surveyor

The Mars Global Surveyor (MGS) was launched on November 7, 1996 and research orbit on September 12, 1997. (NASA, 2004b) The Mars Global Surveyor was the first spacecraft to be launched in a decade-long exploration of Mars by NASA. Since the MGS was launched, NASA launches have occurred every 26 months in 1998, 2001, 2003 and 2005, involving orbiters, landers, rovers, and probes to Mars. Figure 1 is a graphic of the spacecraft.

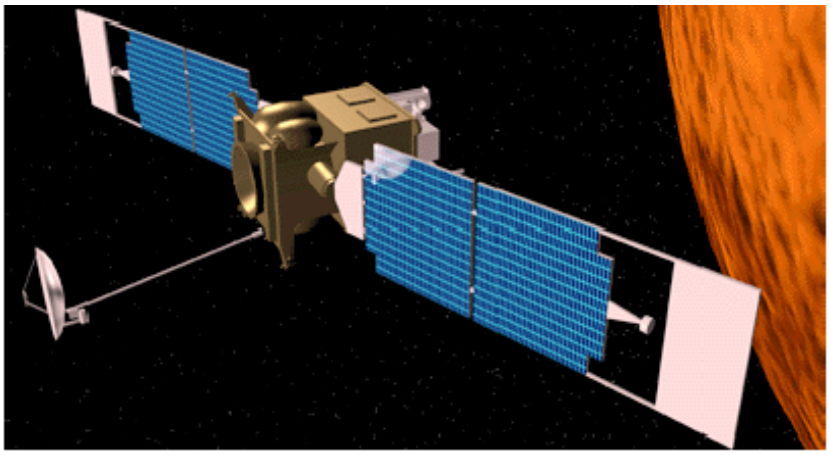


Figure 1 – Mars Global Surveyor computer graphic of the spacecraft. (NASA, 2004a)

MOLA Project

Our project has focused on the data collected by the Mars Orbiter Laser Altimeter (MOLA) project. (NASA, 2004c) The MOLA project collected data until the end of June, 2001, when the instrument failed due to a technical problem (oscillator malfunctioned). Figure 2 shows a photograph of the instrument separated from the spacecraft. The project was designed to map the Martian global topography. The MOLA package works by transmitting a laser pulse from the spacecraft in orbit down towards the surface of the mars. The pulse is then reflected off the Martian surface (or cloud) back to the instrument, where the return is detected. The two-way travel time is recorded, giving a measure of the distance between the spacecraft and the surface. Corrections were then made to the recorded distance based on atmospheric effects and accurate tracking of the spacecraft position allowed an estimate of the surface altitude or cloud height to be adjusted.

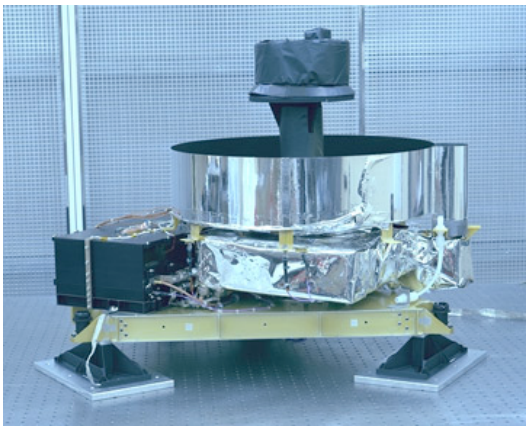


Figure 2 – MOLA (NASA, 2004c)

The dataset we reference consists of more than 600 million measurements gathered between 1999 and 2001 and was adjusted for consistency. This same dataset has been used by the US Geological Survey to generate new topographic map of mars shown in figure 3. This map can be downloaded from the USGS web site given in the reference section.

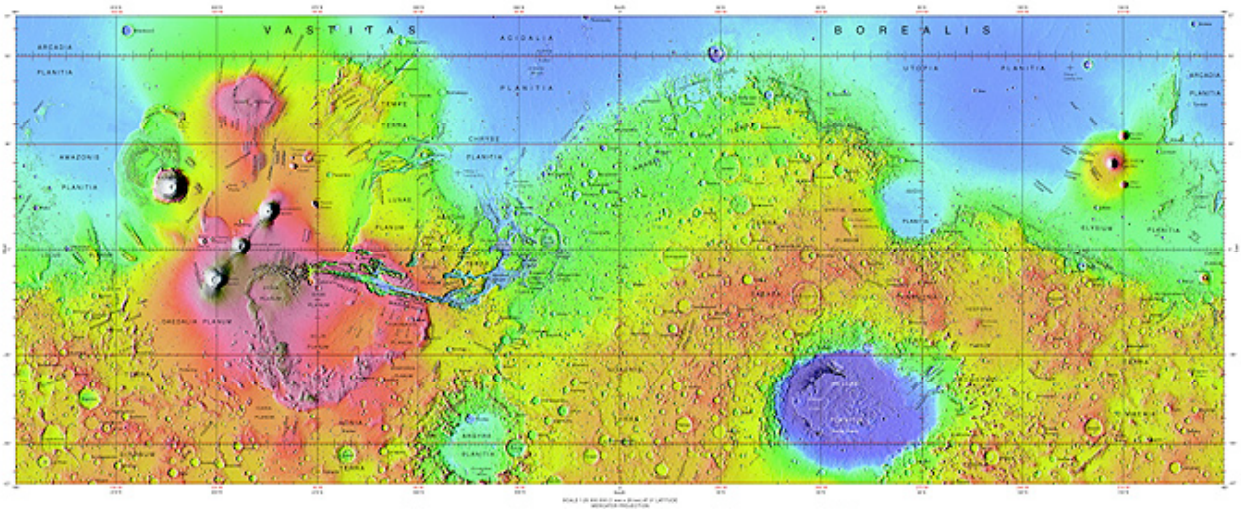


Figure 3 - Mars Topographic Map M 25M RKN (U.S. Geological Survey, 2004)

Created Realities Group

The Created Realities Group (CRG) was formed in 2001 with the focus to research and develop 3D online collaborative systems. (CRG, 2002) The goal is to provide a single, low-bandwidth, multi-purpose interface that allows the delivery of distributed education in both asynchronous and synchronous modes. CRG is working towards combining collaborative tools (audio, chat, overheads, white boards, etc), unified communications (e-mail, conferences, etc), and 3D environments such that it increases discourse and engaged learning. The presentation of the NASA Mars global topographic data demonstrates the ability to scale the system from a single classroom to an entire planet. The portal-based 3D presentation system provides for just-in-time display of information. This allows the over 2Gigabytes of MOLA data to be presented just as the user needs it to be displayed, allowing Internet connected users on as low as a dialup connection to access the world information. The elements of collaboration are then woven into the data presentation to allow students to work in the environment to achieve goals and learning. This will be discussed later in the paper.

Mars Online Project

The first step was to take the MOLA dataset and break it into portals, which are the basic building objects of the CRG 3D online system. The MOLA dataset represents some 600 million entries giving longitude, latitude, and elevation in 0.463km increments in long sequential lines of data representing sweeps of the MOLA package as it made orbital passes over the surface of Mars. Each portal is created from 64x64 data points creating a 29.623km square surface by portal (0.463km * 64 = 29.623sqr km). The 600 million entries generates a little over a 2 Gigabyte database of portal and related group information. Table 1 shows the basic information that was generated by this approach.

Table 1: CRG Mars Online Project Specifications (Created Realities Group, 2002)

Portals:
- 253,440 contiguous portals
- (352 portals NS x 720 portals EW)

Portal Size Representations:
- Single Portal: 29.632 km square
- Next 9 High-Res: 88.896 km square
- Next 16 Low-Res: 148.16 km square

Maximum Visible Distance: 88.896 km
Portal Coverage of Mars: 97.777%
Travel Speed: Approx 2700kph
Total Visible: 25 portals
Database: 12 million group links entries

This allows a user to login into the server and visit any location of the planet Mars that is available in the map data. The following figures are screen shots from the client.

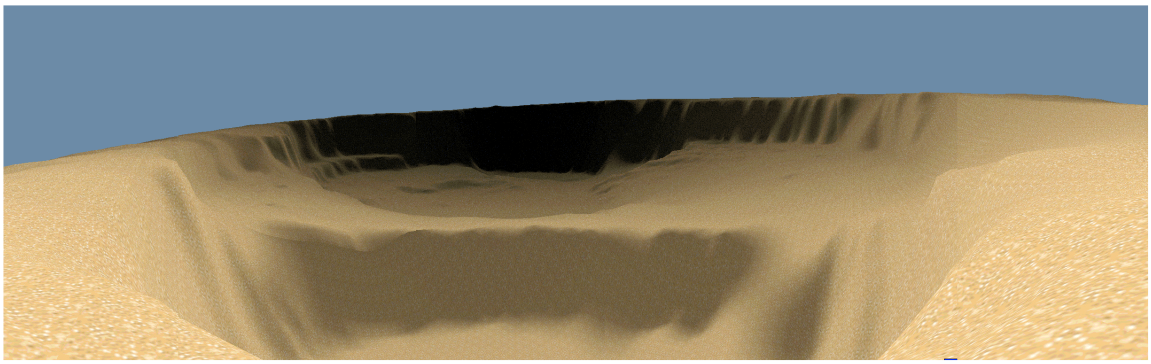
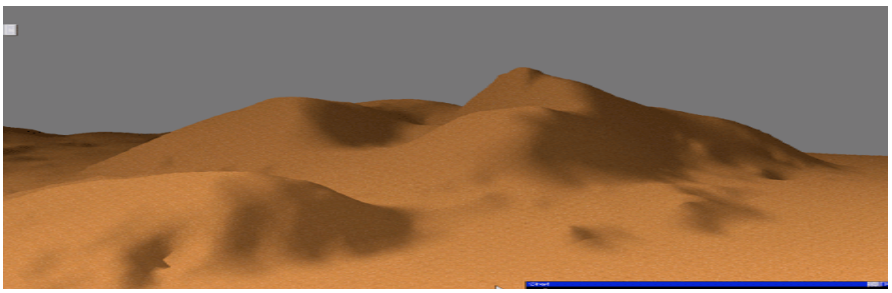


Figure 4 - Panorama Shot of Olympus Mons, Top Cone (MARS_19.0_227.0).



Nicholson crater central peaks (MARS_0.5_195.0).

Conclusion

We are currently working to develop several client widgets that can be used towards the Texas Essential Skills (TEKS) in the areas of 5th grade math and science. The concepts of measuring and scientific investigation can be placed into the Mars environment in order for the students to explore and learn together while completing these essential skills. The potential of taking scientific data and allowing students access to it in a collaborative settings allows new methods of engagement to be employed across many areas of the curriculum.

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