

## **Creating an Immersive Mars Experience Using Unity3D**

Sarah Miles

Mentors: Victor Luo & Alex Menzies

Jet Propulsion Laboratory

California Institute of Technology

Between the two Mars Exploration Rovers, Spirit and Opportunity, NASA has collected over 280,000 images while studying the Martian surface. This number will continue to grow, with Opportunity continuing to send images and with another rover, Curiosity, launching soon. Using data collected by and for these Mars rovers, I am contributing to the creation of virtual experiences that will expose the general public to Mars. These experiences not only work to increase public knowledge, but they attempt to do so in an engaging manner more conducive to knowledge retention by letting others view Mars through the rovers' eyes. My contributions include supporting image viewing (for example, allowing users to click on panoramic images of the Martian surface to access closer range photos) as well as enabling tagging of points of interest. By creating a more interactive way of viewing the information we have about Mars, we are not just educating the public about a neighboring planet. We are showing the importance of doing such research.

## **Introduction**

NASA's current vision has three components: understanding and protecting Earth, exploring the universe, and inspiring the next generation of engineers. Under the third component, NASA has been directed to motivate students to continue pursuing science, technology, engineering, and math (STEM) careers; to provide educators with tools for engaging students in STEM material; to improve the nation's scientific literacy; and to engage the public in NASA's exploration and discovery efforts. My work this summer was in support of this particular component by utilizing Martian data for outreach.

Mars provides a great data set to work with for multiple reasons. Firstly, we already have large volumes of information on it. For example, the two Mars Exploration Rovers (Spirit and Opportunity) have collected over 280,000 images since their launch in 2003. We have information on the paths taken, problems encountered, and conclusions reached. All of these pieces of information can be combined to give the public a very detailed picture of the work conducted by the MER rovers.

Secondly, we're continuing to collect information on Mars. While Spirit is no longer transmitting data back to Earth, Opportunity continues to reach out with new discoveries. Additionally, NASA plans to launch another Mars rover, Curiosity, in late 2011. With Opportunity and Curiosity sending more information back to Earth, we'll continue expanding on the amount of information known about Mars. And with the current president calling for NASA to send explorers to Mars by the 2030s, this information base will become of greater use in future years.

Using data collected by and for these Mars rovers, I contributed to the creation of virtual experiences designed to expose the general public to Mars. These experiences not only work to

increase scientific literacy, but they attempt to do so in an engaging manner more conducive to knowledge retention, letting others view Mars through the rovers' eyes. By creating a more interactive way of viewing the information we have about Mars, we are not just educating the public about a neighboring planet. We are showing the importance of doing such research.

### **Goals and Purposes of Project**

At JPL, NASA Mars Outreach wanted a way incorporate panoramic images collected by the Mars rovers into their currently existing or currently being developed projects, with plans to create a pipeline for getting data from Curiosity added on a daily basis, so people can track its progress. Another intern and I were recruited through our positions with the Planning Software Systems group to help develop this new experience, using currently existing data on Opportunity. The work we were assigned can be divided into two main components: panoramic image viewing and manipulating, and more detailed exploration of the area.

The Mars Outreach team's vision for this new experience was to create 'bubble worlds' out of the panoramic images, one bubble world per panoramic image. Within each bubble world, users can rotate around to view the geography of Mars, with points of interest labeled where users can access more information (photos, captions, et cetera). The desired result can be envisioned as a Google Street View of Mars.

While my partner focused more on the panoramic images (viewing each image, loading remote content to populate the images, and transitioning between images), I focused on the ways various types of users (administrators versus the general public) could interact with the additional information available within each bubble world.

In order to develop these features, an iterative development process was used. We'd create examples of various aspects of the experience and demonstrate our work at weekly

meetings. From feedback gained at these meetings, we'd update our previously developed code and would learn of new features to implement.

### **My Contributions**

The main focus of my internship has been developing intuitive ways for users to interact with the additional data available within each of the bubble worlds. Most of the features I've added have undergone multiple changes throughout the development process.

The earliest feature I worked on within this project was indicating on the panoramic images where users could click to access more photos (ie, perhaps the rover took a rock sample of a rock within the current image). Working with a team member, we came up with icons to display on the map, paired with text labels, to show where users can click.



**Figure 1: Image Indicator, Stage 1**

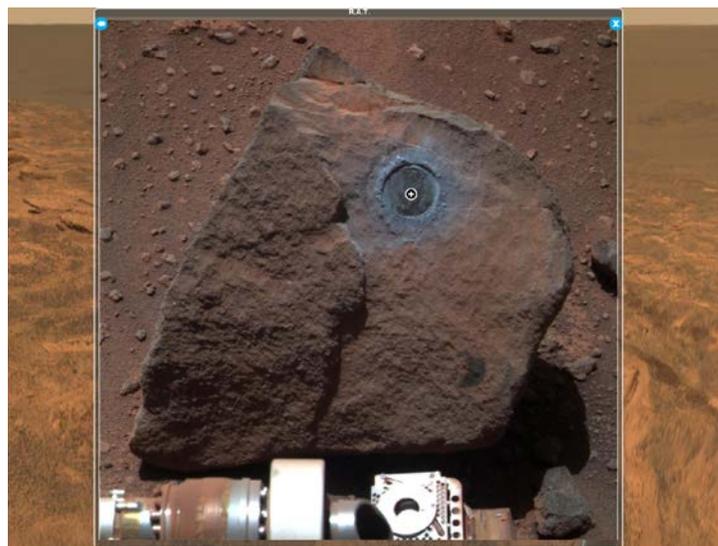
Next, I worked on how to display the images that were linked to these icons. In the most recent version of this code, clicking on an image indicator pops up a window on the screen with the matching image displayed. Users can have multiple windows open, and they can drag the images around on the screen to organize them as they see fit. Each window features a caption and buttons (i.e., arrows and close symbols) drawn when appropriate for users to navigate. The

windows also feature plus icons for users to click on if a closer, more detailed image of the present photo exists (called ‘drilldown’).



**Figure 2: Image Displays**

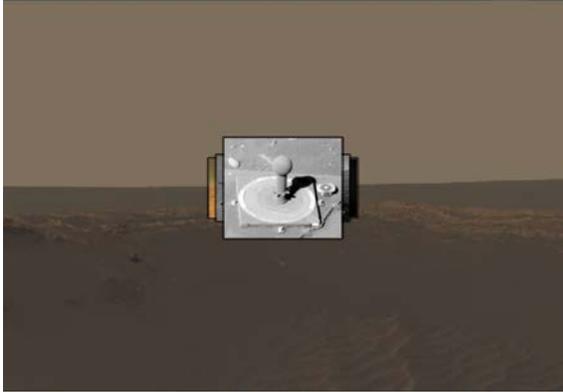
Because drilldown images were to be expected, I next wrote code to handle the drilldown. Whenever users see a plus icon in a window, they can click to transition to the next highest detailed image in the set, with the ability to navigate backwards to previously seen images in the drilldown. For example, if we click on the plus in the Burns Cliff window from Figure 2, we transition to the display in Figure 3.



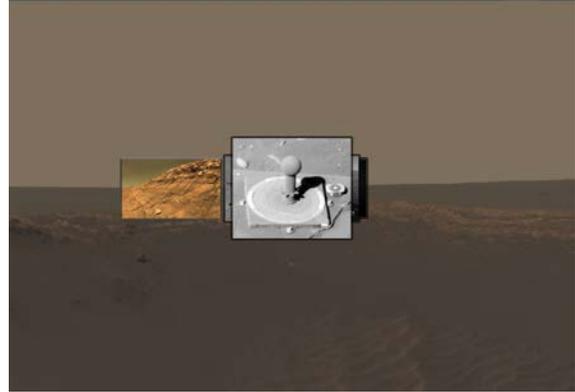
**Figure 3: Image Drilldown**

After getting basic functionality for image indicators, windows, and drilldown working, I began working on making setting up the drilldown more intuitive. In my first versions of the code, drilldown photos were hardcoded. If a photo was to be next in the drilldown, that photo would have to be assigned to its parent. Also, the positioning of the plus icons to indicate drilldown was done by guess and check work. To make both of these easier, I modified my first code version so that image drilldown relied on hierarchies of images. If a photo should be accessible via another, it should exist as a child of that photo. Unity provided code to grab child elements, which made such organization seem a good choice. To help aid in placement, I added a debug tool which, when activated, would indicate the position a mouse was hovering over within the windows. This coordinate information could then be plugged in for placing icons to indicate drilldown.

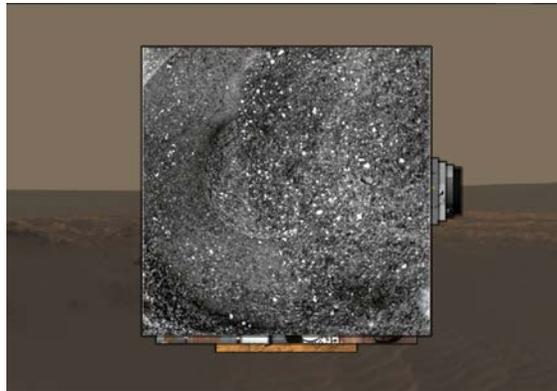
More recently, I built upon the code used to show images to create a slideshow feature. Users can click to enter slideshow mode, which displays all images within the panoramic image for easy browsing (see Figure 4). Hovering over a partially obstructed slide causes it to slide out temporarily to view its entirety (see Figure 5). Clicking on a partially obstructed slide bring it to the front and centers it on the screen. When a slide is front and center, users have the option to initiate drilldown again, which pushes earlier slides in the drilldown below the current slide (see Figure 6). These features have been tabled for now, as Mars Outreach would prefer a format for sequentially viewing images, so that a story can be told. Slight modifications have been made to incorporate this requirement.



**Figure 4: Slideshow Mode**



**Figure 5: Hover Over Animations**



**Figure 6: Slideshow Drilldown**

On top of these features, I've implemented a basic login screen for administrators to validate their sessions (see Figures 7 and 8). By creating a login for these users, more control is possible over who can add tags to the panoramas. In future work, the login screen can tie into storage elsewhere to allow for multiple user names and passwords; for now though, it simply checks against one user name/password combination that are hard coded in the login script.

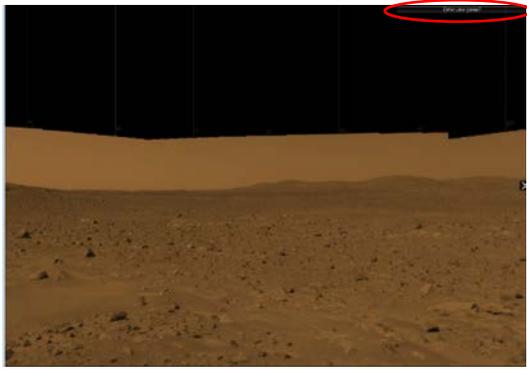


Figure 7: Administrative Login Button

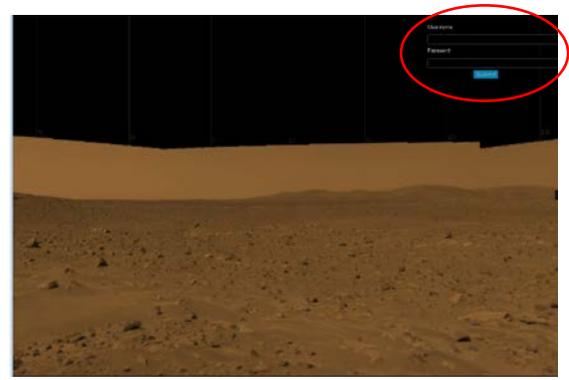


Figure 8: Administrative Login Screen, After Hovering Over Button

### Impact of Internship on Career Goals

As a recent college graduate with a full time job as a program manager lined up, this summer's internship had a larger impact on skills necessary for joining the workforce than my future plans. I still plan to work in a private sector technology position, and I still plan to pursue a graduate degree in psychology or human-computer interaction after working for a few years. The internship served as a valuable stepping stone between collegiate work and what I can expect when I start my job. Firstly, this summer's work was done in a much more collaborative environment than I typically encountered in my college coursework. Instead of working individually, with others having little to no impact on the final product, I worked closely with another intern on our particular aspect of the project and alongside multiple full-time employees, both technical and nontechnical, over the course of the summer. My upcoming employment will involve communicating with both technical and nontechnical people, as the job requires analyzing data collected from users to determine what is wanted and how to implement it to satisfy customers. The position is very customer oriented, and in order to produce a product that will make the most people happy, it requires drawing from a wide range of resources.

More importantly though, this summer's internship has been much more like what I'll encounter in the real world in that it uses a more iterative design approach. Instead of the

collegiate system of doing a task, submitting it, and moving on to the next one, a product isn't necessarily done once it's been released to the public, nor is it typically accomplished in one shot. Designs and specifications take multiple iterations of looking at what consumers want versus what will be most cost efficient to implement and how consumers interact with mock-ups of proposed new features. Additionally, once a feature gets released, a larger group of people are exposed to it and provide feedback for changes in later releases. Because this summer has used an iterative design process while collaborating with employees working on Mars public outreach, I'm better prepared for such an environment.

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