CLICKWORKERS INTERACTIVE: TOWARDS A ROBUST CROWDSOURCING TOOL FOR COLLECTING SCIENTIFIC DATA. S. T. Ishikawa[1] and V. C. Gulick[2], [1]NASA Ames/University of California Santa Cruz (Sascha.T.Ishikawa@nasa.gov), [2]NASA Ames/SETI Institute (Virginia.C.Gulick@nasa.gov).

Introduction: Our initial work, a pilot study known as Mars Clickworkers [1] demonstrated that ordinary citizens are interested in participating in the data analysis process and are able to identify and mark impact craters in orbital images of the surface of Mars to rapidly build accurate crater databases. Our more recent work, HiRISE Clickworkers [2-5] showed that the public was willing and able to identify and mark a variety of geologic features in both HiRISE and MOC images. These features included boulders, channels, craters, dustdevils, windstreaks, dunes, gullies, lava flows, and patterned ground. In our new website, Clickworkers Interactive, users, who include students, educators, science and space enthusiasts and other members of the interested public, will have opportunities to not only identify a variety of geologic features but will also be able to collectively generate geologic feature databases. Clickworkers Interactive builds on the original concept of Clickworkers by providing a scalable platform that both the public and scientist alike can use to collect scientifically useful data.

The delegation of such large-scale tasks to the public, now called *crowdsourcing* or *citizen science*, has recently become quite popular. More importantly, it has proven to be very useful for solving a continuously growing set of problems that require 1) the uniqueness of human intuition and its complex visual system, and 2) a large workforce that operates in parallel to perform tasks that would take individuals an impractical amount of time to complete.

To address this, we developed a set of annotation tools that can be combined and/or modified with relative ease to accommodate a number of large-scale annotation tasks. Our work is part of an ongoing effort to undertake a multitude of tasks not just limited to the analysis of HiRISE, MOC or Viking orbiter Mars images. Instead, our goal is to use Clickworkers Interactive to perform crowd-based analysis of a variety of image datasets where automatic, i.e. non-human, annotation is not yet possible.

Technical Description: Clickworkers Interactive consists of 1) the website where clickworkers interact with various web-based applications that enable them to simply and easily perform accurate measurements and annotations, for example, stamping "boulders," or measuring the dimensions of "gullies"; 2) a MySQL database that stores all the user-generated data; and 3) a PHP back-end that transparently connects the applications to the database and a data set consisting of a large number of images in any web-safe format such as JPEG, GIF, or PNG.

The web applications make use of ProcessingJS, a Javascript library that we used to interactively collect and visualize data.

Annotation Tools: Clickworkers Interactive has a collection of annotation tools that can serve as building blocks to complete most tasks. The *stamp tool* places stamps that act as digital pushpins on the martian terrain and are used to identify the approximate location of landforms. It is an intuitively simple tool, but serves the crucial role of cataloging landforms. Thousands of clickworkers using the stamp tool provide a point-distribution (with approximate geographic coordinates) of various landforms on Mars. Once specific landforms are located they are characterized further by building additional tools to measure specific properties such as area, orientation, and density.

The remaining tools annotate entire regions (as opposed to single points) and capture spatial information. For instance, the *polygon tool* is used for tasks such as labeling a patch of dunes or an area of past lava flow by inscribing them in non-self-intersecting polygons. The *bounding box tool* can be used, for instance, to frame the entire region spanned by a gully, and requires only two clicks; the first, designates one corner of a rectangular box whose size is changed by dragging the mouse over; and the second, to complete the box by specifying the opposite diagonal corner. A *circle tool* is used to circumscribe craters by simply clicking on four points on their rim. A best-fit circle is automatically calculated after the fourth click. Lastly, a *paint brush tool* is used to "free hand" areas by coloring them much like a brush or pencil. This is used to color-in regions on the terrain that require a finer touch.

Other Tools: An *image enhancement tool* was developed to improve the contrast on HiRISE and other Mars images. For example, this tool helps take advantage of the high dynamic range of HiRISE images by providing users a way to manually adjust the image contrast within the browser window. It is particularly helpful in revealing surface features in low contrast images or in shadowed areas (e.g. a crater gully covered by a shadow) or more details in regions of high albedo (for example, where frost or ice is present). Changing the contrast is accomplished via a graphical interface within the browser environment, namely by dragging two sliders to specify the allowed maximum and minimum pixel intensity values. The pixels in the

Figure 1. Screenshot of clickworker performing gully measurements.

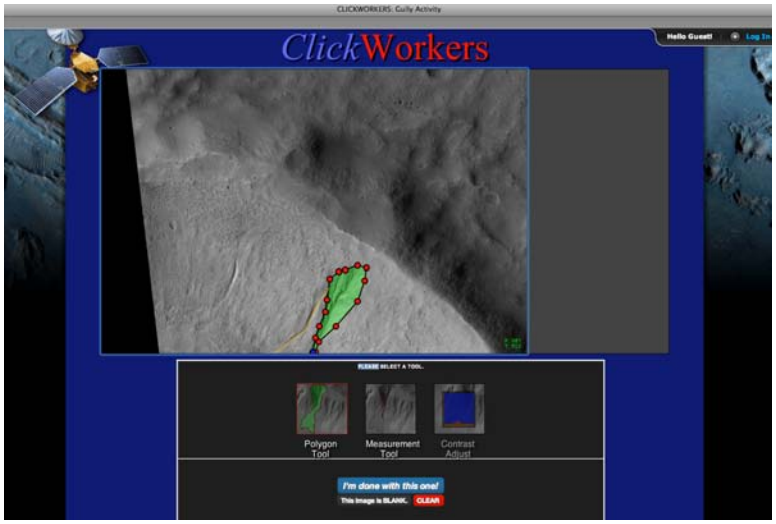

image are normalized to the new range and features that were once hidden may be seen.

Additional tools were developed to visualize the work done by clickworkers and provide encouraging feedback and statistics. Examples of these include a pie chart indicating the distribution of landforms catalogued to-date and a location map that flashes a point indicating the position of the current image relative to the global map of Mars.

Measuring Gullies (an example): Our previous work **[2-5]** showed that we were able to recruit enough volunteers to catalog landforms in HiRISE images. Using Clickworkers Interactive we have implemented a web application (see Figure 1) that we can use, not only to catalog gullies, but also to measure the shapes, location, orientation and size of various geologic features being cataloged. The process is described as follows: First, we search the database for existing entries containing “gullies,” for example. Next, we present these images to a group of clickworkers that have received brief online training sessions on the task at hand. Then the clickworkers annotate and record specific measurements via our online tools and submit their work. This work is then compared and validated by comparing results on the same images with other clickworkers, a method that has been successful in our previous work on validating crater data.

We determined that in order to adequately characterize gullies we need to be able to measure 1) the channel lengths, 2) the drainage area occupied by the gully, 3) the area of any resulting debris aprons and 4) the orientation 5) latitude and longitude and 6) comments about the setting.

We were able to implement most of this by using the Clickworkers Interactive tools: the polygon tool was used to delineate various parts of the gully including the alcove, channel, and the debris apron and a length tool was created with ease by making a few modifications to the polygon tool; instead of clicking on the first point to close the polygon you double-click on the final point of any line segment representing the length of the channel. Other important information is derived by post-processing the data. For example, the general orientation of the gully can be determined by computing the angle of a best-fit line passing through the points obtained from the length tool.

References: [1] Kanefsky, B., Barlow, N., and Gulick, V. LPSC XXXII, Abstract #1272, [2] V.C. Gulick, G. Deardorff, B. Kanefsky, and A. Davatzes. LPSC XXXVIII Abstract #2248. [3] Gulick, V. C., Deardorff, G., Kanefsky, B., HiRISE Science Team 2010. Online Citizen Science with Clickworkers MRO HiRISE E/PO. AGU Fall Meeting Abstracts 8. [4] Gulick, G. 2009. Opportunities in Participatory Science and Citizen Science with MRO's High Resolution Imaging Science Experiment: A Virtual Science Team Experience. AAS/Division for Planetary Sciences Meeting Abstracts #41 41, #41.03. [5] Gulick, V. C., Deardorff, G., Kanefsky, B., Davatzes, A. 2007. Student and Public Participation in Acquiring and Analyzing HiRISE Images. Lunar and Planetary Institute Science Conference Abstracts 38, 2248.

Figure 2: Stamp tool marking gullies.