

Additional File 3: Scripts

High rate acquisition scripts

Script H1: Check to make sure Mikrospec RT-Multi is running

The Mikrospec RT-Multi software occasionally loses the camera connection and abruptly exits, terminating acquisition. This Matlab script checks the acquisition folder to check the time of the most recent image. If the image is more than 2 minutes old, the script assumes the RT Multi software has failed and runs a DOS command to restart the software. Restarting the Mikrospec software is also performed, more rapidly, by a third-party piece of software called PTFB (Push the Freakin' Button; <http://www.ptfbpro.com>). This software detects when the camera connection error window appears and automatically runs the Matlab script that restarts Mikrospec. In addition to checking data flow, this script takes one image per minute for the previous five minutes, and exports these images to JPEG format. The script constructs the JPEG images from the binary files, and stamps the camera name and date-time in the corner. These five JPEG images are transferred using Robocopy (bundled with Microsoft Windows Server 2008 and Windows 7; also available for download at <http://www.microsoft.com>) to our internal webserver computer, which displays the images on the internal and public webpages.

Script H2: Run scripts H2a-d

This script simply runs the following four scripts (2a-d) in the proper order.

Script H2a: Move image files from local to temporary directory for analysis

This script takes the images from the acquisition directory and moves them to a temporary folder for subsequent analysis. The temporary folder is essential because the analysis takes a finite amount of time, during which more images will be added to the acquisition directory.

Script H2b: Measure lava level

This script analyzes the previous hour of images to track lava level. For each image, the script applies a quality control test using the overall maximum temperature in the image. If the maximum temperature is below some threshold, it is assumed that the image is very "fummy", which results in the thermal contrast being muted, and the image is ignored. For images which do pass the quality control test, a customized segmentation routine isolates the lava lake and measures the pixel position of the lake against the back crater wall. This lava level result is output as pixels only, and written to an hourly text file.

Script H2c: Measure crust velocity

This script goes through the previous hour of images, and measures the distance traveled by lava on the surface of the Halema'uma'u lava lake between the current image and the image five images previous. Because image acquisition is one image per five seconds, this corresponds to a time difference of about 25 seconds. The algorithm takes a single window from the center of the lake surface and performs 2D cross correlation with a subsequent image to determine pixel offset over the time span.

Script H2d: Archive images in date folders

Once the analysis of images in the temporary folder is complete, this script moves the image files to archive folders that are based on 1) camera name, 2) year, 3) month, 4) day and 5) hour.

Script H3: Make composite image

Composite images are a stack of images acquired over the previous day. The composite image represents the maximum, not average, value recorded within a given pixel position over the past 24 hours. This approach is essentially the same as that described in Patrick et al. (2010) for normal webcam images, with two exceptions. First, the thermal composite script is run over the complete 24 hours, whereas the webcam composite script is only run over nighttime hours (to show incandescence). Second, the thermal composite script calculates using calibrated temperature values, not RGB colors. The script is run at 6 am so that the daily activity update, which generally is completed by 9 am, has a timely depiction of the last 24 hours. When completed, the composite image is transferred to the internal webserver by Robocopy.

Script H4: Write data to VALVE

This script takes the lava lake level data calculated by Script 2b and writes it to a specially formatted text file that can be ingested by VALVE. VALVE is a web-based program that allows display of many different monitoring datasets together (Cervelli et al. 2002), and is a primary tool for HVO scientists to view monitoring data.

Script H5: Check hard disk space

This script simply determines how much available disk space there is each day. If the amount of free space is less than 3 Gb (amount to about one day of data space left), a text message is sent warning the user that the disk is getting full. Avoiding a full disk is important because acquisition ceases when the disk is full.

Low rate acquisition scripts

Script L1: Acquire single image, make html image, and archive

This is the master script for the low rate acquisition. It first pings the camera to “wake” it, and then runs the Visual BASIC .NET program (Script L1b) that actually connects to the camera and pulls an image. Once the binary image is acquired, the script renames the image, creates a JPEG image from the binary data and transfers the JPEG via Robocopy to the internal webserver. Finally, the images (both the binary and JPEG versions) are transferred to date-based folders (year-month-day-hour) for archiving. This script pulls one binary image only and exits; the image acquisition frequency is determined by how often this script is run by Windows Scheduler.

Script L1b: Connect to camera and acquire single binary image

We were not successful in using Matlab to directly access the Mikron Active X COM control, so we used this Visual BASIC .NET program to run it. This small program runs the Active X controls that connect to the camera, set the camera lens type, and pulls the binary image from the camera. Additional processing of the image is performed by the Matlab Script 4 above.

Script L2: Track temperature trends

This script does simple plots of temperature data through time. It begins by finding the time of the last analyzed image and starting there. For all images since that last image, the script measures several things: 1) maximum temperature, 2) mean temperature, 3) percent of image >50 °C, 4) percent of image >100 °C, 5) percent of image >200 °C, 6) percent of image >300 °C, and 7) percent of image >400 °C. These measurements are only applied to pixels below the horizon, to avoid false alarms triggered by the sun. The measurements which show percent of the image over some threshold temperature are meant to depict the area of anomalously hot material in the image. For instance, if a lava flow is erupted onto the floor of Pu'u Ō'ō cone, the area of the image above these high temperature threshold will increase, thus providing a proxy for area of the active flow through time.

Script L3: Alarm if anomalous temperatures detected

This alarm program is applied to the ETcam and WTcam cameras, which are stationed on Pu'u Ō'ō cone looking out east and west of Pu'u Ō'ō. Normally, temperature are near background in these images, and this alarm is meant to provide a rapid indication of any new activity (e.g. a new vent) around Pu'u Ō'ō cone. The alarm uses a simple temperature threshold of 120 °C. When this threshold is exceeded, a text message is sent out to appropriate HVO monitoring staff.

Script L4: Kill Matlab sessions that have hung up

Occasionally, if some scripts fail the Matlab program will not exit, and if this happens numerous times there will be many instances of Matlab that can slow the computer to a standstill and stall acquisition. Therefore, this script runs once a day and kills all Matlab acquisitions. Although proper Matlab scripting and error handling should avoid this problem, this kill script is a fail-safe to avoid the computer freezing up.

Script L5: Make composite image

As described for Script H3, composite images are a stack of images acquired over the previous day. The script is run at 6 am so that the daily activity update, which generally is completed by 9 am, has a timely depiction of the last 24 hours.

Script L6: Cycle power on thermal camera power relay

We have observed that the cameras running the low rate acquisition occasionally seize, and stop acquisition. The origin of this problem is unknown, but it usually appears after 1-1.5 weeks if left unattended. Cycling the power on the camera always solves this problem and restores acquisitions, and this script simply preemptively cycles the power. The script runs a WGET command, which issues an HTTP address that interfaces with the power relay unit to cycle the power connection.

Script L7: Send email notification if acquisition stalls

This script simply looks at the acquisition directories and gets the time of the last image. If this most recent image is more than an hour old, the script sends an email to various users to notify them that acquisition has stalled.